Final Report

JICA/CRI Joint Study Project on

INTEGRATED WATERSHED MANAGEMENT OF INLAND VALLEYS IN GHANA AND WEST AFRICA

------ Eco-technology Approach ------

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JICA/CRI Joint Study project on Integrated Watershed Management of Inland Valleys in Ghana and West Africa ----Eco-technology Approach----

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(2) 5 December 1997, JICA NEWS No. 295 (in Japanese)
(3) 3 – 6 February 1998, FAO Multilateral Cooperation Workshops for Sustainable Agriculture, Forestry and Fisheries Development, Tokyo, Japan
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Executive summary: Eco-technology approach to sustainable Sawah development in Inland Valleys

1 Abstract: Major Results and Recommendations

1-1 Background

Traditionally various farming systems are mainly uplands including rice in Ghana and West Africa. Lowland utilization is still frontiers for future development. Since the development of upland farming consumes forests, vast areas of forests have disappeared and soils are deteriorating. Even good varieties such as NERICA, new rice in Africa from WARDA, cannot escape from this problem. Ghana has about one million hectares of sustainable lowland for sawah development, especially in numerous small inland valleys. The total potential for lowland sawah development may reach 20 million hectares in West Africa. As shown in Fig. 1, sustainable productivity of one hectare of sawah is more than ten times higher than that of upland farming because of geological fertilization of topsoils and nutrient rich water from upland in a unit watershed. Well-known positive bio-physico-chemical processes of submerged sawah soils are also important reasons. Therefore if 20 million hectares of sawah in inland valleys and flood plains are developed, not only enough rice as food will be produced but also open a space in upland for forest regeneration. Reforestation in upland enhances soil and water conservation in upland, which will further enhance the intensive sustainability of lowland sawah in a watershed. Our strategy is greening and desertification control based on the sustainable increase in food production using lowland sawah development technology.

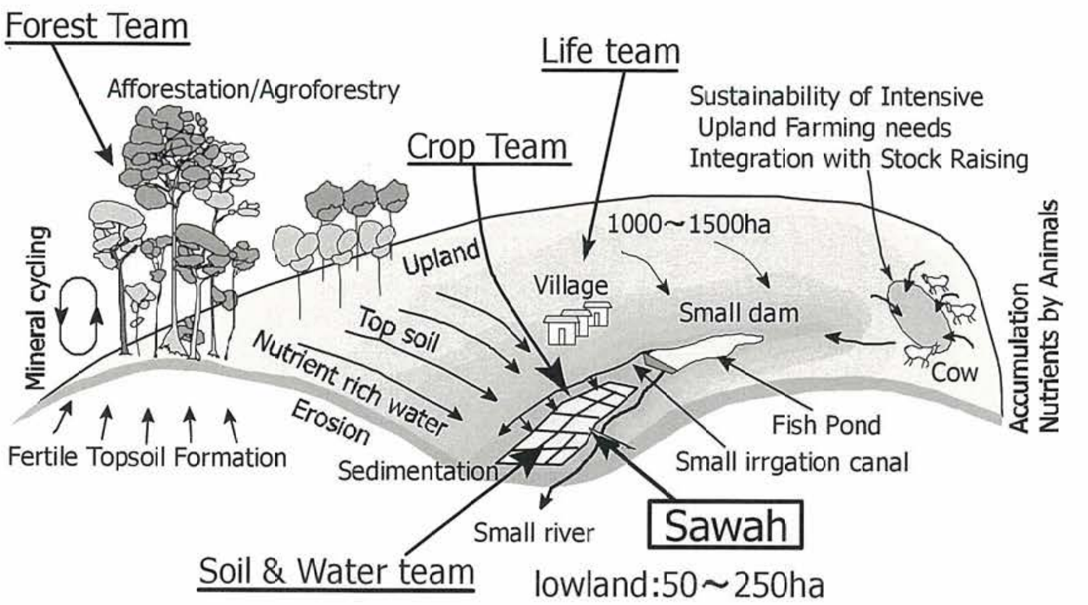


Fig. 1. Integrated Watershed Management Based on Sawah Eco-technology: Sustainable farming system in inland valley watersheds in west Africa: integration of forrest and agroforestry / animal / lowland sawah / fish farming.

1-2 Constrains for sustainable development of Irrigation Systems

In West Africa rice production increased 280% last 30 years, which is far bigger than the increase of other cereals, such as maize 170%, Sorghum 170% and Millet 150%. Never-the-less, the amount of rice import has increased. This increase of rice production basically came from the expansion of upland rice cultivation which causes destruction of forest. Sustainable and intensive lowland rice systems are what is needed and not the ecology-destructive upland rice systems. Rice production can be increased through

(1) Increase lowland irrigation area,
(2) Rehabilitation of old irrigation schemes,
(3) Increase upland rice area by further destroying the forests,
(3) Rice plant improvement for upland and
(4) Rice plant improvement for lowland irrigation conditions.

So far, for example, Ghana Irrigation Development Authorities (GIDA) has 22 irrigation projects, with total area of about 10000 hectares throughout Ghana. However it is now very difficult to build new irrigation project because of the high cost of irrigation and its apparent low net return. As shown in Table 1, a large-scale irrigation project, like Tono irrigation, is very costly. Although the total sales of produces are between 1000-1500dollars per ha, the running cost including maintenance of the systems, machinery for operation, agrochemicals for rice cultivation are very high. Due to the high construction cost, the economic return has been negligible or rather negative for a long period of time (20-30 years). Owing to various problems in large scheme, small irrigation schemes are considered more suitable to develop at present. However, with the present small irrigation schemes, the construction cost is comparable to large schemes as far as their development depends mainly on engineering work by experts. Therefore the project ownership still belongs to the government (engineers) rather than the farmers. The sustainable development of the small irrigation scheme, however, is also questionable, because of the very expensive initial construction cost. The production level of rice farmers could not compensate for the high construction cost. As described in this final report, the eco-technology approach to sustainable sawah development proposed by this joint study will be a promising new method.

Table 1.Comparision of large scale, small scale, traditional system and newly developed ecotechnology approach to sustainable irrigation development in inland valley of Ghana.

	Large Scale Development	**Small Scale Development**	**Ecotechnology Approach to Sawah Development**	**Traditional System**
Development cost per hectare	20,000-30,000 US$ per hectare	20,000-30,000 US$ per hectare	3,000-4,000 US$ per hectare	20-30 US$ per hectar
Economic returns of rice and vegetable etc	1,000-2,000 US$ per hectare	1,000-2,000 US$ per hectare	1,000-1,500 US$ per hectare	100-300 US$ per hectare
Possible income (Economic Returns)	Negative	Negative	1000 US$/ha	100-200 US$/ha
Maintenance cost for the system	High	Medium	Low	Zero
Running cost including machinary	Medium to High (300-500$/ha)	Medium to High (300-500$/ha)	Medium to High (200-300$/ha)	Low (10-20$/ha)
Farmers participation	Low	Medium	High	High
Type of famars	New migrants	Old/New migrants and indigenous	Old migrants and indigenous	Old migrants and indigenous
Project ownership	Government	Goverment/Farmer	Farmer	Farmer
Type of Technology	High input rice based agronomy including machinery	High input rice based agronomy including machinery	Sawah Ecotechnology and medium input rice based agronomy including small machinery	Low input
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	High	Medium
Environmental effect	High	Medium	Low	Medium to high

1-3 Eco-technology approach for sustainable Sawah development in Inland Valleys

During this joint study, the project tested various types of sawah systems including rainfed, pump, spring, weir and canal and integrated types (Table 2), adapting in diverse reliefs, soils and water conditions. Participated farmers groups play major role for the on-farm testing of various types eco-technologies. As described in Chapter 6, based on the various participatory on-farm experiments and evaluations on various sawah eco-technologies, the project could propose the following new eco-technology and loan based sustainable small-scale sawah development for integrated watershed management of Inland valley in Ghana and West Africa. Although following proposal is a draft, it can be improved and consolidated through continuous field practices and dialog with participating farmers.

<u>Possible funding for sawah development to make the eco-technology approach sustainable in Ghana and West Africa</u>

1, Call for sawah group formation of about 10 farmers
2, $6,000 loan for one group: breakdown
   $4,000 for power tiller
   $500 for tools for development and rice cultivation
   $500 for small pump
   $1,000 for annual running cost including fuel, spare parts, fertilizer, sand bags and pesticides
3, Provision of free technical advice, on the job training and education. Institutional backstopping to facilitate such technical advice. The development of sawah system for rice cultivation by sawah group without external assistance.
4, 1 ha of sawah development; 5ha per five years during the five years of no loan payment. During 6-11 years, loan payment with 5% interest (Note: in the case of African bank loan, no interest is necessary to pay). Total payment will be $7,050 and annual mean payment will be $1,175.
5, 1st year income will be $1,350, assuming a rice sale of $ 1100 from 3.5t/ha and dry season vegetable of $200.
6, 2-5th year: total sales will be $2.600-6,500 and running cost, $600- $1000 annually.
7, 6th year: yield will increase to 4.5t/ha; vegetable production will also increase by same rate. Then total sales will be $7,300 per group. The net income will be $5125 after paying mean annual loan, $1,175 and depositing the necessary annual running cost, $1,000. Mean annual income per each farmer will be $500 (currently about $250).
8, Continue to produce more sawah up to about 10 ha. Then annual income will be $1,000.
9. During the project period, plots of multipurpose tree species and other useful trees are enlarged. Fishponds are constructed and tilapia, catfish, etc. are cultured there.

Table 2. Cost estimation for sawah development in dollars per ha

Sawah types	Rainfed type			Pump type	Spring type	Integrated type	Dyke canal type
	Gs	Rs	B2s	As	Ns	Ps	B1s
area(ha)	0.29	0.16	0.61*	0.078	0.60*	0.62	1.22+
Based on Man.day	5,100	4,800	3,800	5,900	4,100	2,400	2,000
Based on soil movement	4,040	3,000	3,400	5,040	3,100	2,400	2,700
Mean	4,570	3,900	3,600	5,500	3,600	2,400	2,350
Machinery cost	1,080	1,080	1,080	1,080	1,080	1,080	1,080
Grand Total	5,650	4,980	4,680	6,580	4,680	3,480	3,430

*Area developed by August 2000

Note: Machinery Cost (Life Span = 5years)

1. Power tiller → $4,000/5ha → $800/ha
2. Water pump → $500/5ha → $100/ha
3. Maintenance cost is 20% of total → $900/5years → $180/ha

Total $1,080/ha

1-4 Recommendations for Sustainable Inland Valley Development

This participatory eco-technology approach to sustainable sawah development in Inland Valleys in Ghana and West Africa can make an impact on the economy of Ghana and West Africa as a whole, if the following recommendations are considered.

(1) Ghana government has plan to develop 5000ha of sawah in various parts of inland valleys in Ghana with an amounts of 20million US$ loan from Africa Development Bank (AfDB). This approach will be an option to examine.
(2) Since major investment is to buy small power tiller to develop sawah, KR-2 donation by Japanese government will be another option to integrate the eco-technology approach.
(3) Based on the results of this joint study project, it is propose to examine the possibility of new approach for the Project Type Technical Cooperation between Ghanaian/West African on one hand and Japanese government on the other.

Since the essence of the participatory eco-technology approach is a training and education program in the fields, new types of technical cooperation have to be developed to integrate the following components.

(i) Institutional backstopping to facilitate the training and education for sawah development,
(i) Integrated technical cooperation in agronomy, engineering construction, and environment,
(ii) KR-2 donation for sustainable agricultural developments,
(iii) Loan based projects of JBIC, AfDB, USAID and/or World bank, and
(iv) Asian African collaboration by examining the best power tillers and sawah development.

2 The Main Goal of the Project

The main goal of the project is the development of sustainable new production systems at whole watershed. The new systems allow intensification and diversification of the lowland farming systems and stabilizing improved production systems on the upland. Furthermore, the project will lead to the development of a tool for land use planners and decision makers for integrated watershed development. As shown in Fig. 2, the joint study was able to successfully achieve the examination of various *sawah* systems developed in the inland valley.

3 Comparison of Large Scale, Small Scale and Traditional Systems with eco-technology Based Development Systems in Ghana

Irrigated *sawah* systems were introduced into Ghana by the experts from Taiwan during the period of 1968 to 1972. So far, Ghana Irrigation Development Authorities (GIDA) has 22 irrigation projects, with total area of about 10000 hectares throughout Ghana. However it is now very difficult to build new irrigation project because of the high cost of irrigation and its apparent low net return.

As shown in Table 1, a large-scale irrigation project, like Tono irrigation, is very costly. Although the total sales of produce is between 1000-1,500 dollars per ha, the running cost including big machinery such as tractors is very high. Due to the high construction cost, the economic return has been negligible or rather negative for a long period of time (20-30 years).

Therefore in such big schemes, foreign aid is a prerequisite to the development of the system. Long-term support for maintenance and rehabilitation is necessary. Since farmers in such project areas are mainly new settlers, project ownership and participation are normally low. This makes maintenance costly and technology transfer/adoption a long process, such as the case in the Tono irrigation project. Their target technology transfer never includes the engineering aspects for irrigated sawah development. Environmental impact was also high. Although existing large irrigation system can be viewed as model irrigation scheme, their sustainable development is now impossible.

Owing to various problems outlined in large scheme described above, small irrigation schemes are considered more suitable to develop at present. However, with the present small irrigation schemes, the construction cost is comparable to large schemes as far as their development depends mainly on engineering work by experts. Therefore the project ownership still belongs to the government (engineers) rather than the farmers. The characteristics of the target technologies are similar to those of the big ones. However, because the scheme is small, technology transfer, i.e. high/medium input irrigated rice based agronomy including machinery, will be relatively easy. The sustainable development of the present small scheme, however, is questionable, because of the very expensive initial construction cost. The production level of rice farmers could not compensate for the high construction cost.

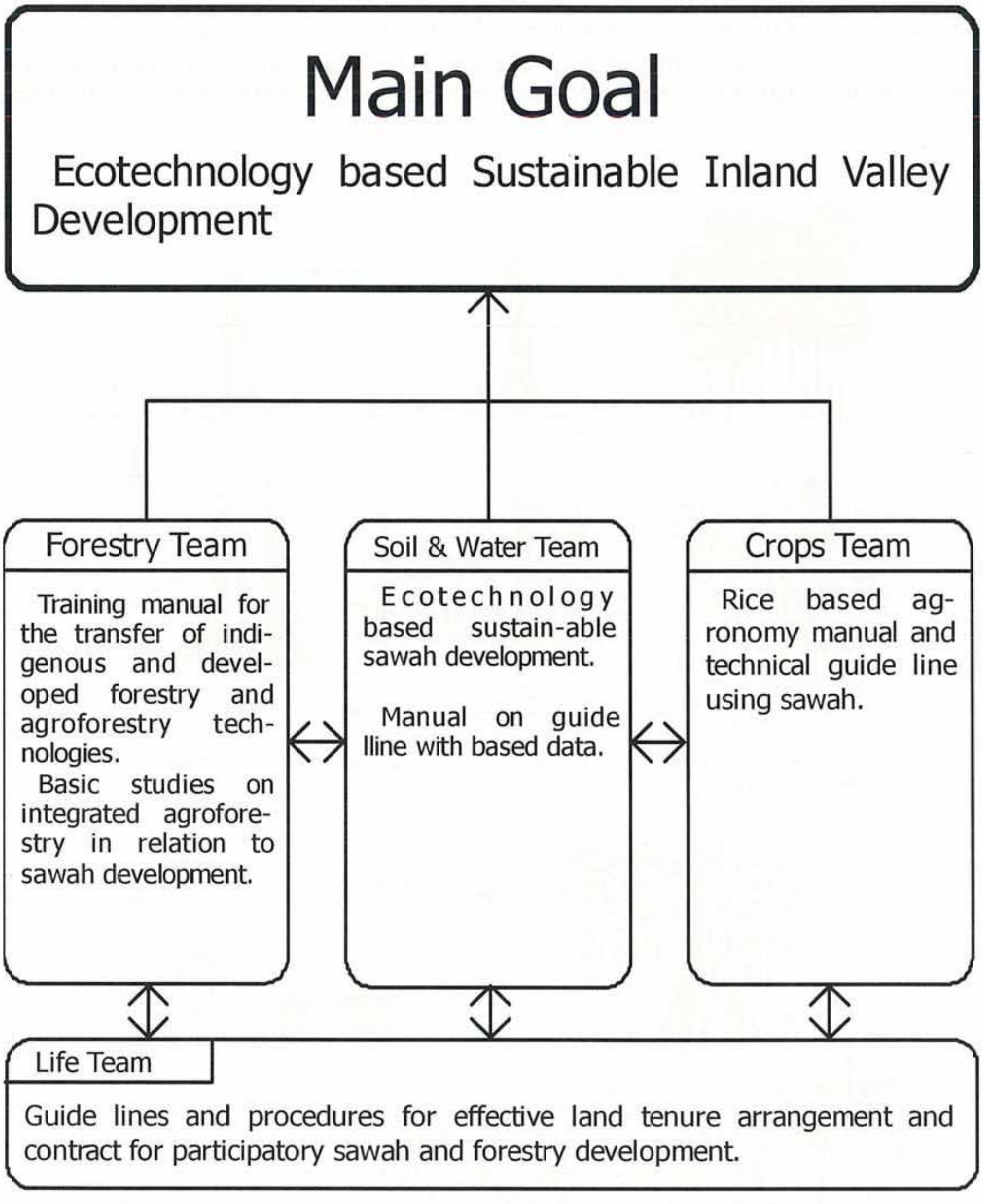


Fig. 2. Main goal of the project.

4 Forestry and Agriculture

There is an upsurge in the use of inland valleys for rice production especially in Ashanti Region. This is as a result of the rapid increase of domestic consumption. However, the sustainability of further development is rather questionable, because of very low yield (0.5 -1.0 t/ha), low economic returns, and relatively strong environmental impact. Low yield requires a larger area for cultivation, which in turn leads to the utilization of a bigger area of forest.

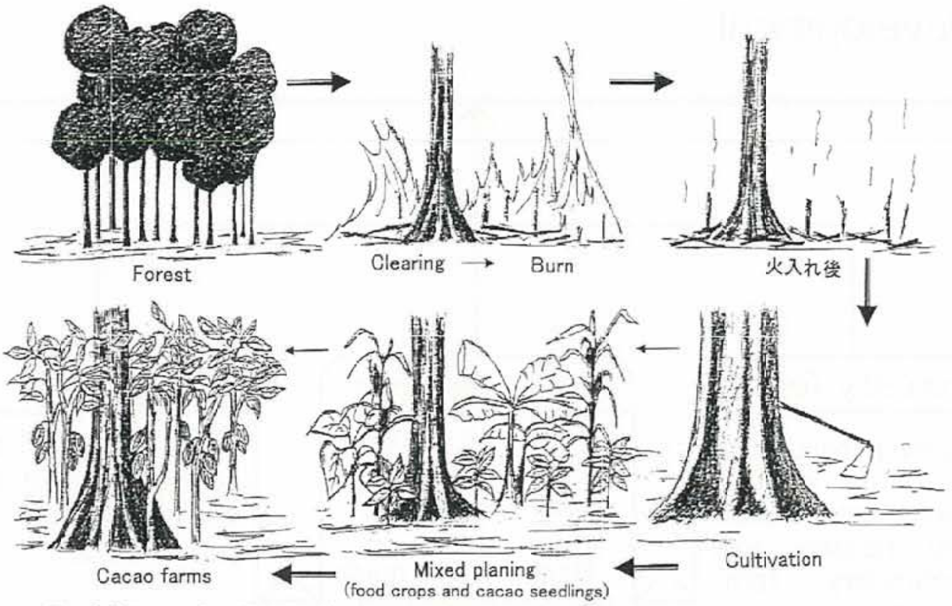


Fig. 3. (Fig. 5-16 in Chapter 5) The establishment of cacao groves in Ashanti region (The first stage).

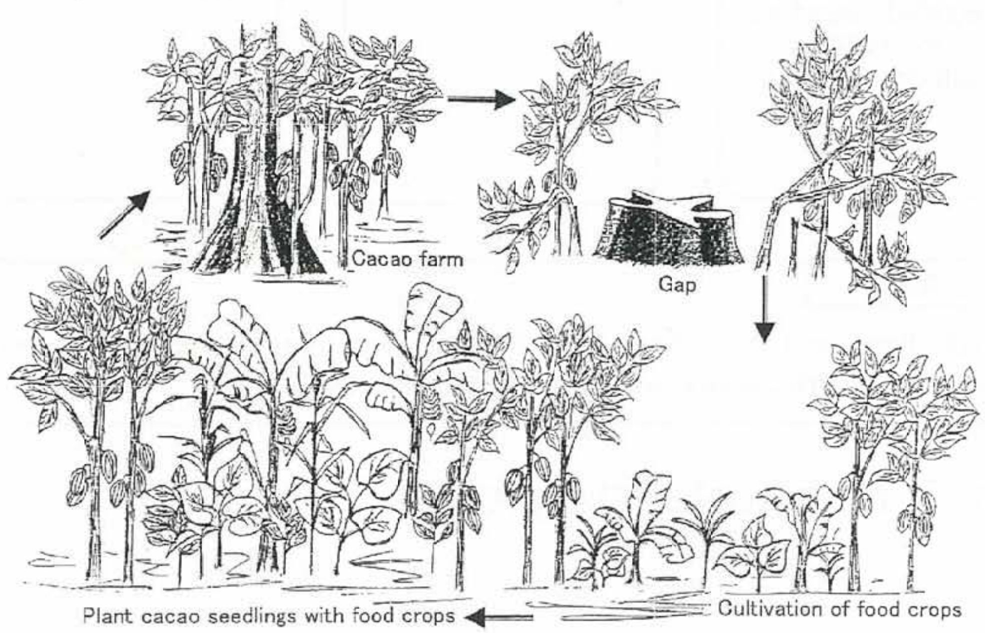


Fig. 4. (Fig. 5-17 in Chapter 5) The reform of cacao farms in Ashanti region.

As shown in Fig. 3 – 5 (Fig 5-16 – 5-18 in Chapter 5), our benchmark site has unique cocoa plantation based agroforestry systems. Fig 3 and 4 shows the new establishment and reform of cacao farm. First, farmers clear a natural forest leaving trees too big to cut down and burn the undergrowth. After burning, they plant such food crops as maize, cocoyam, cassava and plantain first and then plant young cacao trees in the spaces under these crops. As the cacao trees grow taller and begin to shade the land with branches and leaves, they stop growing food crops and the land gradually turns into cacao woods. If relatively big gaps are formed in cacao plantation, farmers grow food crops in the gaps again and plant young cacao trees between the rows of food crops. Finally, cacao woods are renewed (Figure 4). Example of land use in relatively small village of Biemteterete in our project site is shown in Fig 5, which location is shown in Fig. 6. The land surrounding near the village is used for agricultural fields, then the outer part is used for cacao farms or secondary forests.

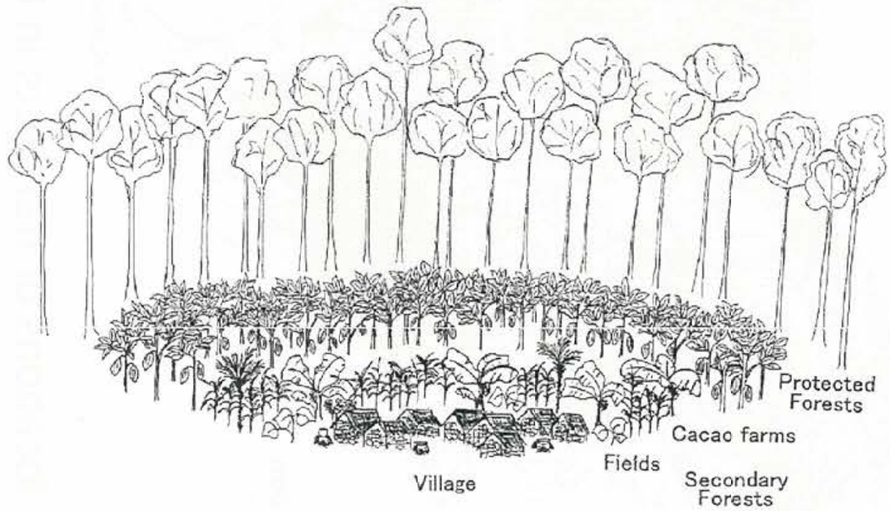


Fig. 5. (Fig. 5-18 in Chapter 5) The land use of Biemtetrete and Adujama villages.

In our project site, the area of forests, including primary and secondary forest, and cocoa plantation, is estimated only of about 30% (Fig. 6 and 7). Natural vegetation of the project site might be almost 100% forest. No bounding and leveling in the traditional systems accelerate the soil erosion, even in the valley bottom. Soil deterioration under present farming systems is clearly seen in comparison with the primary forest as shown in Fig. 8. Although, the indication of the soil degradation is not so clear between the forest and that of cocoa plantation, both upland mixed farming and lowland rice farming under traditional systems shows considerably lower soil fertility than that of primary forests.

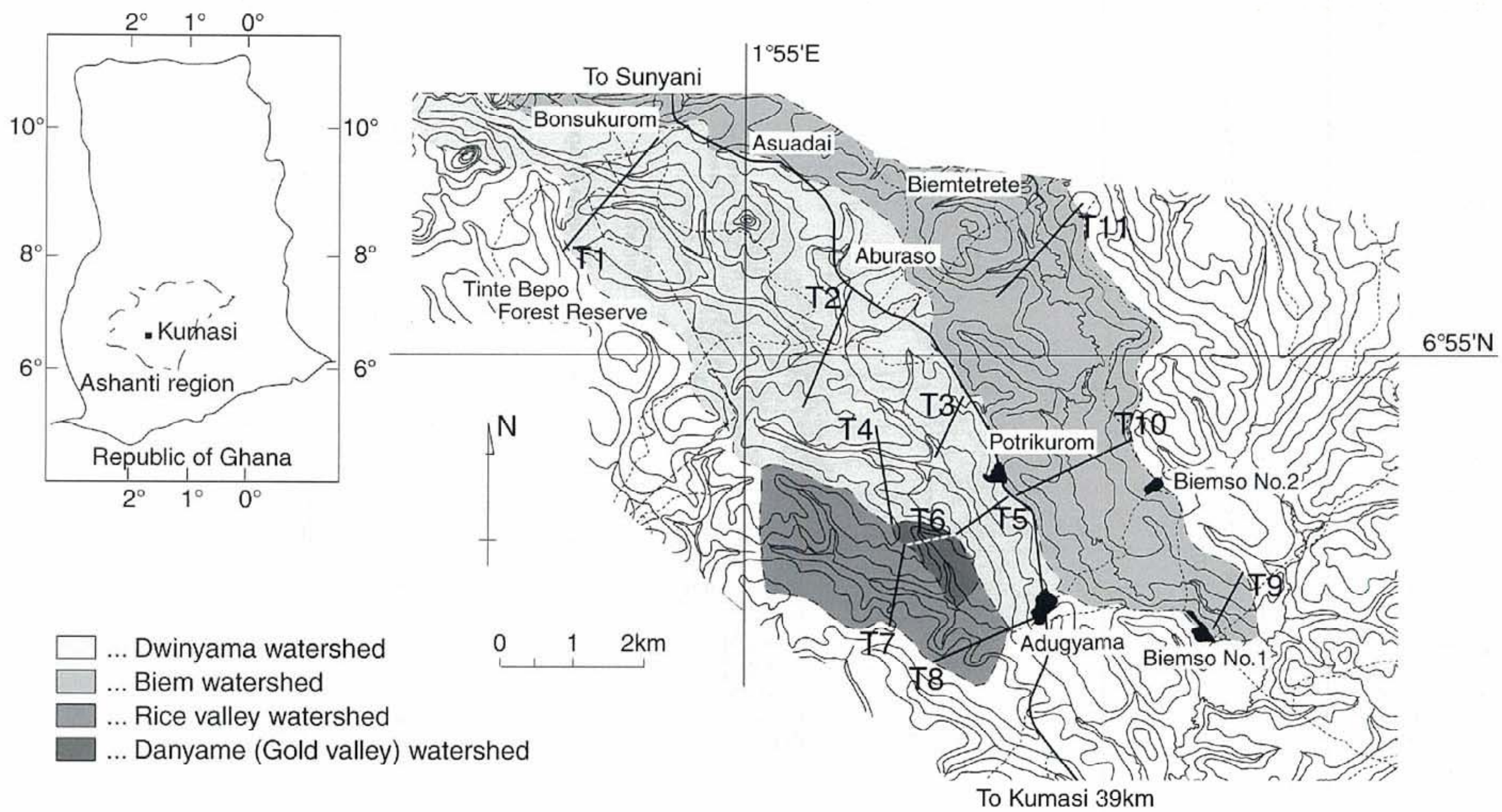


Fig. 6. Research site showing the locations of transects in the watersheds.

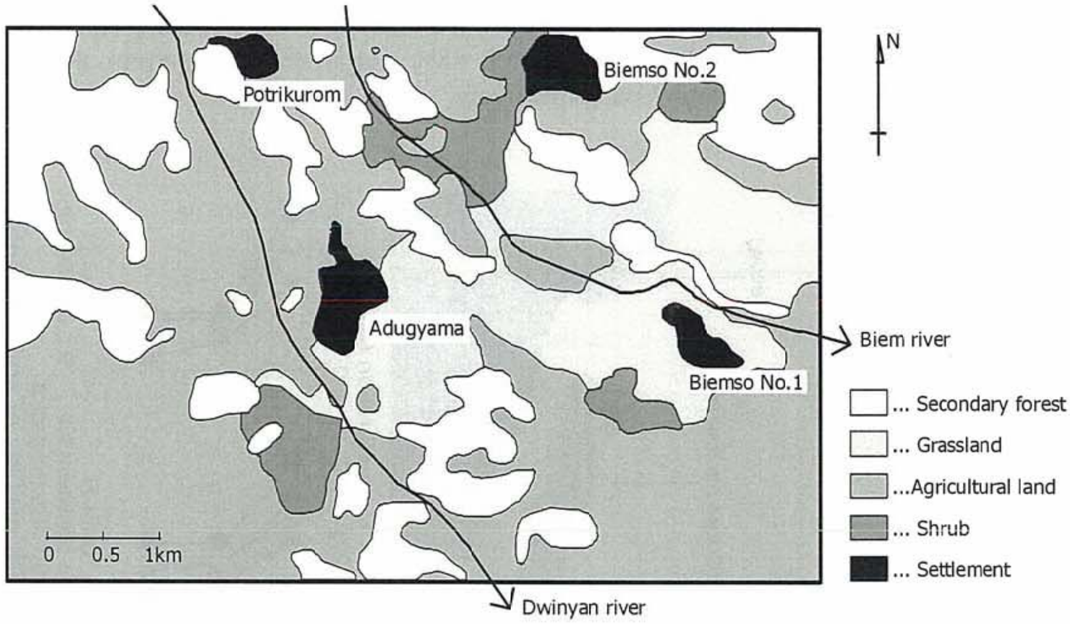


Fig. 7. Vegetation patterns in project area.

Therefore, although the major activities of forestry team was concentrated on the ecological characterization including tree species biodiversity (Fig. 9), nutrient cycling and flow in and between various land use in the project area, preliminary trials on the development of community and private nurseries, wood lots for fire and charcoal production were conducted in the benchmark site. As discussed in the Chapter 2(The Conceptual Frameworks of the Project), since sustainable productivity of 1 ha of Sawah is equivalent to more than 10 ha of upland fields, development of 1 ha of sawah open the field for the afforestation in the degraded upland field in Africa. The total potential area for new sawah development in Africa is estimated at 20 million ha. Thus if we can develop 20 million ha of sawah in the next 50-100 years, we can open an afforestation area of 200 million ha. If we can plant trees with net primary productivity of 5 ton-C/ha/year on 200 million ha, the forest can fixed one billion tons of the carbon dioxide annually in the next 50-100 years, which will roughly reduce the equivalent of 10% of the present global carbon emission. Since it is estimated that such carbon fixation can be sold for not less than 100 dollars per ton in the near future, global market price will not be less than 100 billion dollars annually.

Since the benefit described above will materialize only after a very long period of years, in this project, the forest team worked mainly to develop community and private nurseries. In the communities of Biemtetrete, the community nursery was established on a land provided by the Chief. A greater number of the residents both men and women participated. A nursery management committee was elected and it is still functioning. As at the start of the 1998 cropping season, the Biemtetrete nursery had produced 800 Cassia (*Senna siamea*), 200 Teak (*Tectona grandis*), 100 wawa (*Triplochiton scleroxylon*), 200 Pampina(*Albizi adianthhiflia*), 175 oil palm(*Elaeis guineensis*) and 2240 Cacao (*Theobroma cacao*) seedlings. By mid August 1998, the entire cacao seedling had been sold out at a price of 50 cedis per seedling whilst the oil palm seedlings were sold for 100cedis per each. However, the *Senna siamea*, *Triplochiton scleroxylon* and *Albizia adianthifolia* seedlings have not been purchased. Cocoa pods and oil palm germinated nuts have been distributed to the following communities for nursing; Biemso No.1, 500 seeds and 200 germinated nuts; Biemso No.2, 800 seeds and 200 germinated nuts;

Biemtetrete, 500 seed and 300 germinated nuts. Survival rates were Biemso No.1, 84.5% for cacao and 80% for oil palm, Biemso No.2, 88% and 56.3%, Biemtetrete, 85.'% and 80%, and Adujama, 88.5% and 70% respectively.

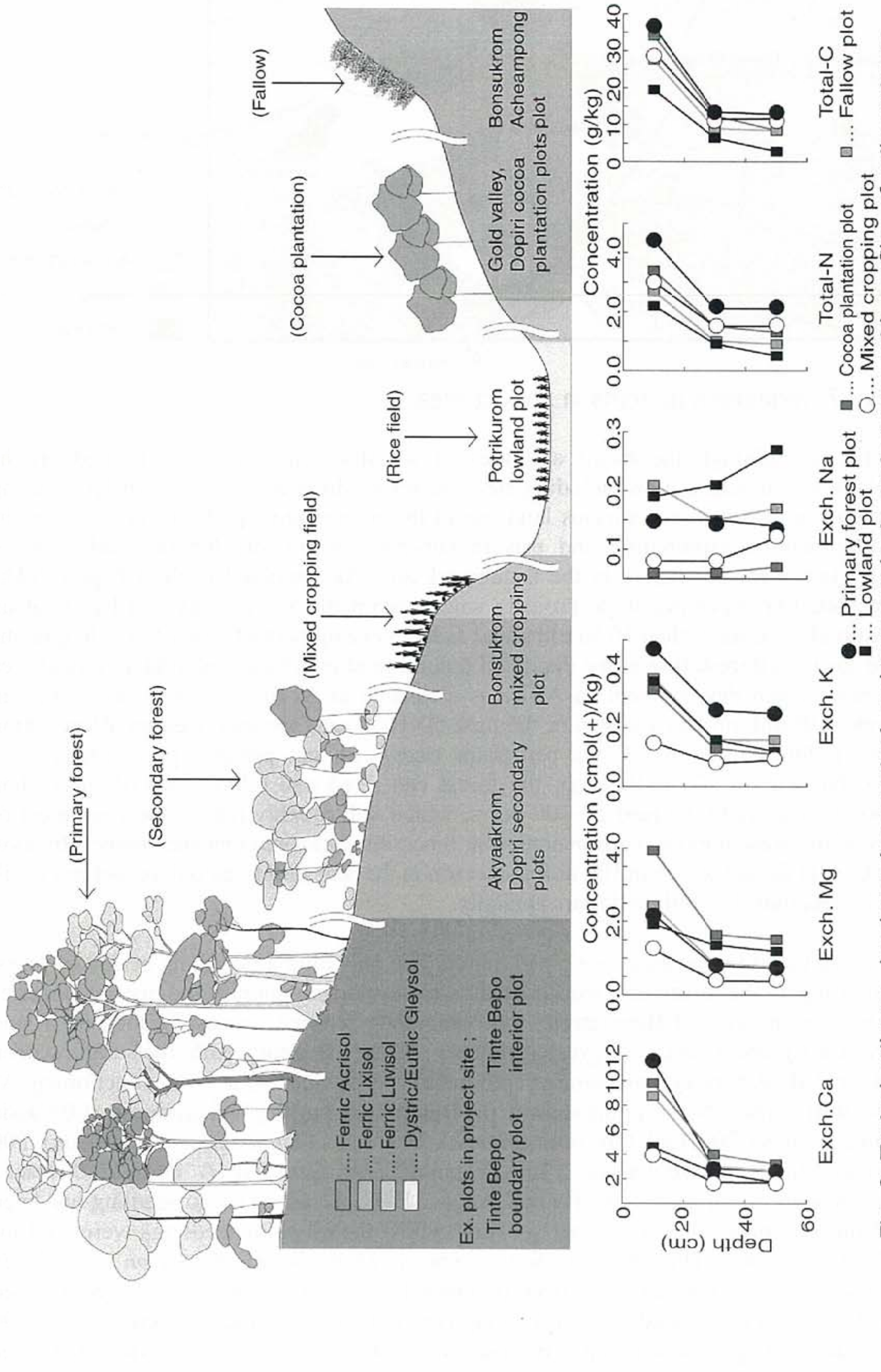


Fig. 8. Typical soil type, land use (vegetation) and topography in project area with profiles of soil nutrients.

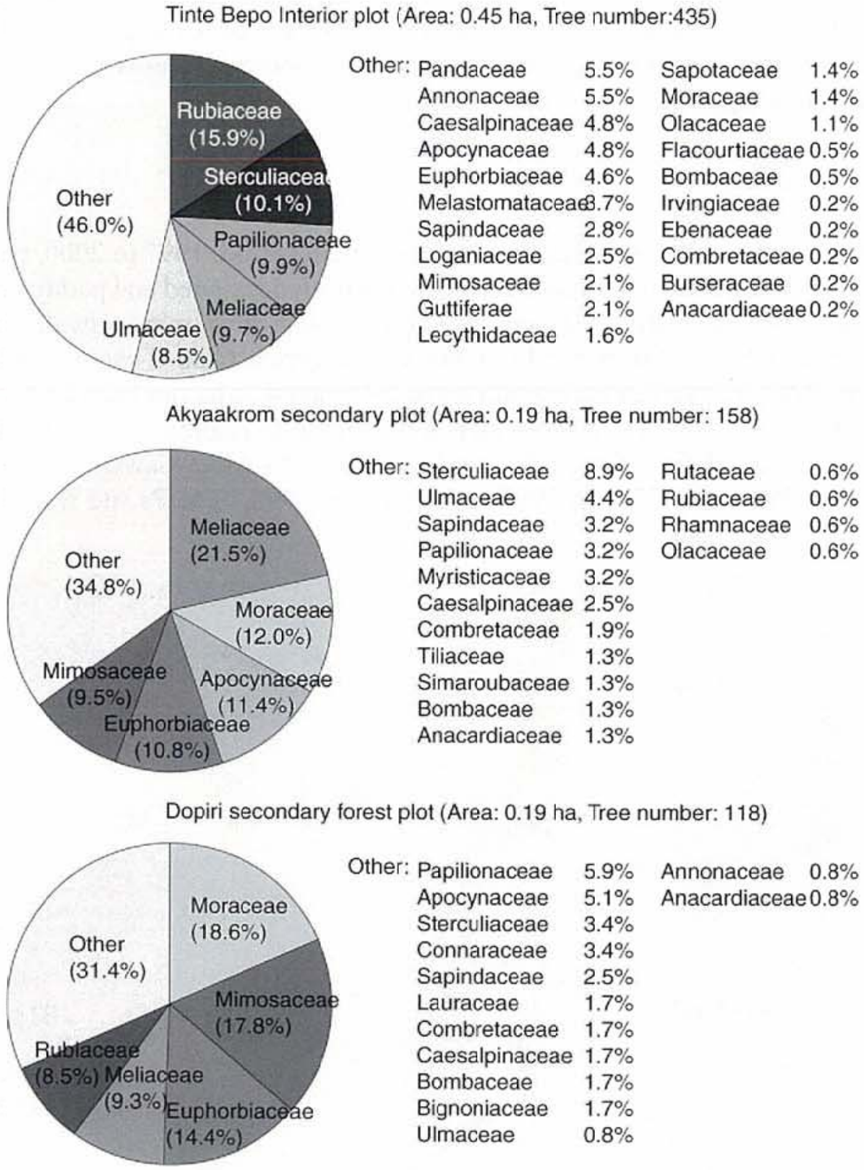


Fig. 9. Top 5 tree families in Tinte Bepo, Akyaakrom secondary and Dopiri secondary forest plots.

5 Design, Construction and Evaluation of Various Sawah Systems

One of the major purpose of the CRI/JICA sawah project is to establish a sustainable development of the small scale irrigated sawah, based on eco-technology, farmers' participation and training in the inland valley. This type of approach will make the construction cost considerably lower and the economic returns will be about one thousand dollars per ha.

(1) Sawah trials

Seven sites of various sawah trials during the project period, 1997 to 2000, and follow up period in 2001 are shown in Figure 10. Area of sawah developed and paddy production in 1999 and 2000 and estimated area including newly developing sawahs in 2001 are presented in Table 3. Mean paddy yields for Adugyma Club-C were 3.9t/ha in 1997, 3.5t/ha in 1998, 4.3t/ha (including ratoon) in 1999 and 4.3t/ha (including ratoon) in 2000. Rice variety used was SIKAMO, which is adaptable to rainfed condition. This variety was newly released from Crops Research Institute of CSIR. Sawah area developed in Potrikurom (Ps) was 0.27ha in 1997 and 0.64ha in 1998. The Ps site was also used for agronomic research trials.

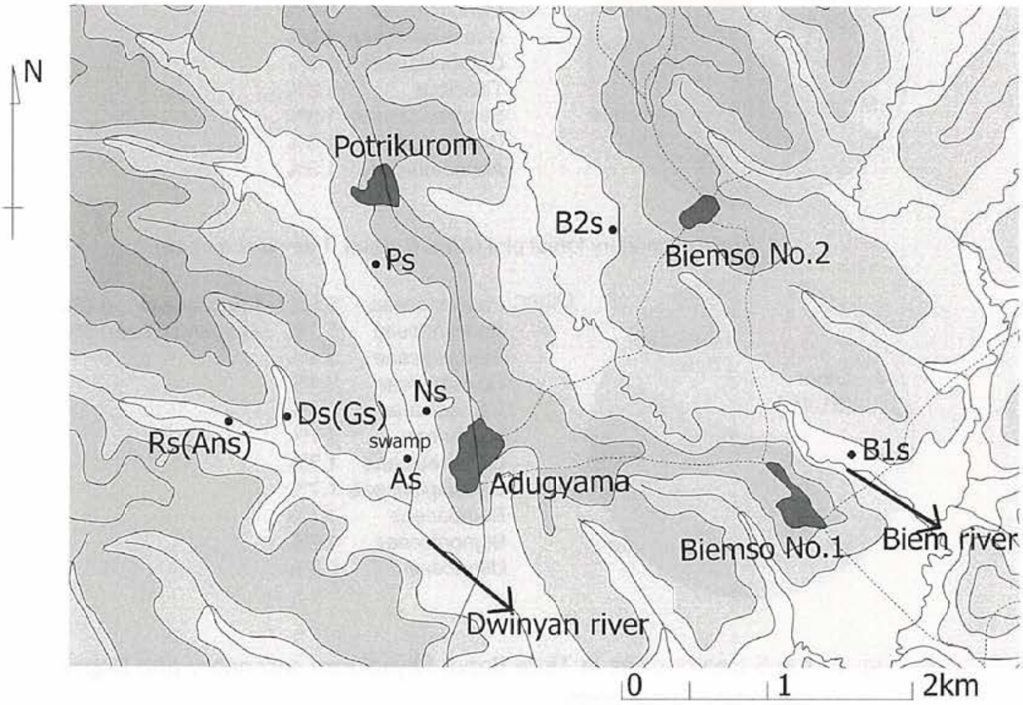


Fig. 10. Various Pilot sawah trials in Benchmark site. Ds (Gs) is Danyame (or Gold valley) site, Rs (Ans) is Rice valley (or Anthony's) site, As is Afreh's site, Ns is Nicolas site including Club-T site, Ps is Potrikurom site, B1s is Biemso No.1 site and B2s is Biemso No.2 site.

During April to August 1999, Biemso No.1 sawah development trials were established in the Biem river watershed. Ten farmers formed an association group for sawah development in this site. An area of 1.22ha of sawah as well as dyke and 800m of canal were developed in 1999. Total paddy production was 5,500kg, of which 430kg (5.5 tins = 275kg) of milled rice was given to the landlord of the sawah and 100kg for family use. Mean yield of 4.6t/ha was remarkable. The remaining 5,000kg of paddy were sold. Total

TABLE 3. LAND AREA AND YIELD FROM THE SAWAH PROJECT SITES

Site/farmers group	Symbol in Fig. 10	Area development and cultivated in 1999	Total paddy production, yield and selling* in 1999	Developed &cultivated area in 2000	Total paddy production, yield and selling in 2000	Developed &cultivated area in 2001
Adugyama Club C						
Danyame (Gold valley),	Ds (Gs)	0.29/ha	4,000kg including 800kg Ratoon rice (4.3t/ha) ¢5 million $1,406/ha	0.29/ha	3,800kg (4.3t/ha) $1,042/ha	-
Anthony (Rice Valley),	Rs (As)	0.16/ha		- (1)		-
Afreh	As	0.08/ha		- (2)		-
Club-T	Ns	0.06/ha		0.06/ha		(0.06hax2)
Nicolas	Ns	0.33/ha		0.54 ha		(0.54hax2) double cropping (1.2ha)
	Sub-total	0.92/ha		0.89ha		
Biemso No.1	B1s					
Sawah group A		1.22 ha	5,500kg (4.5t/ha) ¢5 million $1,066/ha*	1.8 ha	6,100kg (3.4t/ha) $1,222/ha	1.8 ha
Sawah group B**		-	-	-	-	(1.5 ha)
Biemso No. 2	B2s					
Sawah group A		-	-	0.61 ha	1.630kg (2.7t/ha) $585/ha	0.61 ha
Sawah group B**		-	-	-	-	(0.5 ha)
Potrikrom	Ps	0.62 ha Research trials	Research trials site	0.62 ha Research trials	Research trials site	0.62 ha Research trials
Total ha		2.76 ha		3.92 ha		(6.23 ha)

In 1997, 0.49ha Sawah yielded 1896kg paddy rice; 3.9t/ha at Gs, As and Ps

In 1998, 0.70ha (1.37ha including research site of Ps) Sawah yielded 2425kg paddy rice; 3.5t/ha at Gs,

(1) No cultivation in year 2000, because of the withdrawal of Mr. Anthony. Management and availability of water is also a problem.

(2) No cultivation in year 2000, because of the problem of water availability

(.): Including the area estimated for newly developed sites

* Mean exchange rate of 1 dollar for 3865 cedis during December 1999~April 2000

·Club C sold at about 1400 cedis per kg, relatively good price

·Total selling excluding family consumption and for the land, about 5000kg.

Biemso sawah group sold at about 1000 cedis per kg paddy, relatively low price.

Milled rice and Paddy rice ratio is about 65%

** Newly developed group and site in 2001.

***Total production of paddy was 6100kg, which was equivalent to $2200 ($1222 per ha) using the exchange rate 1$ = 7000 cedis at March 2001. In Biemso No.1, rice variety of SIKAMO was logged both in 1999 and 2000.

sales were 5million cedis, which was equivalent to 1,300 US dollars. This is equivalent to $1066 per ha. Adujama Club-C also increased total area to 0.92ha, which produced 4,000kg of paddy, including 800kg of ratoon paddy. Mean yield also increased to 4.3t/ha, including ratoon paddy. Total sales came to 5million cedis, which is equivalent to 1300 US dollars using the mean exchange rate between December 1999 to March 2000. This is equivalent to $1406 per ha. The higher sales per hectare of the Club-C group were the result of the selection of good market price, in December 1999. Relatively lower sales of Biemso sawah group were the results of the poor market price at March 2000. Paddy productions in 2000 were 3,800kg (4.3 t/ha and 1042$/ha) in Club-C and 6,100kg (3.5 t/ha and 1,367$/ha) in Biesmo No1 Sawah group A. After the termination of the project, sawah group farmers expand their number of sawah group and the area. As shown in Table 3 at the end of August 2001, Biemso No1 Sawah group B, which is a new group separated from sawah group A, are expanding new sawah about 1.5ha and Biesmo No 2 Sawah group B, which also new group separated from A, too.

(2) Description of various sawah systems

(2)-1, Rainfed type Sawah/ Drought prone Sawah: Gold valley, Rice valley and Biemso No.2

Fig. 11 shows the sawah at Danyame valley (Gold valley) with a watershed of about 100ha. The central stream is very shallow, not well developed, and does not flow continuously. Major flow occurs during June -July and September. Although some water from the upland flow can be collected at the sawahs during June and September, rice plants in the sawahs suffer from shortage of water during the other growing months. In that case rice have to be irrigated by pump from small pond. Sometime pond water is dried up during the dry spell of August. As shown in the Fig. 11, valley bottom slopes are 1-3%, with a mean of 2%. Mean sawah size was about 200m^2. For the leveling of such mean sized sawah, 200m^2, farmers have to move about

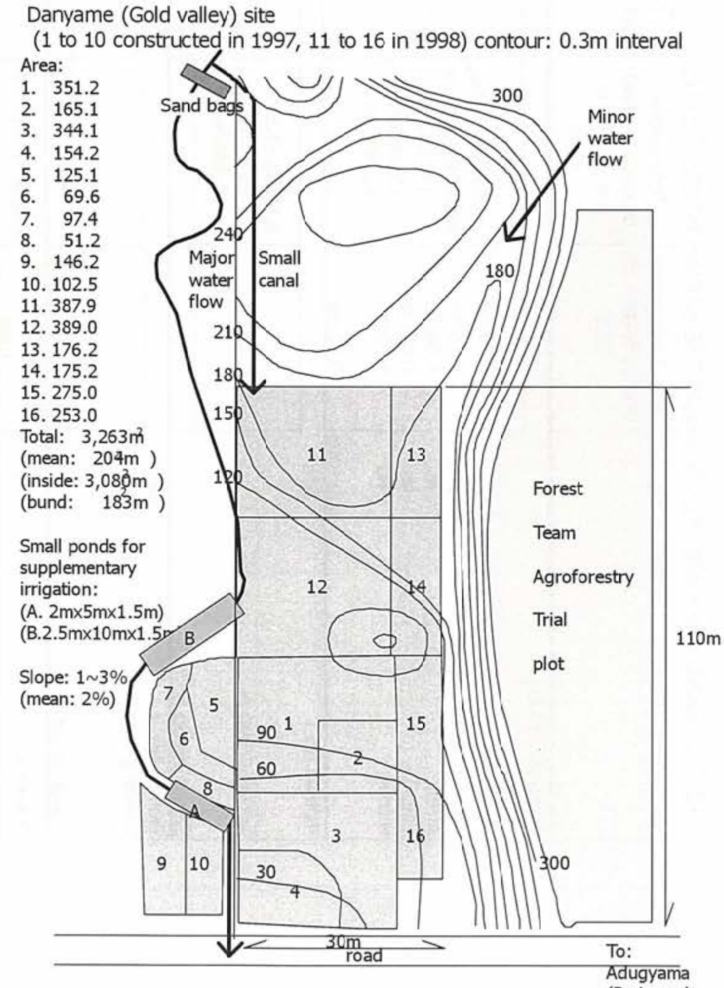


Fig. 11. Sawah system at Danyame (Gold valley site), Ds (Gs).

12.3m^3 of soil. Therefore, for the one-hectare sawah development, farmers have to move about 615m^3 of soil for leveling. For the construction of the bund, with 0.4x0.4x0.8m size, about 400m^3 of soil have to be dug and construct to bund. For the construction of two small ponds, 53m^3 of soil has to be dug out per 0.33ha, for one hector 161m^3. Although it was not necessary, three termite mounds per 0.30 ha were also removed. Mean size of the termite mound was bottom diameter 10m and height was 2m. The volume of one termite mound was 52m^3. The amount of soil movement to destroy the termite mound per ha was 53x3x3= 477m^3. If we assume three termite mounds per ha will be leveled, total soil movement necessary to develop one ha of sawah was estimated to about 1,333m^3 (Table 4).

Table 4. Comparison of Engineering parametersof various Sawah systems tested

	Rainfed type			Pump type	Spring type	Integrated type	Dyke canal type
Site	Ds	Rs	B2s	As	Ns	Ps	B1s
Mean slope	2(1~3)%	0.75(0.5~1)%	.95(0.4~1.5)%	4(3~5)%	1.5(1~2)%	0.6(0.2~1)%	0.55(0.1~1)%
Sawah+bund area(ha)	0.29+0.02	0.16+0.01	0.61+0.02	0.078+0.005	0.39+0.02	0.62+0.02	1.22+0.05+0.06*
Mean sawah size(m^2)	200	335	485	166	276	531	444
Soil Movement(m^3/ha)							
Leveling	615	286	436	1067	518	287	213
Bunding	400	320	288	420	336	267	273
Pond	160	235	250+		(973)*	25	
(Termitaria)**	158	158	158	158	158	158	158
Dyke	-	-	-	-	-	-	12
Canal	negligible	negligible	-	-	-	56	200
Total(m^3/ha)	1333	999	1132	1645	1012	793	856
Total labor cost(dollars/ha)***	3999	2997	3396	4935	3036	2379	2568
Drought problem	severe	severe	severe	severe	No	sometimes	No
Flooding problem	No	No	?	No	Slightly(flush)	Sometimes(standing)	Slightly(standing)
Fuel cost for pump	High	High	High	Very High	Low/Medium	Midium to High	Low
Operation of power tiller	Somewhat difficult	Easy but long distant	Easy	Somewhat difficult	Somewhat difficult	Easy	Easy
Soil fertility	High	Medium	Low	Low	High	High	High
Occurrence of valley tpye	Many	Many	Many	Many	Few	Many	Many
Priority to Sustainable sawah development	Medium	Medium	Medium	Low	High	High	High
Remarks	Long distance from village. Depends on the incentives of farmers. How to solve the drought problem			Poor Eco-technology site. Mainly pump depended	Easy water control	Likely to depend on pump	Dyke and canal maintenance. Initial cost for dyke materials (Wooden piles,cement blocks, plastic and jute bags) were one million cedi (=400dollars,May.1999) for 5 ha

Ds;Danyame valley, Rs;Rise valley, B2s;Biemso No.2, As;Afreh, Ns;Nicolas, Ps;Potrikurom, B1s;Biemso No.1

*area occupying by termite mounds,Pond at Ns is for fish pond.

**Assumind 3 termite mounds per ha are destroyed

***Labour cost for soil movement per cubic meter was about 3dollars,which was equivalent to 7500 cedi before May 1999.In August 2000,1dollar=6000 cedis.

(2)-2, Small pump irrigation sawah: Afreh's site

Fig. 12 shows the sawah system at Afreh's site (As) which location is shown in Fig. 10. A timber road stretching from Adugyama has created permanent swampy area in front of the Afreh's site. Small water pumps, 60-100 liter per minute, were used for the irrigation of the site using the swamp water. Although the swamp water last long, up to December, irrigation efficiency was poor, because of the about 2m lift and 30-40 m carrying distance of water. Furthermore, due to very sandy nature and some holes, which are seen in the Fig. 10, water permeability of plow layer of the sawah was extremely high. Thus water requirement of the sawahs was estimated to be higher than 5 cm per day. All these factors make pump irrigation very poor in this site.

Slopes of the sawah site were 3-5%, with a mean of 4%. Mean sawah size was $166m^2$ in our trial based on the participating farmers' work. Necessary soil movement for the leveling was $1,067m^3$ and for bounding $420m^3$ per ha. Two termite mounds were leveled which necessitated the movement of about $105m^3$ of soil for 0.08ha, i.e. for one ha $1,316m^3$. Total soil movement was estimated at $1645m^3$ (Table 4), including $158m^3$ for the three termite mounds. If we try to remove all termite mounds that existed, mean about 10 per ha, additional $1158m^3$ termite soil will have to be moved per ha of sawah (although this is not necessary).

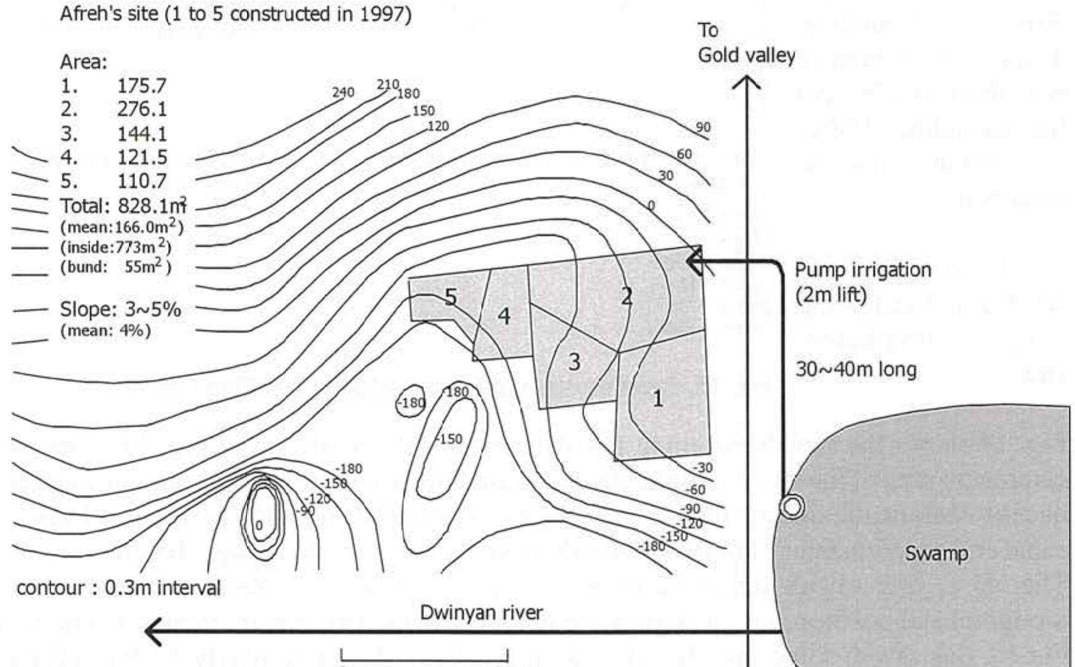


Fig. 12. Sawah System at Afreh's site (As).

(2)-3, Spring water Sawah: Nicolas's site

Fig. 13 shows the sawah system at Nicolas's site (Ns) as shown in Fig. 10. A permanent spring source was available which is also used for drinking water by the Adugyama villagers and for fishpond owned by the Club-C leader. The spring may partly originate from Adujama village or township, population of 4,000 people. The spring flow rate was estimated at 2-5 liters/sec, mean of about 3 liter per second, of which roughly half was used for the fishpond. The remaining 1.5-liter per second will be available for the sawah. This amount of water can make about 1.5 ha of sawah irrigation. So far about 0.39ha of sawah has been developed by the end of August 1999, and 0.60ha by the end of July 2000. Slopes of the sawah site were 1-2%, with a mean of 1.5%. Mean sawah size was 276m^2. Necessary soil movement was 518m^3 for leveling and 336m^3 for bounding. Total soil movement was about 1012m^3 per ha, including 158m^3 of termite mound treatment.

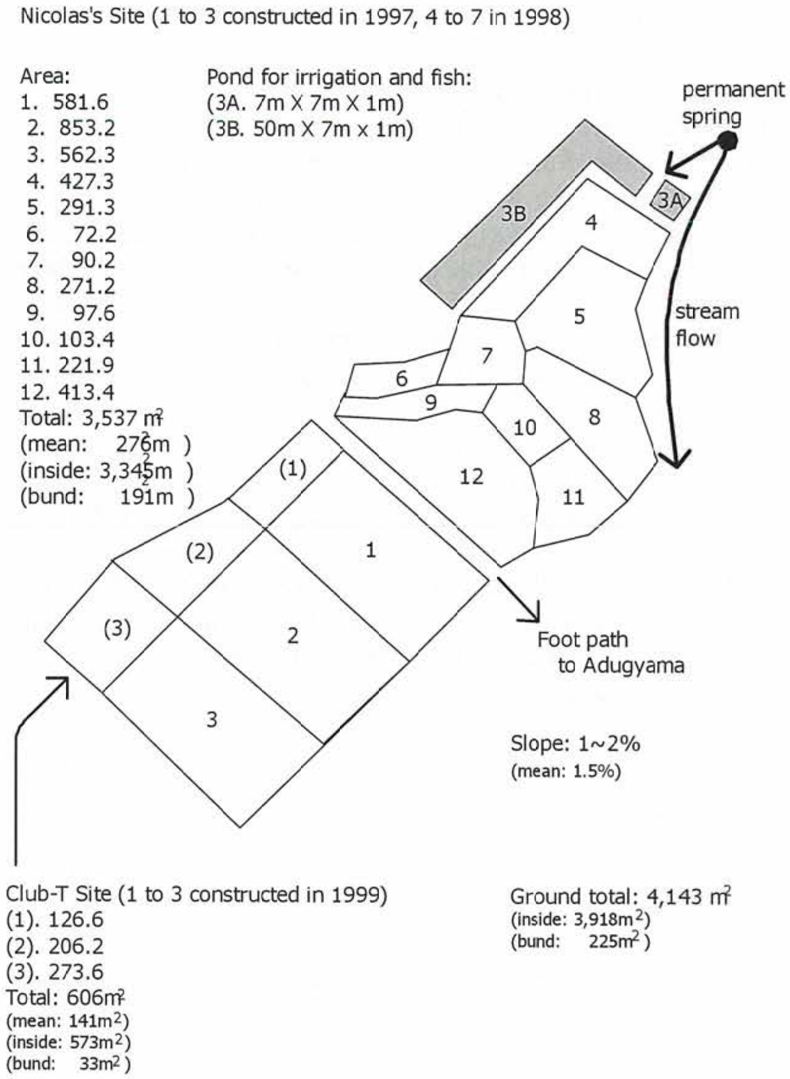


Fig. 13. Sawah system at Nicolas site(Ns) and Club-T site

(2)-4, Sawah with small canal and pump irrigation: Potrikurom site

Fig. 14 shows the sawah system at Potrikurom site (Ps) as shown in Fig. 10. Since the catchment area of the site is about 2500ha, second order valley, flow of the central river is usually sustainable during June to November. A small dyke made from sand bags and canal and supplementary pumping directly from the stream can manage the sawah system. Therefore, this sawah never suffer the shortage of water. Rather, because of its topographical position, i.e., just after the junction of the two major streams as shown in Fig.10, this sawah sometimes to suffer deep flooding of approximately 30-50cm for 1-2 weeks during June.

Slope of this site is about 0.2-1%, with a mean of 0.6%, and mean size of sawah was 531m^2. Necessary soil movement was 287m^3 for leveling and 267m^3 for bounding. Although two small ponds, 2x4x1m size was necessary, additional soil movement was only 16m^3 per 0.64ha, i.e., 25m^3 per ha. A small canal with 0.6x0.6m size and 150m long was dug out, which required soil movement of about 36m^3 per 0.64ha, i.e., 56m^3 per ha. Total soil movement was therefore about 793m^3 per ha for the development of the sawah, including 158m^3 of termite mounds treatment (Table 4).

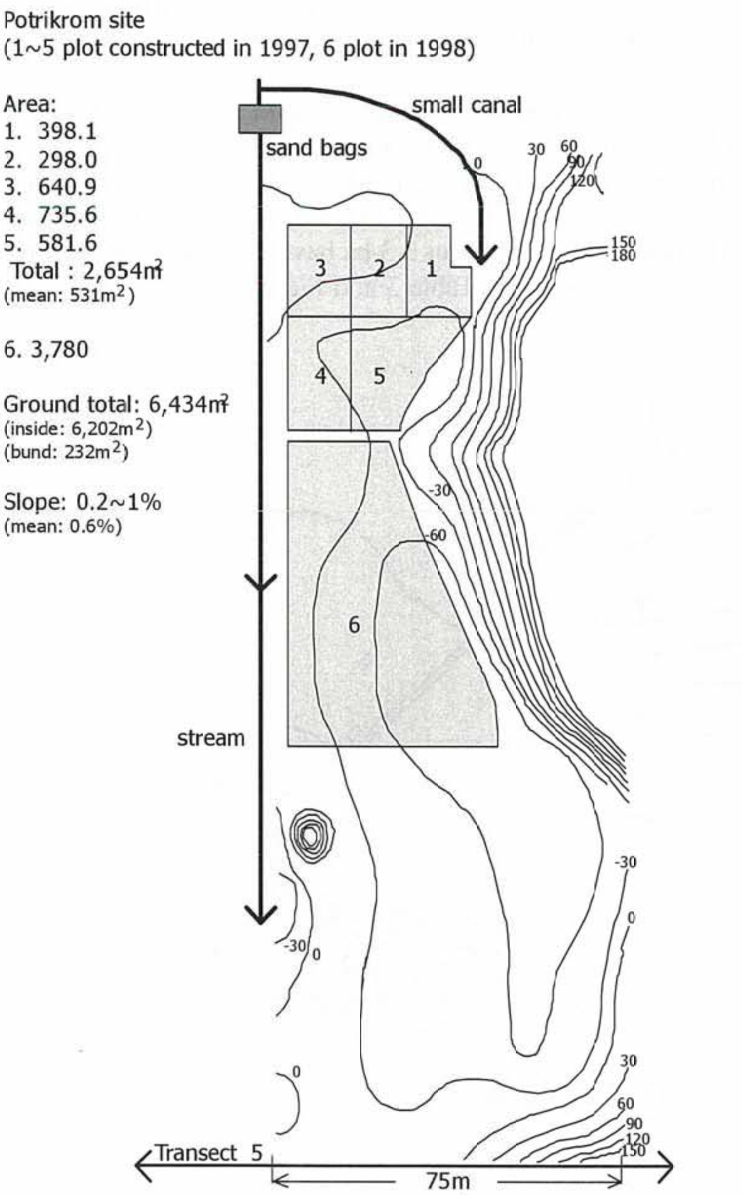


Fig. 14. Sawah System at Potrikrom Site for Research field.

(2)-5, Dyke irrigation sawah: Biemso No1.

Detail of this system was described in the previous section. Fig. 15 and 16 show the sawah system at B1s, Biemso No. 1 site which location is shown in Fig. 10. This system composed of dyke, canal and sawah offers full irrigation.

The dyke was constructed with 60 wooden piles (locally available hard wood), 5x10cm size with 1.5 to 3.5 m length. The piles were pushed into the riverbed up to 1m depth. The four lines of wooden sticks were roughly interconnected using long and slender bamboo plates. Central part of the wooden sticks was fixed to each other using the same 3.5m long wooden piles. The bottom part of the dyke was constructed using the soil from nearby upland. Clayey soil was paddled with the foot till it became very plastic. This was used to seal the pores within the first bamboo dyke, which received the direct impact of the river force (Fig.17). Sandy-clay soil from the riverbed was excavated from a distance of 1.5m from the dyke. This was heaped and compacted to form a triangular shape. The detailed of structure of the dyke are shown in Fig. 17. Fig. 18 shows how to control the canal flow by adjusting the bottom height of the spillway using sandbags.

An 800m long canal with a size of 1.5x1.0m and mean depth of 0.8m was dug. Total soil movement for the construction of the canal was $800m^3$. Since a depth of 1m will be better, the total soil movement for the canal excavation was estimated at $1000m^3$. Slope of this site was 0.1-1%, with a mean of 0.5% and the mean size of the sawah was $444m^2$. Necessary soil movement per ha was $213m^3$ for leveling and $273m^3$ for bounding. Total soil movement was $486m^3$ per ha. Since Biemso No.1 farmers developed 1.22 ha for the first year actual soil movement was $587m^3$. Based on this potential, total soil movement per ha of the sawah system was $856m^3$, of which the breakdown was $12m^3$ for dyke construction, 200m^3 for canal excavation, 213m^3 for leveling, 273m^3 for bounding, and the treatment of 158m^3 of three termite mounds (Table 4).

The measured maximum amount of water intake through the canal was about 40 liter per second. If we assume water loss of about 50%, and mean of possible intake of 20 liter per second, then potential irrigated area will be more than 5ha. As shown in Fig. 19 and Fig. 15, the area between the cross section C7 and C1 (and beyond) have 8ha of potential for the development of irrigated sawah, of which about 3.3 ha have developed by the end of August 2001 by two sawah groups as shown in Table 3 and Fig.15

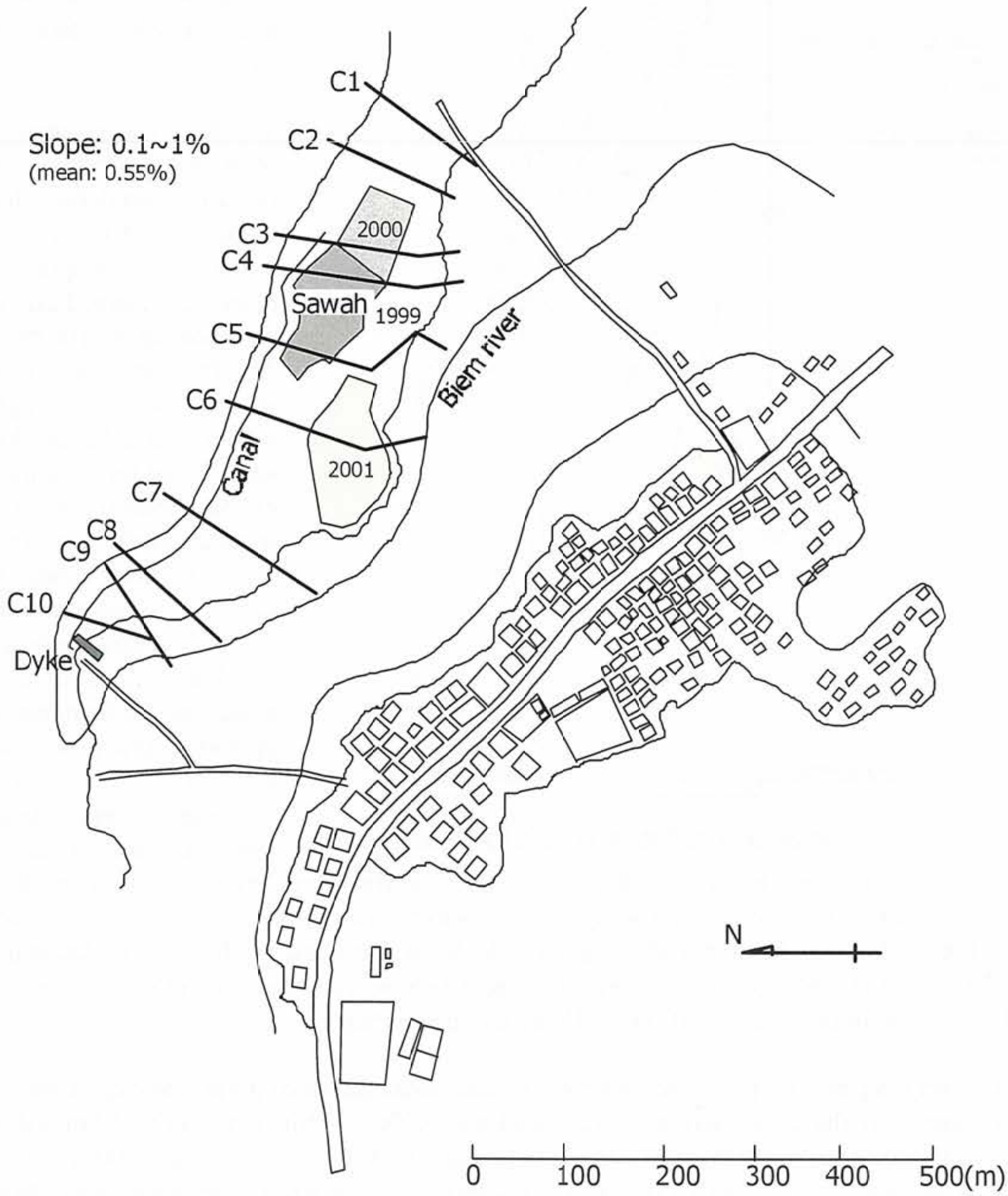


Fig. 15. Biemso No.1 sawah system with cross section lines (C1~10).

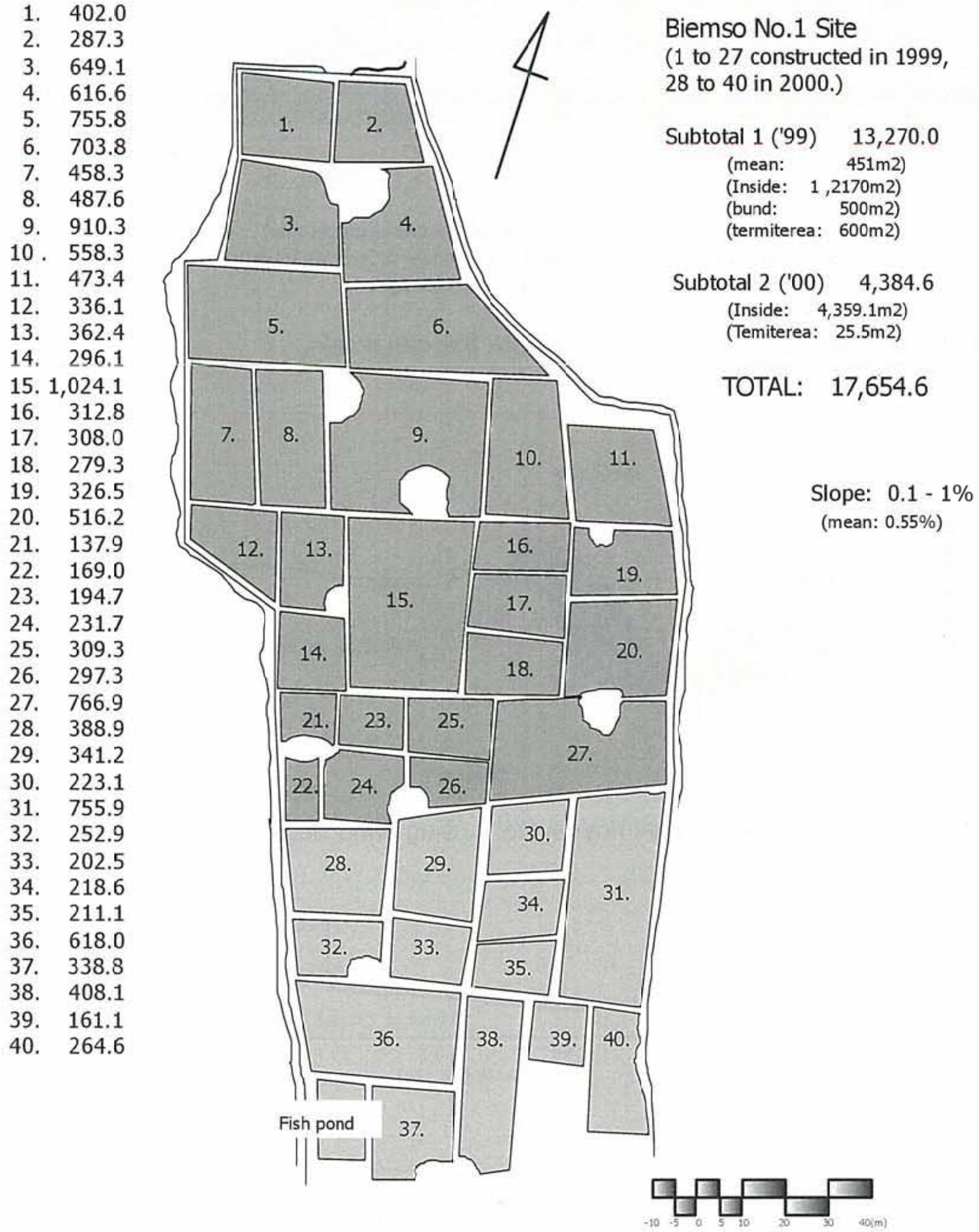
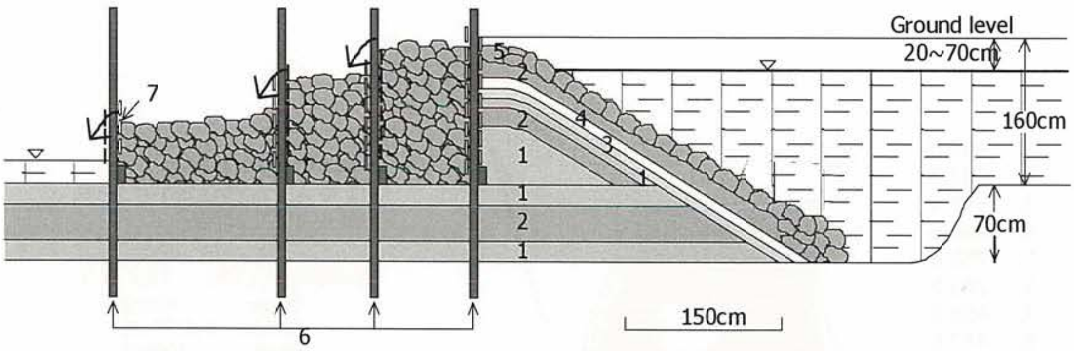


Fig. 16. Sawah system at Biemso No.1 (B1s).



1. - sandy clay
2. - sand and gravel mix
3. - clay sheet
4. - silty clay (termitaria)
5. - sand bags (sand and gravel mix)
6. - wood, 2x3 inches, 1.5~3.5m length
7. - bamboo slender plate

Fig. 17. Biemso No.1 Dyke, side view from the canal side.

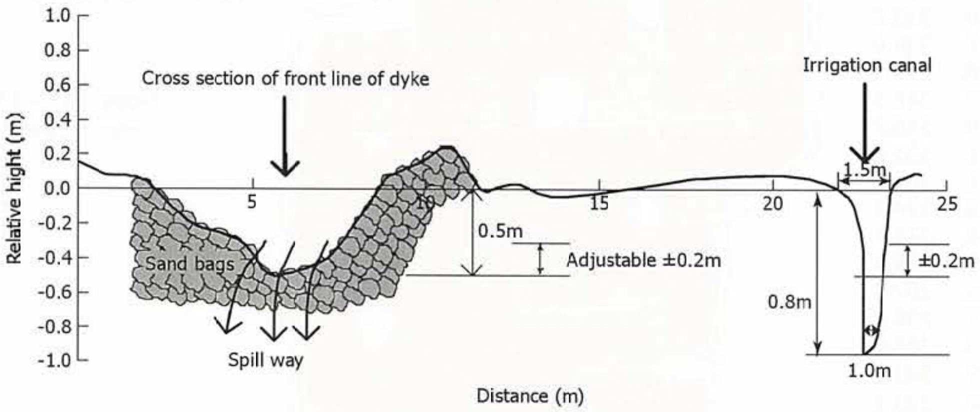
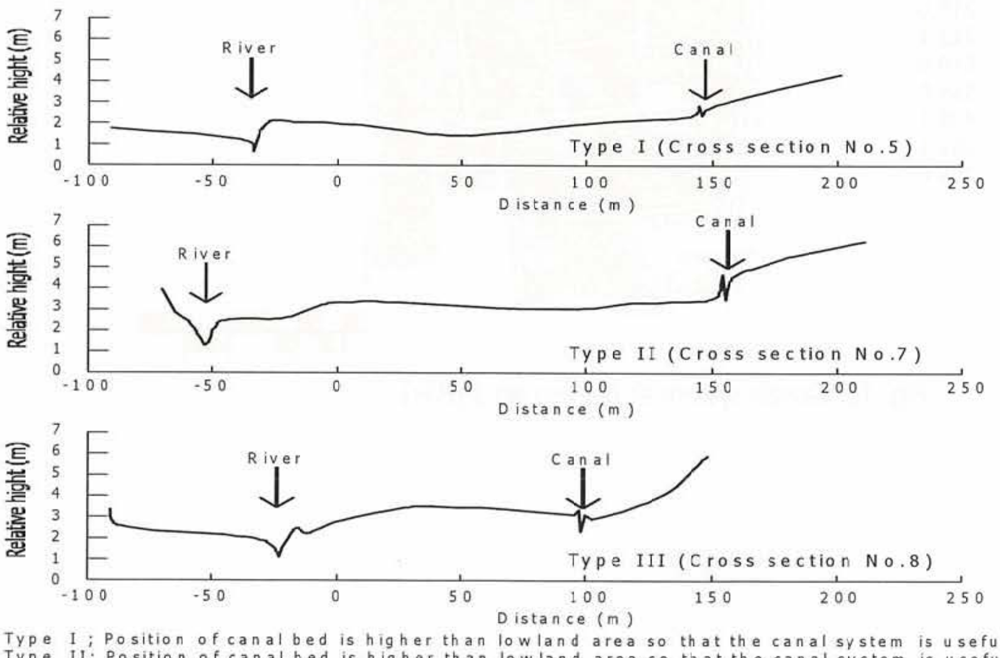


Fig. 18. Ajustable canal flow system using sand bags.



Type I ; Position of canal bed is higher than lowland area so that the canal system is useful.
Type II; Position of canal bed is higher than lowland area so that the canal system is useful.
Type III; Position of canal bed is lower than lowland area so that the canal system is useless.

Fig. 19. Cross section of lowland in Biemso No.1.

(3). Comparative evaluation of various sawah systems tested

The engineering and economic parameters of various sawah systems tested in this study are summarized in Table 4 and 5. The rainfed type of Gs and Rs (also B2s) need considerably larger work for soil movement because of relatively steep slope of 1-4%. It seems slope difference between Potrikurom/Biemso No.1 and the Gold valley/Rice valley is negligible (1-3% to 0.1-1%). However, for sawah development, the difference was significantly as necessary soil movement for the leveling was more than double. If we include all necessary components, such as bounding, pond digging, dyke construction, canal excavation, and the minimum treatment of the termite mounds, the total amounts of soil movement of each system, i.e., Gs, Rs, B2s, As, Ns, Ps, and B1s were 1333, 999, 1132, 1645, 1012, 793, and 856m^3 per ha of sawah system respectively. The cost estimation for the sawah system development based on the soil movement (about 18,000 cedis, which is equal to 30 dollars, per cubic meter on August 2000 at Kumasi) was as follows., i.e., 3999 dollars for Gs, 2997 for Rs, 3396 for B2s, 4935 for as, 3036 for Ns, 2379 for Ps, and 2568dollars for B1s, respectively. This is why the sawah development at Adugyama Club-C site was smaller in size and the area developed per year was smaller compared to the Potrikurom and Biemso No.1 site.

The drought prone nature of the rainfed type sawah is another problem we have to consider. Even using excavated pond, water availability is small, therefore it is difficult to manage large sawah. Drought problem reduces the major advantage of sawah system, i.e., weed control by flooding water. Therefore, rice plant may suffer from both shortage of water and weed under drought condition. This is another reason why the Gs and Rs site can not be made into a larger sawah. Because of delay of rainfall both site had no cultivation in 2001 growing season. Fuel cost for pumping from pond will be considerable. Relatively steep slope made the operation of the power tiller somewhat difficult. The relatively long distance from the village to the sites of Gs and Rs as shown in Fig. 10 is another problem since power tiller and pump have to be carried to the site. Soil fertility is medium to high. Although, these kinds of valley bottoms are extensive (under surveying), their priority for sustainable sawah development will not be so high.

To get the irrigation water for the Afreh's site, 100% operation of pump is necessary. Because of sandy nature of soil, water requirement is very high. This makes fuel cost very high. Apart from the fuel cost, this site has the highest slopes among those tested. Therefore soil movement for the construction of sawah was the highest, 1645m^3 per ha without the excavation of both pond and canal. Also soil fertility was poor. The site has since been abandoned in 2000 after three years of cultivation as shown in Table 3.

Nicolas's site is special due to a permanent spring supplying irrigation water. Although, slope is somewhat high and required soil movement is great, water management is the easiest among the sawahs tested and soil fertility is relatively high. Potential area for irrigation will be about 1.5ha, since rice double cropping or ratoon harvest is easy, this kind of site should be surveyed. However the distribution of this kind of permanent spring is rare in the project site, maybe 2-3 sites for the 3500 ha of Dwinyam watershed and 6-10 sites (under surveying) for Biem river watershed, maximum sawah area based on the spring type will be less than 20 ha in the two watersheds.

In terms of sawah development, Potrikrom site will be the easiest, since soil movement will be the minimal. Soil fertility is also high. Minimum scale dyke, made by just using small sand-bags, can supply enough irrigation water for the sawah. Supplementary irrigation from small pond is also available. The only problem of this site is flooding, which may continue for more than two weeks. This happened in June 1998, one year among the four tested in this project. Transplanted young rice plant suffered considerably and fertilizers were flushed away. Since this kind of valley is wide spread in the valley bottom in this area, the priority for the development is very high.

TABLE 5. COMPARISON OF ECONOMIC PARAMETERS OF VARIOUS SAWAHS TESTED

	Rainfed			Pump	Spring	Integrated	Dyke and canal
Sawah types sites	Gs	Rs	B2s*	As	Ns	Ps	B1s
Sawah (ha)	(0.29/ha)	(0.16/ha)	(0.63ha)	(0.078 ha)	(0.39 ha)	(0.62 ha)	(1.22 ha)
Sawah + Bund (ha)	(0.31/ha)	(0.17/ha)	(0.65ha)	(0.083 ha)	(0.41 ha)	(0.64 ha)	(1.27 ha)
Soil Movement (man.days/ha)							
Clearing	150	150	150	150	150	150	150
Leveling and bunding	2120	1840	1316*	2770	1890	950	600****
Pond	260	380	402*	-	(1460)* *	40	-
Dyke	-	-	-	-	-	-	20
Canal	-	-	-	-	-	42	150
Total (man.days/ha)	2530	2370	1866	2920	2030	1122	920
Actual works in man days for each site development	921 (2 termites)	403	1176 (one termites)	382 (2	972 (2	826 (2 termites)	1975 (2 termites)
Fuel for pump at construction /ha	74500	74500	74502*	196000	52000	25000	25000****
Fuel for power tiller for leveling/ha (cedi/ha)	45000	45000	67500*	59000	38000	32000	90000****
Total cost in dollars per ha for sawah development	5100	4800	3790	5900	4100	2400	2000
Agronomic works in man days /ha***	273	273	266	294	267	256	250
Fuel for pump	21000	21000	42000*	124000	24000	21000	5000
Fuel for power tiller	46000	44000	30000*	44000	36000	30000	30000
Fertilizer	152000	136000	150002*	137000	183000	137000	108000
Chemicals	21000	25000	23000*	39000	30000	29000	29000
Maintenance of machine	175000	175000	175000	175000	175000	175000	175000
Total (in cedi /ha)	195000	469000	420000	519000	448000	392000	347000
(in dollar/ha)	166	188	168	208	179	157	139

* Estimated data based on the data from Gs, Rs, Ps, and B1s

** Pond at Ns (Nicolas site) is for fish culture

*** For the breakdown, see table 6. These values should be reduced through the improvement of agronomic skills of farmers

**** For one man day is equivalent to 5000 cedis , which is roughly equivalent to two dollars during 1998 – 1999.

***** Power tiller was used for moving muddy soil by attaching wooden plate which accelerate leveling work considerably . Pump was used only at the period when dyke was broken in June-July,1999.There were no pump operation during the sawah development in 2(

Biemso No.1 system has the full facilities for irrigated sawah constructed. Since the slope is minimum, leveling and bonding are the easiest among the sawah tested. The dyke was broken two times in the first year, June and August, 1999, but have been repaired and improved during March and April 2000 by the Biemso No.1 group of farmers in participatory manner with Ghanaian counter parts as described in Fig. 17. By September 6, 2001, the newly repaired dyke was working last two years without any problems after second minor repairing on April 2001. As a result of easiness of the expansion, the area of the sawah reached about 3.3 ha by the end of August 2001. Since dyke and canal system are new for the farmers, the project has to carry out special on the job training for one or two years. Once the participant farmers can master the basic eco-technology for the development and maintenance of the system, the expansion will be easier. The distribution of the valley bottom adapted to this system is widespread (under surveying); therefore, the sawah system also has the highest priority for the watershed development in this area.

Table 5 summarizes the economic parameters of various sawahs tested. Labor mandays for soil movement per ha was 2530, 2370, 1866, 2920, 2040, 1182, and 920 mandays per ha for Gs, Rs, B2s, As, Ns, Ps, and B1s respectively. These figures can be compared with the total soil movement as shown in Table 4. Since labor cost was about 2dollars per manday, estimated cost for the construction of the various sawahs were 5060, 4740, 3732, 5840, 4080, 2264, and 1840 dollars per ha for Gs, Rs, B1s, As, Ns, Ps, and B1s, respectively. In addition to these labor cost, the costs of fuel for pump and power-tiller for the development were estimated at 48, 48, 57, 102, 38, 23, and 46 dollars per ha for Gs, Rs, B2s, As, Ns, Ps, and B1s respectively. In the case of B1s, materials for dyke construction were purchased. Total cost was about one million cedis, equivalent to 400dollars for the dyke, which has a capacity to irrigate more than 5ha. Therefore the cost per ha was 80 dollars. Total costs for the development of the various sawah systems were therefore 5100, 4800, 3800, 5900, 4100, 2400, and 2000dollars per ha for Gs, Rs, B2s, As, Ns, Ps, and B1s, respectively.

Table 2 compared the cost estimation for the sawah development in dollars per ha both based on estimated mandays for the development (Table 5) and on the volume of soil movement (Table 4). The mean cost including fuel and materials was 4570, 3900, 3600, 5470, 3600, 2400, and 2350 dollars per ha for Gs, Rs, B2s, As, Ns, Ps, and B1s, respectively. If the cost of power tiller and pump are 4000$ and 500$, respectively, life span of the machines are five years, and the maintenance is 20% of the total machinery cost, then machinery cost per ha of sawah development will be 1080$. Therefore the grand total will be 5650$, 4980$, 4680$, 6580$, 4680$, 3480$, and 3430$ per ha for Gs, Rs, B2s, As, Ns, Ps, and B1s, respectively.

Cost estimation of various agronomic practices for rice farming in mandays was summarized in Table 5. The breakdown of the various agronomic practices was shown in Table 6. Since the participant farmers were all new in sawah based rice farming, these figures will be reduced through the improvement of agronomic skills of farmers.

Among the cost that farmers have to bear, fertilizer and spare parts comes first, then fuel. Total cost in dollars equivalent per ha was estimated at $139 for B1s site, the lowest, and $208 for As site, the highest. Although at the moment we cannot estimate the cost of the maintenance for the pump and power tiller properly, those will be the most expensive. Apart form the development works, tentatively we put the 2 % of the total price of the machines for agronomic works. Total running cost can be estimated in the range of 174 to 276 dollars per ha per year.

Table 2. Cost estimation for sawah development in dollars per ha

Sawah types	Rainfed type			Pump type	Spring type	Integrated type	Dyke canal type
	Gs	Rs	B2s	As	Ns	Ps	B1s
area(ha)	0.29	0.16	0.61*	0.078	0.60*	0.62	1.22+
Based on Man.day	5,100	4,800	3,800	5,900	4,100	2,400	2,000
Based on soil movement	4,040	3,000	3,400	5,040	3,100	2,400	2,700
Mean	4,570	3,900	3,600	5,500	3,600	2,400	2,350
Machinery cost	1,080	1,080	1,080	1,080	1,080	1,080	1,080
Grand Total	5,650	4,980	4,680	6,580	4,680	3,480	3,430

*Area developed by August 2000

Note: Machinery Cost (Life Span = 5years)

1. Power tiller → $4,000/5ha → $800/ha
2. Water pump → $500/5ha → $100/ha
3. Maintenance cost is 20% of total → $900/5years → $180/ha

Total $1,080/ha

Table 6. Rice Production Cost in man days / ha based in 1999.

	Gs	Rs	As	Ns	Ps	B1s	B2s
				(man days/ha)			
Site cleaning	10	10	10	10	10	10	10
Ploughing	19	19	19	19	13*	13*	13*
Leveling & Puddling	38	38	38	38	27*	27*	27*
Transplanting	69	69	69	69	69	69	69
Fertilizer + chemical	3	3	3	3	3	3	3
Weeding	5	5	5	5	5	5	5
Water pumping	21	21	42	5	21	5	31
Water control**	-	-	-	10	-	10	-
Harvest	92	92	92	92	92	92	92
Drying	16	16	16	16	16	16	16
Bird scaring	10	10	10	10	10	10	10
Total	283	283	304	277	266	260	276

* assuming 30% more efficient for power tiller operation because of bigger and lower slope.

** no data available ,only estimation

Note: These values of man day should be reduced through the improvement of agronomic skills of farmers

6 Possible funding for sawah development to make the eco-technology approach sustainable in Ghana and West Africa

Finally we described our draft proposal for sustainable development in the future. Farmers' evaluation of our proposal was also described.

Possible loan for Eco-technology approach

1, Call for sawah group formation of about 10 farmers

2, $6,000 loan for one group: breakdown

$4,000 for power tiller

$500 for tools for development and rice cultivation

$500 for small pump

$1,000 for annual running cost including fuel, sandbags spare parts, fertilizer, and pesticides

3, Provision of free technical advice, on the job training and education. Institutional backstopping to facilitate such technical advice. The development of sawah system for rice cultivation by sawah group without external assistance.

4, 1 ha of sawah development; 5ha per five years during the five years of no loan payment. During 6-11 years, loan payment with 5% interest. Total payment will be $7,050 and annual mean payment will be $1,175.

5, 1st year income will be $1,350, assuming a rice sale of $ 1100 from 3.5t/ha and dry season vegetable of $200.

6, 2-5th year: total sales will be $2.600-6,500 and running cost, $600- $1000 annually.

7, 6th year: yield will increase to 4.5t / ha, vegetable production will also increase by same rate. Then total sales will be $7,300 per group. The net income will be $5125 after paying mean annual loan, $1,175 and depositing the necessary annual running cost, $1,000. Mean annual income per each farmer will be $500 (currently about $250).

8, Continue to produce more sawah up to about 10 ha. Then annual income will be $1,000.

Since this is a draft plan, we can improve the proposal based on further interaction with farmers' group and more detailed economic analyses. The above proposal has no insurance component to secure the farmer during the season of abnormal climate or disasters. We should include such insurance components. Working load of power tiller for sawah development is considerably higher than that of rice agronomy, which should also include.

7 Participant Farmers' Response to the sawah approach

This survey was conducted by the special cooperation of Ms. M. Nawano, Master course student of UST, University of Science and Technology, Kumasi, during September 1999 to August 2001.

Majority of participant farmers, 83%, showed a strong interest to join the proposed project in order to increase their income and job opportunity. None of the farmers have used loans in the past. Many farmers responded that the amount of the loan, $6,000 is too high, compared to their present mean annual income of about $250. With regards to the construction work, although the majority of farmers, 83%, said that they will be able to continue work if small support, such as food, (1500cedi =0.21dollars at the exchange rate on August 2001), is available, especially at the first years for the sawah development. Although they wanted the payment for their the labor cost for sawah and related construction work, especially for the demonstration period. However after the demonstration period of 1-2 years, sawah group farmers accepted to work without any payment from the project side. The new group of farmers, however, received daily lunch food support equivalent to 0.21US$ per person during sawah system construction from the project.

Farmers thought that if other farmers knew about the sawah activities, they would be attracted by the proposed project. Now farmers who have interest in the sawah are rapidly increasing. Farmers who have experienced traditional upland rice cultivation will easily confirm the superiority of the sawah rice farming. This proposal is further more fascinating because of the loan for power tiller and pumps. Although they have to pay back, they can own all of it in future. This proposal makes what was thought impossible possible. It also seems to open before them a life of higher purchasing power very different from the present one of rural insufficiency. They though the proposal will be a gate way to solving the present extreme poor conditions of village life.

However the breakdown of the power tiller will be a severe problem. Some special measures should put in place to cater for machinery troubles and abnormal low yields. They were worried about the fluctuation of rice price and whether it was possible to find enough labor even after full operation for five years. Since sawah is quite a new technology for the farmers, they felt that technical advice alone might not be enough. More systematic training or the On the Job training will be necessary. The income is very satisfactory, but we have to consider the harshness of the work. Our past successes were only possible because of the help of Japanese experts. Farmers insisted on getting the food help during the construction work.

On the advantages of the sawah, they explained that high yield, intensive nature, and sustainable yield due to the irrigation, and possible second season cropping were very big advantages of the sawah system together with the effective use of machinery such as power tiller and pump are also advantage. Major problems were hard and laborious work during the sawah system construction. Some farmers said that water management and transplanting of sawah is difficult and hard work.

8 The Response of Village Observer Farmers

About 120 villagers from Adujama and 100 villagers from Biemso No.1 were selected randomly and interviewed.

As a result, it was revealed that 95% of the farmers knew and were interested in the project that they are doing. Actually 90% of the farmers observed the newly developed sawah. 85% farmers could explain the difference between the sawah based rice farming and traditional rice cultivation. The major reasons for the interest shown in the sawah systems were to learn the new sawah technology, high yield and intensive nature of the system, and potential increase in income. Some farmers, especially women, observed that the sawah systems are beautiful.

9 Land Tenure Arrangement at Sawah Project Sites

(1) Current Procedure for Acquiring Land for Project Purposes

In discussion with District Chief Executive of the area, if a land is to be acquired for project purposes there are some procedures that should be followed. Land is never sold for such purposed since it is communally owned.

For the land at the project sites, the lands are in the custody of the Akyempemhene, Amakomhene and Afarihene at Fawoman for the Ashantihene. After the examination of the land and the preparation of the site plan, approval should be sought with these three chiefs. The group that would be obtaining the land should have been registered with the Department of Cooperatives. It is suggested that governing board should be formed to include the funding agent of the group, a member from the district assembly, the group representative, NGO, a chief and a representative from a rural bank through which funds should be channeled from the funding agent to the group.

If these procedures were followed, then the land would be given out for the purpose of the project without any cost. The only cost would be that of drinks and royalties that would be agreed on by the chiefs and the group as well as one for the number of years that the project would be in existence.

(2) Land Tenure Arrangement for the Participant Farmers' Group

Land ownership and tenure is not much of a problem in the project sites. People have access to wetland and so could adopt any production practices to increase production, however when it comes to constructing permanent bund on land, its access becomes a problem to people who may not own their land but have to rent or hire land to farm on. No rational farmer for instance would invest so much in his farm operations because of an improved technology and at the end would give out half of the produce to a landowner who just contributed land. It is therefore important to look at the land tenure arrangements of the areas in which the JICA/CRI project operates. Through formal and informal discussions with chiefs and key informants among sawah group members the following results were obtained.

The different types of tenure arrangements are describe as it prevails at each of the sites.

Type 1: Biemso No. 1 and No.2

In these villages, the sawah land belongs to a family or families of one or two of the sawah group members. As shown in Fig. 20, the group leader of Biemso No. 1 rented the land to the group, including himself and has signed a six years lease agreement. The terms of payment is a yearly rent in the form of rice produced on the land. In the sawah of Biemso No.1, two landlords will get 5.5 tin of milled rice per sawah developed. In 1999, sawah group gave 400kg of paddy to land lords. Considering that the area developed was 1.22ha and paddy production was 5600kg, rent cost was less than 10%. Since the traditional rice yield in the same area is less than 1000kg, this fixed rate of rent is happy for both sawah group and landlord. Therefore, after six years, renewal may not be much problem. However, since sawah system is a good infrastructure for increase rice production, the best incentives for the farmer who is willing to develop sawah is the permanent tenure ship, or at least long term effective contract 20-30 years.

Type 2: Adugyama

Adugyama sites, there are two types of land tenure arrangement, i.e., the first types as described above and a second type. With this type, the land belongs to a big family. Six members of the sawah group, Club-C, belong to that family. They have therefore given the land willingly to the Club-C member of which they are part to farm on it without any rent payment. They share the produce equally among all the 10 Club members.

FARMING AGREEMENT

This agreement is made between JOHN ADU YEBOAH of Biemso No.1 in the Ahafo Ano South District of Ashanti (hereinafter called the First Party) and SA.. PROJECT of Biemso (hereinafter called the Second Party)

It is mutually agreed between First Party and Second Party as follows:-

1.That First Party is the owner of a piece or parcel of land at Biemso No.1 at a place commonly known and called "KWANHO" and having boundaries with the property of KWABENA ADDEI, KWABENA BOADI, ADWOA TIAH and Biem River and he has hired a portion of the land to Second Party to cultivate rice on it.

2. That Second Party shall pay First Party three and a half kerosene tins of rice per year starting from 1999.

3. That Second Party is to hire the land for a period of six (6) years.

4. That Second Party has no right to operate any illegal business on the land.

5. That Second Party shall not farm beyond the portion given to them.

6. That Second Party shall quit the portion hired to them after the 6-year period unless this agreement is renewed.

DATED IN KUMASI THIS 13TH DAY OF JULY, 1999

WITNESS:-

FRANCIS MANU-ADABOR
P. O. BOX 1909,
KUMASI/ASHANTI.

His mark

FIRST PARTY

SECOND PARTY

(PER ANDREW OSEI MENSAH)
CHAIRMAN OF THE COMPANY)

Endorsed by:

P. O. BONSU
COMMISSIONER FOR OATHS
P. O. BOX 750. KUMASI

Fig. 20. Land use contract at Biemso No.1