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INSTITUTIONAL AND TECHNICAL OPTIONS IN THE DEVELOPMENT AND MANAGEMENT OF SMALL-SCALE IRRIGATION

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INSTITUTIONAL AND TECHNICAL OPTIONS IN THE DEVELOPMENT AND MANAGEMENT OF SMALL-SCALE IRRIGATION

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THE SAWAH HYPOTHESIS

Why has the green revolution not yet occurred in West Africa and Ghana in spite of its success in Asia in the 1960s? The green revolution laid the foundation for the rapidly growing economies of Asia today. The layouts of groups of sawahs in the watershed were adapted to the local topography for efficient irrigation and drainage. The main cause of the present agricultural and environmental crises in West Africa is the general underdevelopment of lowland agriculture. Environmentally creative technology or ecotechnology, such as sawah farming in lowlands, is not traditionally practised in sub-Saharan Africa or in Ghana. Sawah is the prerequisite for realizing the green revolution as well as for preserving and even restoring ecological environments. Irrigation and drainage without sawah farming technologies has proved inefficient or even dangerous because of accelerating erosion. Thus, the development of irrigation has been slow. In the absence of water control, fertilizers cannot be used efficiently. Consequently, the high yielding varieties are useless and soil fertility cannot be sustained. Hence, the green revolution cannot take place.

The tropical monsoon climate has enabled sawah farming systems to operate. The Asian monsoon sustains rice production on 100 million ha of sawah land and, assuming a yield of 4 t/ha and annual rice consumption of 200 kg per caput, produces food for 2 000 million people. The monsoon prevailing in West and Central Africa (Yasunari, 1991) may be able to sustain about 20 million ha of sawah farming and to provide food for 400 million people.

Currently, only about 300 000 ha of sawah is under cultivation. The major rice ecology in West Africa is upland farming. As a result, the rice yield has remained low, while upland deforestation and soil degradation have increased substantially. This has created a further decrease in water availability over the past 30 years. This vicious circle needs to be broken and transformed into one of sustainability.

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Floodplains and coastal delta cover about 19 million and 6 million ha in West Africa, respectively (Windmeijer and Andriesse, 1993; Wakatsuki, 1994). About 10 million ha have potential for small-scale irrigated sawah rice farming in small inland valley watersheds. About 9 million and 3 million ha have potential for middle to large-scale irrigation schemes in floodplains and coastal deltas respectively (Wakatsuki, 1993 and 1994; Hirose and Wakatsuki, 1997). In Ghana, the potential area for small-scale irrigated sawah farming in inland valley watersheds is estimated at 700 000 ha, or 3 percent of the total land area. If the floodplains are included, the total potential area for irrigated sawah farming may reach 1 000 000 ha in Ghana.

In West Africa, rice is cultivated under five systems:

- rainfed, upland conditions, 64 percent of total rice area of 3 million ha;
- irrigated conditions, 5 percent;
- rainfed lowland conditions in inland valleys, 19 percent;
- mangrove swamp rice, 7 percent;
- floating rice, 5 percent.

Production under rainfed upland conditions is risky due to unreliable rainfall and to shallow and erodible low fertility soils. The numerous small inland valleys scattered across the region offer the best rice ecology if the main problem of controlling water is resolved by small-scale irrigation. For example, in Ghana, the Valley Bottom Rice Development Project was initiated in 1989 to develop sustainable technologies for integrated soil, land, water and crop management in the production of rice and other crops in the inland valley (Otoo, 1994). Although considerable progress has been made in addressing some of the constraints, there is a need to devise a simple, low-cost and environmentally friendly system for managing the inland valleys that can be adapted by the resource poor farmers (Hirose and Wakatsuki, 1997).The Asian experience in sawah development which studies not only the valley bottoms but the total watershed is therefore worth considering.

SAWAH AND IRRIGATION

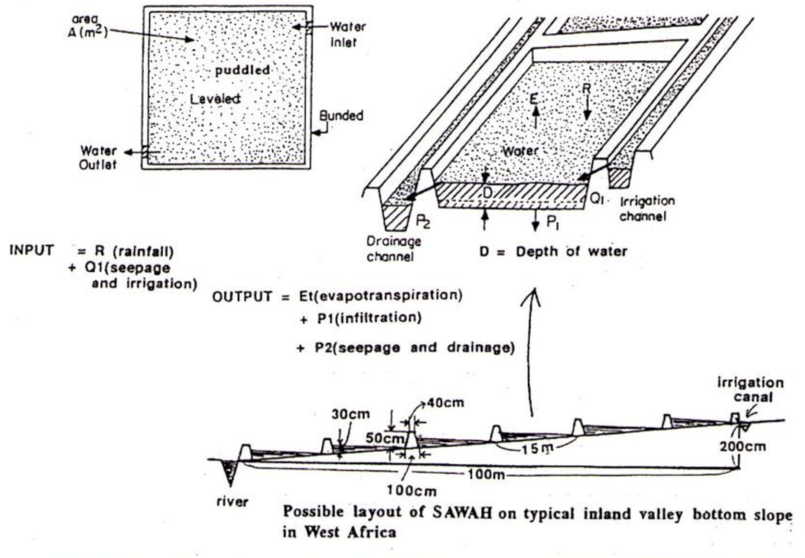
Sawah

The term sawah refers to a levelled rice field surrounded by bunds with inlet and outlet connecting irrigation and drainage (Figure 1). The term sawah originates from Malayo-Indonesian. The English term, paddy or paddi, also originates from the Malayo-Indonesian term, padi, which means rice plant. In West Africa, the term paddy refers to rice grain with husk. Most of the paddy fields in Asian countries correspond to the definition of the term sawah. Paddy field is almost equivalent to sawah for Asian scientists. However, in West Africa, the term paddy field refers to just a rice field including upland rice field. Therefore, in order to avoid confusion between the terms rice plant, paddy and the improved man-made rice growing environment, the term sawah is used.

Irrigation and sawah

Another frequent source of misunderstanding in West Africa is the term irrigated rice. In Asia, the meaning of this term is clear, as the sawah is prepared first by farmers before completing the

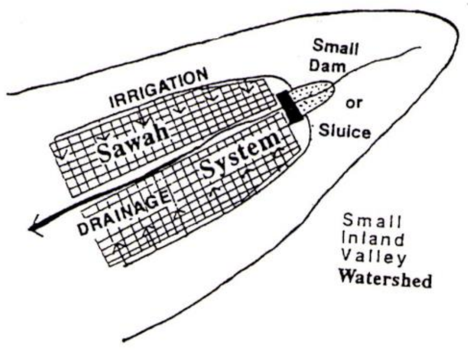
FIGURE 1
Sawah: a levelled, bunded and puddled rice field with inlets and outlets to control water



irrigation system. However, there are many irrigation systems without propersawah preparation in West Africa (Figure 2).

In the past, research on water control of inland valleys concentrated on irrigation and drainage systems, such as the central-drain system, the interceptor-canal system, the head-bund system (Oosterbaan *et al.*, 1987; Windmeijer and Andriesse, 1993) and head-dike system (Savvides, 1981). The contour bund system is somewhat similar to the sawah in terms of bunding and levelling. The contour bund system, however, may be more difficult for local farmers to construct and manage than the sawah system. It may be difficult for local farmers to share land and irrigation water fairly using the contour bund system, which may be more suitable for large-scale rice farming in the United States and Australia.

FIGURE 2
Sawah and irrigation/drainage facilities for the control of water in a watershed



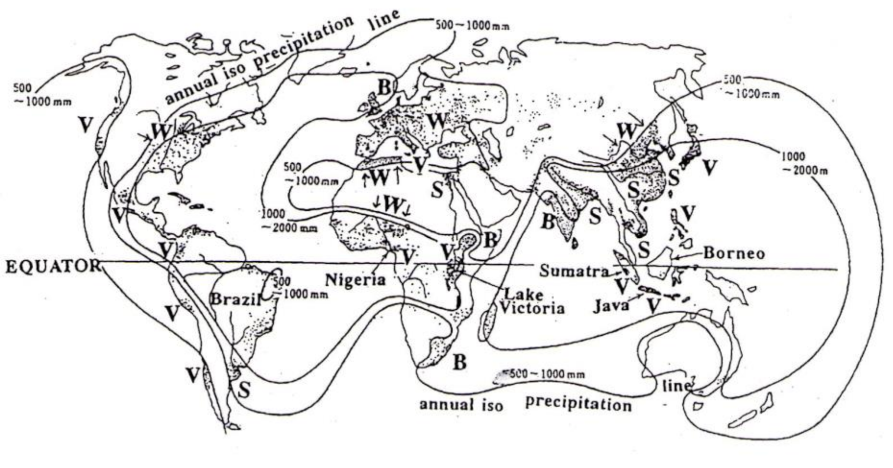
Generally, the construction cost of sawah is far higher than that of irrigation facilities in terms of labour and amount of soil moved. Out of the total expenditure, 50-70 percent should be allocated for sawah construction and 30-50 percent for irrigation and drainage. Therefore, in order to achieve sustainable development, sawah systems need to be constructed with the active participation of farmers. The key element is the sawah. In sustainable irrigation systems in inland valleys, the sawah technology should be extended to the farmers first.

GEOLOGICAL FERTILIZATION PROCESS AND SAWAH SYSTEMS

The distribution of fertile soils, and hence the distribution of population in the world, is related to the amount and quality of geological fertilization processes (Figure 3). Four geological fertilization processes can be identified: (i) the lowland soil formation process; (ii) the volcanic ash soil formation process; (iii) the loess soil formation process; and (iv) the dynamic equilibrium between soil erosion and formation (Wakatsuki, 1994).

FIGURE 3

Global distribution of geological fertilization, fertile soils and population density. Dense dots show the areas of dense population

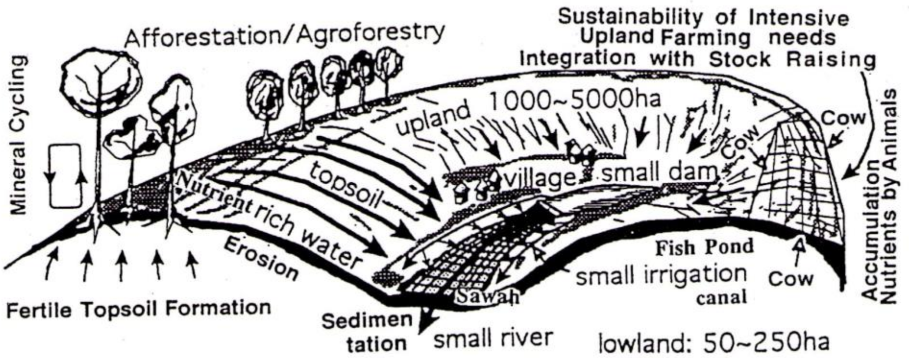


four geological fertilization processes W: loess deposition by wind, S: sediments by river, V: volcanic ash, and B: dynamic balance between soil formation and erosion on base rich parent material

Lowland soil formation involves the transportation and sedimentation of eroded upland topsoils by river water. Large-scale examples include the formation of fertile deltas, such as the Nile, Ganges and many Asian deltas. In the sawah farming system, this geological fertilization process can be enhanced. The long-term sustainability of sawah farming can be attributed to this process (Figure 4).

The sustainable productivity of sawahs is more than ten times greater than that of upland rice fields. Because of this geological fertilization process and the biochemical processes of inundated sawah soils as described by Kyuma and Wakatsuki (1995), the sustainable productivity of 1 ha of sawah may be equivalent to more than 10 ha of upland fields. This value was estimated by assuming that the mean yield of upland rice without fertilizer application is 1 t/ha and the mean yield of sawah rice without fertilizer application is about 2-2.5 t/ha. To

FIGURE 4
Sustainable farming system in inland valley watersheds in West Africa: integration of forest and agroforestry/animal/lowland sawah/fish farming



sustain the yield, upland fields have to lie fallow (3-year cultivation and 12-year fallow, for example). On the other hand, the lowland sawah rice can be cultivated continuously for more than a thousand years. Thus, the sustainable productivity of sawah is 12.5 times higher than that of upland rice field, i.e. 12.5 = (2.5/1) x (15/3).

To date, the importance of dynamic equilibrium between soil formation and soil erosion on parent materials to maintain the soil fertility has not been well examined. If the rate of soil formation far exceeds that of soil erosion, leached soils like oxisols may develop, and if erosion is not compensated for by soil formation, soil degradation and eventually desertification will occur. The earth's mean rate of soil formation is estimated at 0.7 t/ha/year. Cool temperate granitic watersheds show a rate of 0.02 t/ha/year. Andesitic watersheds in West Sumatra, Indonesia, show a rate of 1.8 t/ha/year (Wakatsuki *et al.*, 1993). Although the rates of soil formation in West Africa have not been measured, if one estimates a value of 1 t/ha/year, then 5 percent of lowland areas can receive fertile topsoils eroded from 95 percent of upland areas at the rate of about 20 t/ha/year. The sawah system may contribute to the trapping of such eroded topsoils, so maintaining the lowland soil fertility.

GENERAL SOIL CHARACTERISTICS OF INLAND VALLEYS OF WEST AFRICA

Issaka *et al.* (1997), and Buri and Wakatsuki (1996) have studied the general fertility and geographical distribution of soils of inland valleys and floodplains in West Africa. Their general fertility has been compared to those of tropical Asia (Kawaguchi and Kyuma, 1977) and tropical America. The results are summarized in Table 1. The total carbon and nitrogen contents were low for West Africa and Asia. The mean values of available phosphorus suggest that the phosphorus status of West Africa is very low throughout the region. Base status such as exchangeable calcium and potassium and effective cation exchange capacity are particularly low. The soils of the inland valleys of West Africa are characteristically low in the majority of plant nutrients. For effective and sustainable crop production, new farming systems that are both soil restoring and enriching must be developed.

TABLE 1
Mean values of soil fertility properties of inland valleys (IVS) and floodplains (FLP) of West Africa in comparison with lowland topsoils of tropical Asia and Japan

Location	Total C (%)	Total N (%)	Available P (ppm)	Exchangeable Cation (Cmol/kg) Ca	K	Mg	ECEC	Sand (%)	Silt (%)	Clay (%)	CEC/Clay
IVS	1.3	0.11	8.7	1.89	0.25	0.88	4.20	60	23	17	25
FLP	1.1	0.10	7.3	5.61	0.49	2.69	10.31	48	23	29	36
T. Asia*	1.4	0.13	18	10.4	0.4	5.5	17.8	34	28	38	47
Japan*	3.3	0.29	57	9.3	0.4	2.8	12.9	49	30	21	61

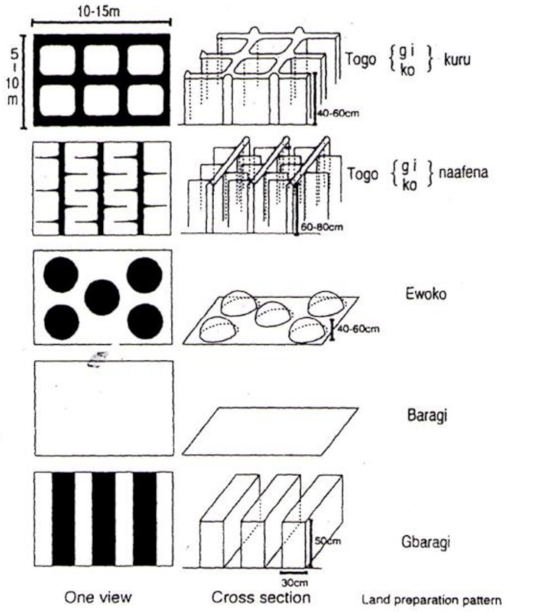
*Kawaguchi and Kyuma, 1977
Source: Hirose and Wakatsuki, 1997

PRESENT CONDITIONS OF INLAND VALLEY RICE FARMING IN WEST AFRICA

Inland valleys in West Africa are narrow, 10-500 m. The total area of a watershed is 500-5 000 ha, of which inland valley bottoms occupy 10-250 ha. The river discharges are in the order of 0.01-1 m^3/s. Water control through sawah construction may not be difficult for local farmers. However, there are very few farmers growing a second rice crop using sawah systems prepared by themselves.

Most soils of the West African inland valleys are characterized by a very coarse sandy texture and low fertility. This may be partly related to the traditional systems of rice farming where water control is not considered important. Some farmers, such as Nupe farmers, have developed indigenous rice farming systems which have some water control (Figure 5). According to their cropping calendar including rice, second season crops and fallow, various land preparation forms are processed as a sequence of land preparation patterns as shown in Figure 6 (Ishida and Wakatsuki, 1997).

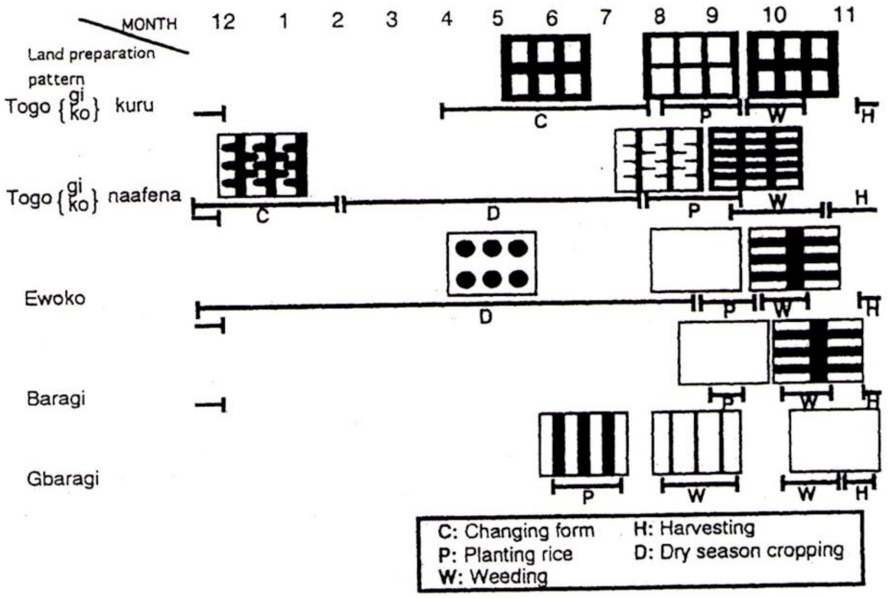
FIGURE 5
Land preparation patterns for cropping lowland rice (Ishida *et al.* 1966)



ON-FARM RESEARCH FOR THE INTRODUCTION OF SAWAH FARMING IN INLAND VALLEYS IN BIDA, CENTRAL NIGERIA

On-farm research for the introduction of sawah farming systems was initiated in 1986 as a part of the research activities the International Institute for Tropical Agriculture (IITA) (IITA, 1988, 1989; Carsky and Masajo, 1992). The studies consisted of: (i) hydrological characterization and

FIGURE 6
Sequence of land preparation patterns for cropping lowland rice (Ishida *et al.* 1966)



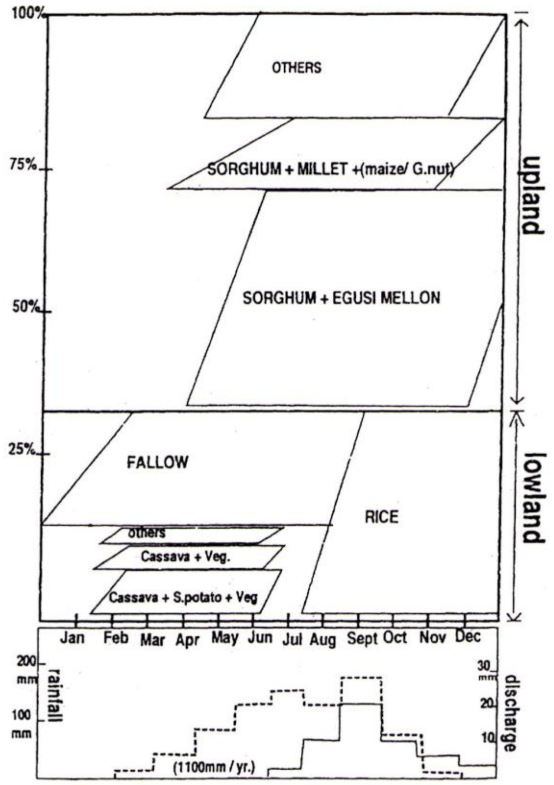
monitoring of water conditions in the field and land use dynamics; and (ii) on-farm research into the effects of sawah farming systems on rice yields and soil conservation.

Hydrological studies and monitoring of water conditions in fields

Figure 7 shows a typical cropping pattern for upland and lowland cultivation in relation to the basic hydrological data, rainfall and discharge pattern (Fashola *et al.*, 1996). The inland valley bottoms are intensively cultivated throughout the season. Tubers, vegetables and pulses on mounds and/or ridges are grown in the dry season, while in the rainy season, rice is cultivated on traditional systems (Figures 5 and 6). Under upland cultivation, various crops, such as sorghum, millet, egusi melon and groundnut are cultivated in the rainy season. The rice cultivation practices are determined by water discharge rather than the rainfall pattern (Figure 7). Although the water discharge is only 10-20 percent of the total rainfall, as the area of the valley bottom is only 1-3 percent of the total watershed, the water discharged accumulates in the valley bottom.

Figures 8 and 9 show the relation between the rainfall pattern, groundwater/surface water and land use dynamics in the Gara and Gadza valleys in the Bida area of central Nigeria. The amount of rainfall in 1987 approached the lowest on record in Bida. In Gara, rice fields on the valley fringe suffered a continuous shortage of water. However, rice in the valley bottom received a moderate supply of water even in 1986 and 1987. In addition to rice, sugar cane was cultivated on the fringe and on slightly higher positions of the bottom land. After rice, cassava, okro, eggplant, sweet potato and cowpea are the common dry season crops on the valley bottom using residual moisture. In Gadza, water conditions are more favourable. Except for the valley fringes, water shortages have not been observed, even in 1987.

FIGURE 7
Cropping pattern and crop calendar of rice-based farmers



On-farm research on an improved sawah system

In the period 1986-89 small-scale trials for sawah improvement were conducted at two benchmark inland valleys, Gara and Gadza. As the valleys already had small-scale irrigation schemes constructed by the Bida Agricultural Development Project (BADP) assisted by the World Bank, some maintenance for head-dike and peripheral irrigation canals was done. Farmers' rice fields were improved to allow sawahs with a regular shape and a larger plot size. Major work consisted of making a bund that was compact and big enough to prevent leaking. Some levelling and puddling were performed using a Philippine made turtle power tiller. The optimum size of the plot and bund may change depending on slope and the amount of available water. The example at Gadza is shown in Figure 1.

The yield of various rice varieties was doubled through sawah construction. Most of the high yielding varieties, such as ITA 230, 306, 308, 312, FARO 10 and TOX3118-6-E2-3, showed yields of 2-5 t/ha at the fringe and 4-7 t/ha at the bottom (Fashola *et al.*, 1996), whereas the yields of farmers' rice fields were less than 1-2 t/ha at the fringe and 1-3 t/ha at the bottom. The response to higher rates of fertilizer was nearly double in the improved sawah compared to that of farmers' fields in small-scale irrigation schemes (IITA, 1988 and 1989).

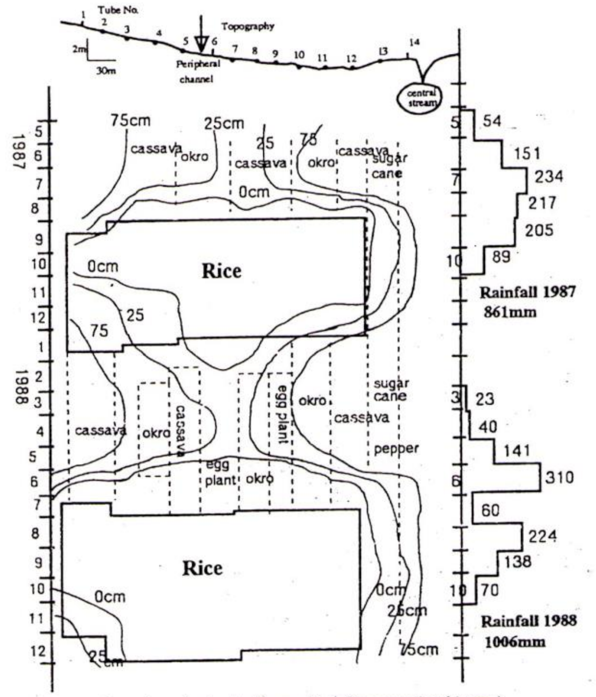
As most of the operations were performed using traditional hand tools, the quality of the bunds and degree of levelling were low. In the subsequent cropping, it was expected that the quality of the bunds and levelling would improve, provided that the farmers did not destroy the bunds of sawah developed.

AFRICAN ADAPTIVE SAWAH FARMING

The introduction of Asian lowland sawah rice farming in the indigenous farming systems of tropical Africa appeared promising. However, although the sawahs constructed during 1986-87 for on-farm research have been maintained in Gara valley, the sawahs at Gadza were destroyed in 1991 after the completion of the IITA research programme. The owner of the land preferred the traditional rice production because the turtle power tiller was not available for puddling.

In 1992, a fresh start was made to develop ways to use long-term sustainable farming systems. One hectare of sawah was constructed, which required 250 work-days for bunding and 210 man-days for levelling. The annual cost for maintenance and land preparation was equivalent to 115 work-days. As the labour costs were paid for by the research programme, the construction cost was US$690 per hectare and the maintenance was US$173 per hectare. Only African hoes, machetes and sickles were used. As the skills of the Gadza farmers had improved after two years of on-the-job training, the efficiency of sawah preparation increased. If there are appropriate on-the-job training schemes for sawah construction and if rice farmers themselves have mastered the skills required to prepare, use and maintain the sawah rice farming system, the development of sawah will be accelerated.

FIGURE 8
Cross-section of topography, rainfall pattern, ground/ surface water and land use dynamics in river flow valleys (Gadza, Bida), Central Nigeria

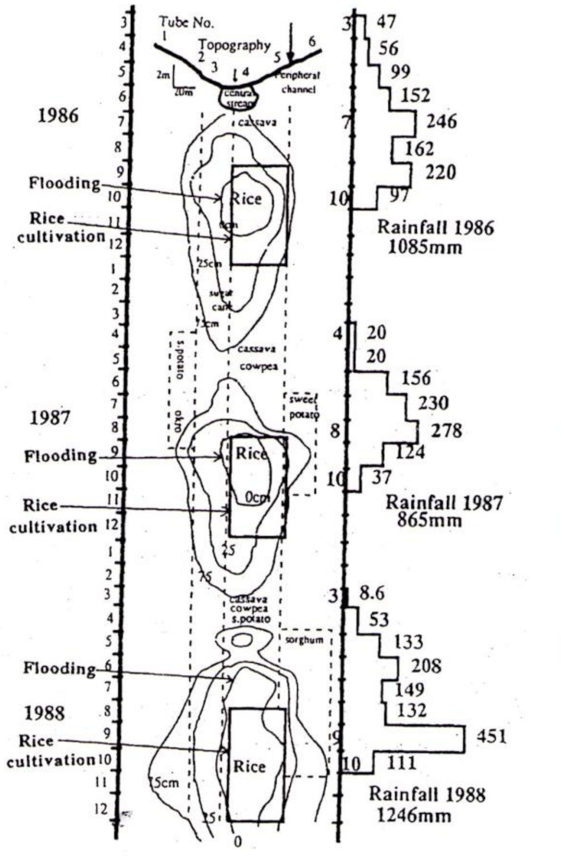


(Contour lines show the depth of ground / surface water level in cm)

The yields, however, did not reach the levels of the 1986-89 trials. Sawah construction was undertaken with the farmers in the period August-September every year. Thereafter, rice farming practices at the sawahs constructed were conducted by farmers. As a result, the rice yields in the newly developed sawahs were only 2-4 t/ha.

It would not be difficult for a trained family to prepare 0.1 ha of sawah annually. Within ten years, 1 ha of the sawah system could be completed by a trained family. If 1 000 000 farmers were trained, 1 000 000 ha of sawah could be developed within ten years. The key issue is how to establish a training and educational system to transfer the sawah technology from experts to extension officers, from extension officers to leading farmers, and from leading farmers to ordinary farmers by the application of on-the-job training. If such a training system is developed, sawah and small-scale irrigation technology will spread rapidly.

FIGURE 9
Cross-section of topography, rainfall pattern, ground/surface water and land use dynamics in stream flow inland valley, Gara, Bida, Central Nigeria



Another strategy is to look not only at valley bottom development but at the total watershed to integrate forestry, agroforestry, animal husbandry, lowland sawah and fish farming as shown in Figure 4. Although effective development will be achieved only after long-term cooperation between Africans and Asians, the key issue is how the new sawah systems can be integrated in the indigenous African farming systems through trial and error with farmers' active participation.

GADZA FARMERS' EVALUATION OF THE ON-FARM TRIALS ON SAWAH RICE FARMING, AGROFORESTRY AND FISH CULTURE

Sawah development

Although the purpose of sawah construction was explained to the farmers, the survey showed that without remuneration, the individual farmers and the Gadza community farmers would not have cooperated. The basis for research and development activities was preconceived without farmer involvement. More on-site information, specifically in Gadza, could have been gathered on farming system constraints that need to be alleviated or existing opportunities that could be exploited. The study revealed that the individual farmer would not use the sawah for rice cultivation at present. Farmers would prefer their traditional system because they do not feel water is a constraint. Moreover, soil fertility is not regarded as a constraint while the availability and cost of chemical fertilizer is. Farmers also complained of lower yields in the sawah compared to their fields and about the high labour demand for construction, though they were told that the high labour demand was only for construction. This they considered impossible because they insisted that the bunds had to be destroyed for dry season cropping after the rice harvest and then rebuilt the following rainy season for rice cultivation.

Furthermore, it appeared that the participation of women in the sawah system was not actually voluntary. The women do not usually participate in any lowland rice cultivation. They participated in transplanting rice seedlings because of the cash incentive which served as an opportunity to earn extra income in an otherwise slack period.

It appears that because of the land tenure system, sawah farming will not be sustainable. For example, the land which the community developed is on lease for the period of the Japanese research team's stay and will revert to the owner after the research activities.

Maintenance of small irrigation canals

Lack of irrigation infrastructure maintenance is the reason for the failure of most irrigation facilities in Africa. The users cannot be blamed for this. Policy-makers rarely consider farmers and their practices and install facilities without farmer participation. As a result, the farming communities usually regard such facilities as 'government's' and leave maintenance to government. The situation in Gadza is no different.

It is not known whether the farmers have to pay for water as they have not been asked to do so for a long time in Nigeria. Canal maintenance is conducted haphazardly as farmers whose fields are located near an intake clean only that section and this not regularly. This was responsible for the non-rebuilding of a section that was broken near the head-dike. There was also another section that a farmer broke during his land preparation to divert water into his own field. The broken sections remained unrepaired until the Japanese research project started. Although the farmers rebuilt the broken sections, they would not have done so without the Japanese contribution in kind.

Fish culture

The research project constructed two small fish ponds of 150-200 m^2 each using only hoes. The labour requirement was about 40 man-days per pond. Fish production was an innovation that both male and female farmers discussed enthusiastically as it provided an alternative use for their by-product, the rice bran. However, questions about its sustainability remain. The farmers, though knowing that the fingerlings came from outside the Bida area, did not know the cost implication. When asked why each farmer had not attempted to construct a pond of his own, the cost of the fingerlings was one of the reasons given. Another question mark about sustainability is the comparative cost and returns of traditional fishing practices of the farmers and the aquaculture.

Agroforestry

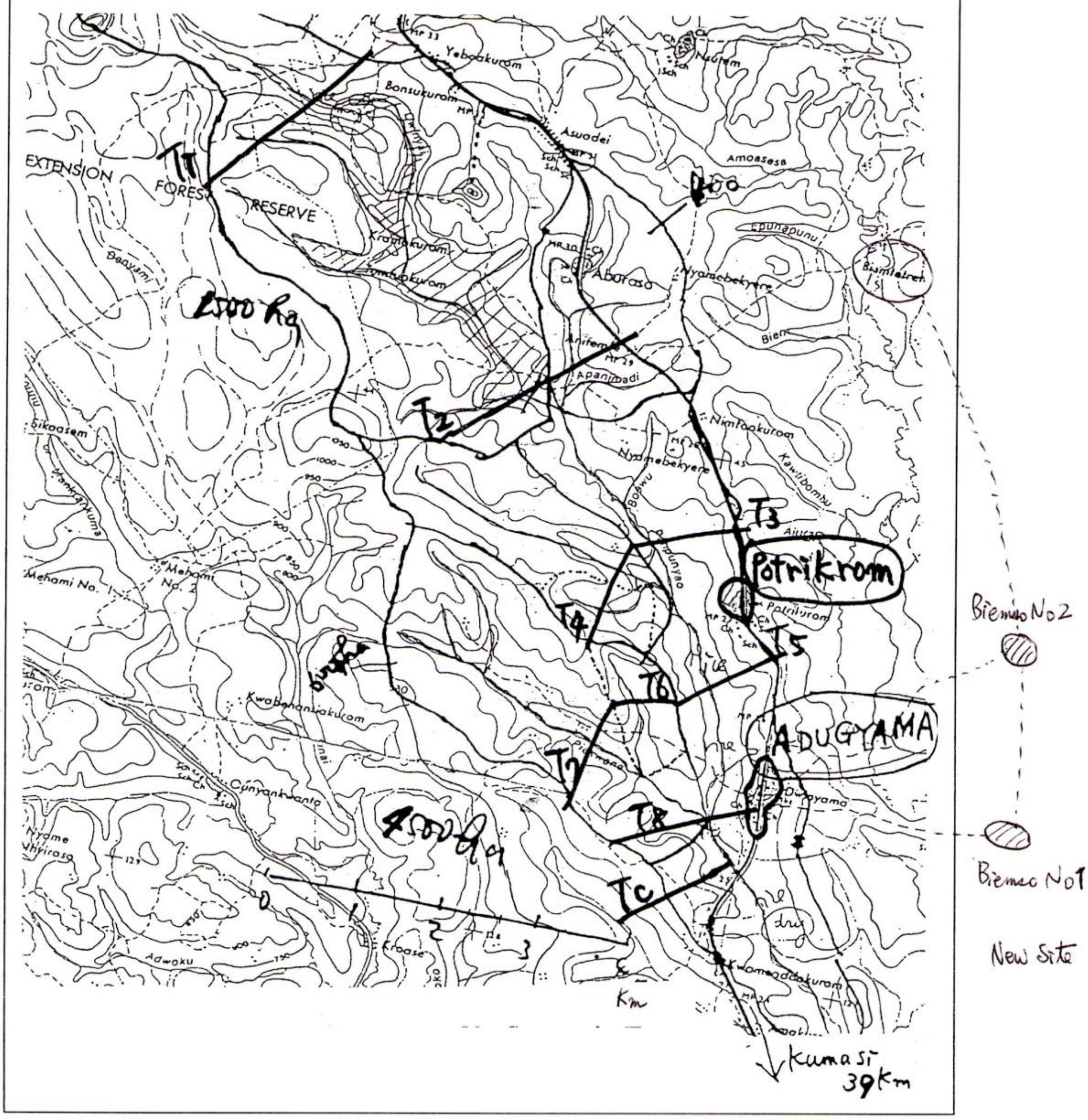
Traditionally, farmers in Gadza plant some fruit trees such as mango, citrus and cashew for fruits and shade around their compounds. The establishment of permanent crops is greatly dependent on land tenure. In most cases, tenant farmers are not allowed to cultivate permanent crops on leased land. Although, this may not appear to be a problem in this particular case, the question of who is allowed to gather fruits or keep the proceeds from the sale of fruits from the forest will affect sustainability. The farmers, especially the women, would like to grow tree species which they could harvest for firewood.

THE JOINT STUDY PROJECT ON INTEGRATED WATERSHED MANAGEMENT OF INLAND VALLEYS OF THE DWINYAM RIVER, ADUJAMA, ASHANTE, GHANA

Objectives

The focus of the research activities is to develop suitable ecological engineering technologies for integrated watershed development. Ecotechnologies should be adaptive to indigenous farming systems and rural village societies. A benchmark watershed, about 4 500 ha, which is

FIGURE 10
Benchmark watershed of Dwinyama River and Adujama and Potrikrom T1-T8: strategic transect monitoring lines

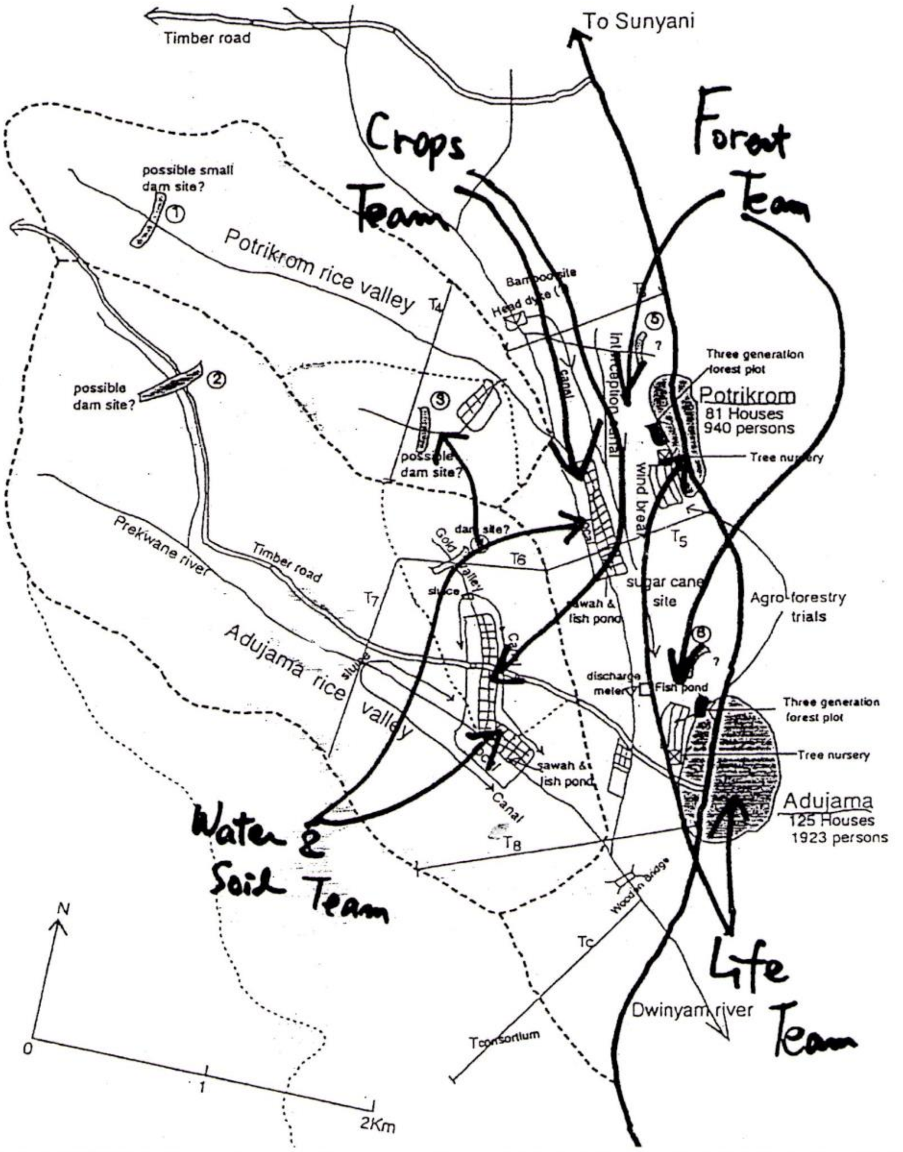


located 40-50 km northwest from Kumasi (Figure 10), was selected for a basic agro-ecological survey. Within the watershed, the various sub-watersheds of the Adujama and Potrikrom villages were selected for detailed survey and intensive field testing (Figure 11).

The term ecotechnology is defined as an ecology based sustainable farming technology viable in local socio-cultural systems to increase farming productivity and to improve the environment.

FIGURE 11

Adujama and Potrikom sites T3-T8: strategic transect monitoring



The main objective is the development and testing of a system for the entire watershed management of small inland valleys based on the sawah principles and participatory approaches for the production of food crops, animals and fish by resource poor farmers.

Some base-line semi-detailed information on watersheds in this area was available from the Inland Valley Consortium (Otoo *et al.*, 1996). In order to confirm the participatory approach, Opoku-Apau *et al.* (1996) made a base-line survey on the two villages. This survey showed a strong participatory willingness of the people.

The following four categories of ecological engineering will be examined in terms of productivity, ecological adaptability, economic return and socio-cultural viability:

- forestry related ecological engineering (F-technologies);
- crop production related ecological engineering (C-technologies);
- village-life related ecological engineering (L-technologies);
- water control and soil management related ecological engineering (W-technologies).

Study framework

Forestry related ecological engineering (F-technologies):

- base-line studies on forestry related indigenous ecotechnologies;
- ecological studies on nutrient cycles in various land uses;
- basic studies on tree and crop layout for soil and water conservation to improve the landscape;
- community or private nursery of multi-purpose trees (MPTs);
- MPT windbreak or shelter belts;
- wood lots for firewood and charcoal production;
- three-generation afforestation plots: 2 ha, two villages.

Crop production related ecological engineering (C-technologies):

- base-line survey on crop production related indigenous ecotechnologies;
- irrigated sawah based farming systems: Potrikrom 'sugar cane site', and Adujama 'fish pond site';
- partially irrigated sawah farming systems: 'rice valley' and 'gold valley';
- rainfed sawah farming systems: 'gold valley';
- traditional rice farming: control plots;
- comparative studies on irrigated sawah, partially irrigated sawah, rainfed sawah and traditional rice farming;
- variety and other agronomic trials;
- advanced sawah based multi-farming (rice, fish and duck);
- integration of the rearing of various animals for soil management and crop production.

Water and soil management related ecological engineering (W-technologies):

- base-line survey on water and land management related indigenous ecotechnologies;
- base-line survey and monitoring on rainfall, evaporation and discharge;
- strategic transect monitoring on land use, soil nutrient and water dynamics;
- design and construction of various sawah systems;
- test on shallow tube-wells and multi-purpose small ponds for fish production and irrigation;
- test on various sluice systems: soil, wood, bamboo and concrete;
- test on various canal systems: contour bund, interceptor canal;
- trials on soil fertility improvement in upland and lowlands;
- introduction and trial of agricultural tools and machinery in the sawah system.

Socio-economics of village-life related ecotechnologies (L-technologies):

- ethno-ecological studies on traditional agricultural systems and evaluation of village life related indigenous ecotechnologies;
- base-line survey (using participatory approaches) on land use systems, major farming and forestry activities;
- base-line survey on marketing, preservation, post-harvest;
- base-line survey on present status of waterborne diseases;
- socio-economic monitoring and evaluation of the various ecotechnologies tested;
- financial and economic assessment of the various ecotechnologies tested;
- adaptation and impact analyses of the various ecotechnologies tested.

Expected results

It is envisaged that the development of the sawah system modified to suit the Ghanaian conditions will lead to a more efficient utilization of the numerous inland valleys scattered across the country. This will ultimately lead to higher living standards for resource poor farmers and at the same time improve water cycling to conserve soils for sustainable crop and forest production.

The joint study will develop new technical skills for the integrated development of inland valley watersheds based on African adaptive ecotechnologies and a participatory approach. As there are numerous similar inland valley watersheds in West Africa, the results of this joint study could be of great benefit for similar agro-ecological zones in West Africa.

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