

4.2 Development of Rice Farming and Environmental Conservation Strategy in West Africa

4.2.1 Roles and Limitations of NERICA Rice/WARDA

NERICA rice is a major scientific achievement of WARDA and represents an epoch-making new technology born out of West Africa. As the technology to develop NERICA varieties is combines the genes of African rice varieties with Asian rice varieties, it may contribute to future rice cultivation in Asia in addition to that in West Africa. The further strengthening of basic and applied research in this field through JIRCAS and other bodies is, therefore, essential. Now is the best opportunity to strengthen the research and development and extension system for rice cultivation in West African countries with the “NERICA technology” playing a central role. ARI is required to slightly change its course and to aim at improving the environment and developing the infrastructure for rice cultivation instead of being simply engaged in the increased seed production and extension of the NERICA varieties developed so far. It should be engaged in a full range of support activities under a strategy of which the medium to long-term target is the promotion of intensive as well as highly sustainable lowland *sawah* rice cultivation. However, it must be noted that assistance for WARDA, a multilateral organization, should be provided in parallel with the strengthening of the rice cultivation program in each West African country. This is because the ultimate increase of rice production may not be achieved if the excessive concentration of assistance for WARDA reduces the assistance for individual countries.

WARDA is basically responsible for the improvement of rice varieties and the development of cultivation techniques for the improved varieties. The development of varieties for rainfed upland rice cultivation has been the central role of WARDA as a CG-AIR center. However, the scope of development remains varieties for rainfed upland rice cultivation and even NERICA varieties cannot ensure the sustainable development of rice cultivation in West Africa in the long term. Although assistance for the development of NERICA varieties for lowland application by WARDA is necessary, extension of the use of many Asian rice varieties which promise a yield of approximately 5 tons/ha at *sawah* fields anywhere in West Africa is possible without waiting for the development of NERICA varieties for lowland application. For the promotion of rice cultivation and environmental conservation in West Africa, the extension of a management technique that balances “variety” with “water” and “fertilizer” is particularly important. In this case, the consolidation of a rice cultivation program in each country is essential as a genuine program to promote rice cultivation cannot be implemented with continued reliance on international organizations. Under the present circumstances, the highest priority should be given to the development of infrastructure for low cost rice cultivation in each West African country. WARDA is not responsible for the implementation of research, development and concrete projects for the realization of such low cost infrastructure, i.e., irrigated *sawah* system for rice cultivation.

More detailed recommendations for assistance measures are described in Chapter 7. In the short-term, the dispatch of agronomists to increase the production of seed rice and financial assistance for the extension activities of PVS, CBSS, etc. should prove useful for the future development of rice cultivation in West Africa.

4.2.2 Spontaneous Expansion of Small-Scale *Sawah* Field Development at Rainfed Lowland

Cases 1 through 3 and 5 in Table 4-5 show the target values adopted in 1988 by WARDA, which made a fresh start as a CG-IAR center, for its research strategy for the period from 1990 to 2000. Meanwhile, Case 4 in Table 4-5 shows the calculation results based on the estimated data for rice cultivation by type of cultivation and the estimated average yield by type of cultivation given in Table 4-2.⁹ As WARDA itself regards this type of statistical data as not being very reliable, the analysis below takes such limitation into consideration.

What is absolutely clear is that, since 1990, WARDA has devoted all of its strength (some 60-80% of its research resources) to improvement of the rainfed upland rice cultivation. As a result, it has achieved the epoch-making creation of NERICA varieties in the academic field. However, the contribution share of rainfed upland rice in the doubling of the overall rice production in the last 15 years is a mere 10% compared to 52% by rainfed lowland rice and 24% by irrigated *sawah* rice. This is quite different from the target adopted 15 years ago. Since its establishment, the traditional development target of WARDA has been rainfed upland rice cultivation (which commands priority because rice cultivation sites in West Africa are rainfed upland) and its research and development strategy has been established on that basis. In reality, however, farmers and local governments themselves have accelerated the trend towards irrigated *sawah* rice cultivation in lowland areas, indicating the need for a major change of the strategy to favor the expansion of *sawah* based rice cultivation (particularly in rainfed lowland areas). The urgency for changing the strategy is verified by the field survey in this study. Moreover, research staff of WARDA who have replaced previous staff in recent years emphasize that the medium to long-term strategic target is improvement of the water management for rice cultivation in rainfed lowland areas.

Dr. Kanayo F. Nwanze, the Director General of WARDA, believes that the special achievement of NERICA is the development of “a new technology” (combination of Asian rice and African rice) rather than “a product” and stresses the promotion of new research efforts to further develop this technology. According to Dr. Nwanze, the NERICA varieties developed so far (for rainfed upland rice cultivation) are considered to play the role of short-term relief and it will be sufficient if these varieties provide the opportunity for the stabilization of rainfed upland rice cultivation in Guinea, Côte d’Ivoire, etc. While the Study Team members basically agree with this view, there is a risk of the unexpected wide extension of upland NERICA varieties due to the strong attention paid by the mass media and others resulting in the undesirable spread of degraded farmland. Although the inflow of refugees due to the civil war in Sierra Leone has been mainly responsible for the spread of degraded farmland in Guinea and the careless extension of NERICA varieties must be coupling with soil and water conservation measures, in order to prevent a further spread of degraded farmland. Judging from the trend of rice cultivation in West Africa in the last 10 years, the participatory and low cost development of *sawah* fields in rainfed lowland areas may not be only a medium to long-term target but may also represent the most effective

⁹ Defoer, T., Wopereis, M. C. S., Jones, M. P., Lançon, F. and Erenstein, O., “Challenges, Innovation and Change: Towards Rice-Based Food Security in Sub-Saharan Africa,” article presented at 20th session of the International Rice Commission, Bangkok, July 23-25, 2002, pp. 1-25.

development strategy at present for an environmental conservation-type sustainable expansion of rice production.

4.2.3 Promotion of Inland Valley Bottom Farming Method: Technical Cooperation for New Style, Small-Scale Irrigated *Sawah* Field Development at Low Cost, Supporting Self-Help Efforts of Farmers

(1) Côte d'Ivoire

Short-Term Perspective

To start with, it is hoped that a comprehensive study to formulate a medium to long-term rice production and environmental conservation strategy will be conducted in five main countries (Guinea, Ghana, Côte d'Ivoire, Nigeria and Mali) based on properly compiled statistical data on rice cultivation, including the findings of (i) research using the remote sensing technology and (ii) a study on different types (forms) of rice cultivation and soil degradation caused by the slash and burn method of farming. This could be followed by low cost, small-scale *sawah* field development projects with some two phases of five years each using the Food for Work program of WFP as described in Section 5.4. This is a new method for irrigation system development to assist the self-help efforts of poor farmers and is also new to WFP itself. As described in (3) below, the creation of a new method is hoped for in full collaboration with the inland valley bottom farming method promoted in Ghana, Nigeria, etc. For this purpose, coordinators/advisors should be dispatched to WFP, ANADER (the National Rural Development Agency) or PASEA (the Farming System Improvement Project for Small-Scale Irrigated Agriculture) to establish linkage between the WFP program and PASEA. It would also be possible to collaborate with AICAF and other organizations that can support the cultivation of NERICA varieties.

The WFP method is an excellent result achieved by one Japanese coordinator in cooperation with staff members of WFP and ANADER. In regard to JICA's past project-type technical cooperation in the irrigated rice cultivation field, four or five experts have been respectively responsible for such fields as extension, water management, irrigation and drainage, rice cultivation, vegetable cultivation, agricultural machinery, etc. However, the excessive specialization had led to a lack of overall coordination in some cases. As West African countries have improved their general capability, the key to the success of low cost technical cooperation may be the adoption of a single coordinator or a one-man project method where the work in individual specialist fields is left to local counterparts.

Medium to Long-Term Perspective

The expansion of sustainable development in small lowland catchment areas is hoped for by establishing linkage between WFP and PASEA/CFMAG (the Agricultural Mechanization Training Center). Such development should be systematically linked to 2KR (the Grant Aid for the Increase of Food Production). A project combining WFP, PASEA, CFMAG and 2KR should be formulated as a wide area training and development project with a view to extending the project from Côte d'Ivoire to neighboring Guinea, Burkina Faso and Ghana (also in collaboration with the ARI). What is important is the consolidation of a national program by means of strengthening CNRA (the National Agriculture Research Center) instead of continually relying on WARDA. Self-reliance is possible when the promotion of

bilateral research cooperation using JIRCAS becomes a reality as in the case of Thailand. In the meantime, experimentation with (i) the integrated development of a catchment area incorporating forestry, agroforestry, lowland paddy field development, reservoirs, fish culture, etc. and (ii) a pilot environmental conservation project is hoped for which a view to restoring a degraded catchment area covering several million hectares dotted with cropped ironstone.

(2) Guinea

Short-Term Perspective

Urgent assistance is required to prevent farmland degradation and forest destruction due to the continual inflow of refugees in the last 10 years. Politically, Guinea is the most important West African country for Japan as it embodies African idealism in the forms of resistance to Western colonization and the quest for ethnic equality as well as African unity. In a historical context, Japan was the first country in the world to express its support for President Sekou Toure, who aimed at achieving Guinea's true independence from the De Gaulle regime. The preferable first step is the dispatch of an advisor on agricultural policies with a view to the joint preparation of Japan's contribution to the comprehensive promotion of agriculture, forestry and fisheries as well as environmental conservation with the Government of Guinea. For this reason, statistical data on rice should be developed using the remote sensing technology, findings of a study on soil degradation by type of rice cultivation, including the slash and burn cultivation and others. A comprehensive study should then be conducted using the properly established data to prepare medium to long-term rice cultivation and environmental conservation strategies as in the case of Côte d'Ivoire. At present, SG2000, an international NGO, is providing assistance which mainly focuses on rice cultivation. However, there appears to be a real need for assistance on a bilateral base (including JICA) in addition to private sector-led assistance.

Medium to Long-Term Perspective

The inflow of refugees caused by the civil wars in Sierra Leone and Liberia in the last 10 years has had a large impact on local farming and the restoration of catchment areas covering more than several million hectares where ironstone has outcropped due to traditional shifting cultivation using the slash and burn is essential. It is hoped that an integrated development project featuring forestry, agroforestry, lowland *sawah* field development, reservoirs, fishponds, etc. and a pilot project for environmental conservation will be implemented with emphasis on the restoration of degraded farmland and the regeneration of forests. In the past, North Korea has provided assistance on agricultural technologies for lowland *sawah* fields in Guinea because of the personal friendship between President Sekou Toure and Chairman Kim Il Sung. In recent years, however, such assistance has been far from satisfactory because of the economic and food crises in North Korea. Consequently, lowland *sawah* field development appears to be conducted on the initiative of farmers. However, the reality is poor in terms of the rice varieties planted, fertilizer application, breeding technology and water management. Collaboration with other Asian countries such as Vietnam and Thailand and the active assistance of NGOs should be sought to assist the promotion of lowland *sawah* rice cultivation in Guinea.

(3) Other West African Countries

1) Nigeria

Short-Term Perspective

Nigeria accounts for 50% of the increased rice production in West Africa in the last 20 years. This increase can be mainly attributed to the policy of banning rice imports introduced in 1986 by the then Babangida regime. In the next five years or so, rice production in the country tripled. The subsequent political instability under the Abacha regime, isolation from the international community and limitations of rainfed upland rice cultivation eventually caused the stagnation of rice production in Nigeria as seen in the last five years with the yield showing a declining trend. Nevertheless, as the country still boasts lowland water management attempts in the largest scale in West Africa with the self-help efforts of farmers, cooperation based on the WFP method or the inland valley bottom method described in 4.3.4 should prove highly effective. Nigeria is expected to have a more stable future if the presidential election scheduled in June 2003 is successfully held. At present, the JICA Nigeria Office has three staff members, none of which is an expert of rice cultivation. If there is a security problem in the next couple of years, the dispatch of two or three experts (an agronomist specializing in NERICA and other rice varieties and a coordinator for lowland *sawah* field development) through IITA, etc. may be an idea. One highly effective method for the low cost development of new *sawah* fields is the provision of power tillers, fertilizer, pesticides and rice polishing/processing equipment under 2KR to be linked to the actual development of small-scale irrigated *sawah* fields and to be managed by a coordinator/advisor.

2) Ghana

Ghana gives priority to lowland development in terms of rice production. The country has been increasing its rice production in the last 10 years and is currently implementing a project to develop 50,000-100,000 ha of new *sawah* fields in the next 10 years to achieve self-sufficiency in rice (the current self-sufficiency rate is approximately 50%). The Small-Scale Irrigated Agriculture Promotion Project, project-type technical cooperation by JICA, achieved its targets in five years and a follow-up project lasting for two years is currently in progress, including the rehabilitation of some facilities. Integrated inland valley bottom development that has been implemented near Kumasi with JICA's research cooperation has produced the inland valley bottom farming method, "Ecotechnology Approach to Sawah Development in Inland Valley". This is a new lowland *sawah* field development method enabling autonomous development and, therefore, represents a further step forward from the WFP method. A follow-up project should be implemented with the dispatch of a coordinator associated with 2KR.

4.3 International Cooperation in Research and Extension of Rice Farming in West Africa

4.3.1 Introduction

Rice cultivation in West Africa has been led by WARDA for the last 30 years and its past and current situation can be summarized as follows.

- 1) Traditional rice cultivation in the region is dominated by rainfed upland rice cultivation (more than 80% of the total rice cultivation area). Continuous research and extension activities focusing on the improvement of mainly upland rice varieties and farming systems, however, have failed to achieve significant results. As shown in Table 4-5, WARDA's 10 years target was upland rice improvement, but major production increase came from the improvement of lowland rice during 1984-1999. The development of NERICA, which is an important achievement of WARDA's recent research, is an extension of its past research strategy emphasizing rainfed upland rice cultivation.
- 2) There has been hardly any research on the development of sustainable irrigated *sawah* fields while the implementation of various development projects mainly featuring civil engineering work has relied on ODA funding. As a result, *sawah* field development has proved to be costly as it does not match the economic situation in the region. The transfer of rice cultivation techniques based on the completed *sawah* field system has been conducted under the project-type technical cooperation scheme. Nevertheless, the permanent establishment of irrigated *sawah* rice cultivation has been found to be difficult, especially in the case of large-scale systems, and the maintenance of such systems has been inadequate in many cases, requiring assistance for a long period of time. Consequently, the present emphasis is placed on the rehabilitation of facilities constructed under past irrigated *sawah* field development projects.
- 3) There is no fully established method in West Africa to develop new irrigated *sawah* fields of which the further development is possible without external assistance.

4.3.2 Overview of Leading Rice Cultivation Areas in West Africa (1986 – 2001)

(1) Progress of Establishment of *Sawah* Rice Cultivation

Rice cultivation in West Africa using African rice varieties (*Olyza glaberrima*) originated from slash and burn cultivation combining flood plain (including deep water) cultivation in inland deltas in Mali and fonio cultivation at highland in Guinea. After the 15th Century, Europeans brought Asian varieties through coastal areas in connection with the slave trade, developing rice cultivation in mangrove belts. In the 1950s, Britain established the first research institute for irrigated *sawah* rice (currently the National Cereals Research Institute of Nigeria) at Badeggi near Bida City in central Nigeria. However, it was not until cooperation by Taiwanese teams in the 1960s and 1970s that a genuine proliferation of *sawah* rice cultivation techniques throughout West Africa was achieved. Côte d'Ivoire was the central focus of Taiwanese activities.

Figure 4-3 shows the overview of major rice cultivation areas studied by Wakatsuki from 1986 to 2001. The black dots on this map indicate the soil sampling sites of Wakatsuki to compare the soil fertility to that of *sawah* fields in tropical Asia and Japan. Table 4-7 outlines the general conditions of these rice cultivation sites. Figure 4-4 shows the dispatch of Taiwanese engineers to Côte d'Ivoire while Figure 4-5 shows the general picture of Taiwanese technical cooperation for *sawah* rice cultivation in Africa in the 1960s-1970s. Table 4-8 summarizes the results of the comparative analysis of soil fertility.

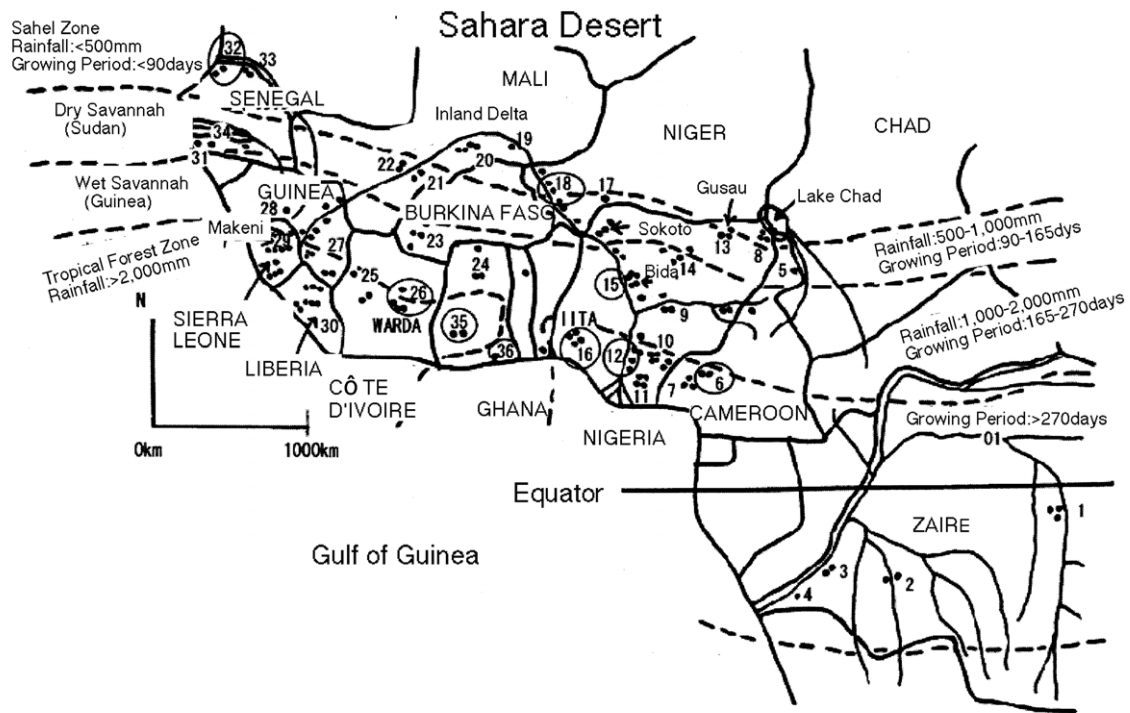


Figure 4-3 Major Rice Producing Areas in West Africa (1986-2001)

Note: The numbers show the places indicated in Table 4-7; circled numbers are Japan-assisted irrigated rice projects.

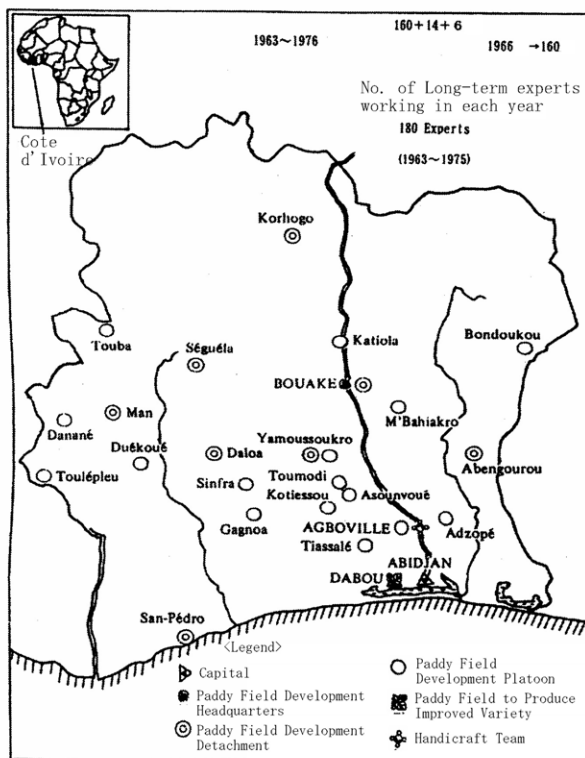


Figure 4-4 Development of Taiwanese Experts in Côte d'Ivoire

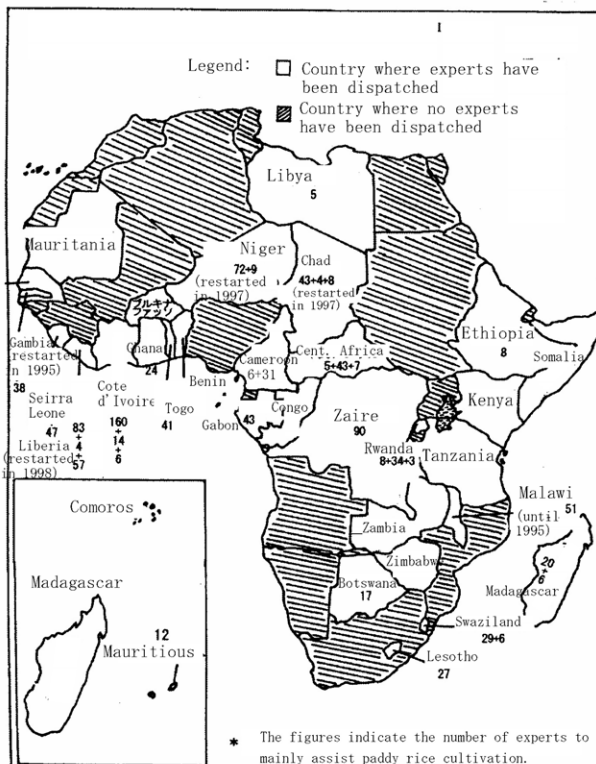


Figure 4-5 Distribution of Taiwanese Experts in Africa

Table 4-4 above shows the changes of the planted area, production, yield, etc. in the last 30 years under the auspices of the Office du Niger in Mali. A steady increase of the yield commenced in the early 1990s. The direct cause of this increase was the effective use of a high yield variety (introduced from Sri Lanka, etc.), in turn achieved by (i) the spread of water management techniques to farmland of individual farmers and (ii) the effective application of fertilizer. The efforts of farmers to improve the efficiency of water use at each *sawah* field by properly sealed creating ridges using a plow drawn by two oxen are particularly impressive.

(2) Taiwanese Technical Cooperation for *Sawah* Rice Cultivation

Taiwan has played a pioneering role in technical cooperation for paddy rice cultivation in Africa. In the 1960s when the population of Taiwan was estimated to be approximately 12 million, Taiwan dispatched some 1,200 *sawah* rice cultivation engineers/agronomists throughout Africa to provide grassroots guidance on *sawah* field development and rice cultivation at the village level (Table 4-6). Côte d'Ivoire received the highest number of engineers as shown in Figure 4-4 and Figure 4-5 and, at a peak in the mid-1960s, 180 experts were stationed at more than 20 sites, creating the foundations for the country's inland valley bottom *sawah* fields seen today. As this technical cooperation only continued for some 10 years because of Taiwan's loss of diplomatic ties with Africa to Mainland China, confusion and stagnation occurred in the 1980s. Nevertheless, the foundations for the WFP method that was introduced in 1999 were laid prior to the withdrawal of Taiwan's cooperation.

Table 4-6 Irrigation Facilities Constructed by Taiwanese Agricultural Technical Teams in African Countries (1961-2000): Phase 1 (1961-1974) and Phase 2 (1995-2002+)

Country	Irrigation canal (m)	Drainage canal (m)	Dam	Pumping station	Irrigated land (ha)
Botswana	6,650	3,701	5	10	44
Burkina Faso	89,345	57,860	1	0	2,447
Cameroon	28,611	16,282	36	1	209
Central African Republic	35,957	7,787	4	18	153
Chad	69,909	34,900	0	4	578
Dahomey (Benin)	62,690	83,480	2	6	782
Gabon	39,265	44,872	0	27	257
Gambia	130,322	20,083	1	172	1,372
Ghana	13,068	11,538	1	1	108
Ivory Coast	1,000,828	619,865	161	0	5,475
Lesotho	26,803	11,907	7	8	133
Liberia	96,136	139,235	10	5	845
Libya	1,000	0	0	1	2
Malagasy	12,599	16,250	7	1	190
Malawi	132,172	149,680	1	4	1,383
Mauritius	783	920	0	0	3
Niger	680,730	44,666	0	25	1,569
Rwanda	164,120	122,253	0	0	821
Senegal	34,330	19,908	10	18	817
Sierra Leone	18,106	11,056	6	12	117
Swaziland	16,683	9,737	0	2	103
Togo	48,200	36,660	3	8	284
Zaire	78,572	64,003	8	12	550
Total	2,783,579	1,523,643	263	335	18,244

Source: Hsieh, Sung-Ching, "Agricultural reform in Africa – With special focus on Taiwan assisted rice production in Africa, past, present and the future perspectives", *Tropics*, Vol. 11, No. 1, pp. 33-58, 2001.

Table 4-7 Major Rice Development Projects in West and Central Africa (Wakatsuki, 1992 Revised)

<p>(01) Bumba: Irrigated <i>sawah</i> field project by Taiwan (1966 – 1972)</p> <p>(1) Kindu: Traditional slash and burn rice cultivation</p> <p>(2) Kikwit: Taiwanese aid (1966 – 1972) was followed up by Chinese aid (since 1980)</p> <p>(3) Kinshasa: Creation of concrete dam reservoirs and <i>sawah</i> fields by Taiwan (1966 – 1972) and thereafter by China</p> <p>(4) Mbanza Ngungu: Creation of inland valley bottom farmland, weirs and <i>sawah</i> fields by Taiwan (1966 – 1972) and thereafter by China</p> <p>(5) Yagoua: Three project sites in Cameroon are controlled by the SEMARY Corporation (Société d'Expansion de Modernisation de la Riziculture de Yagoua). The Yagoua project pumps water 3 – 4 m from Logone River flowing along the border with Chad. The total <i>sawah</i> field area is 4,800 ha. The Maga project has constructed 27km long dykes to create Lake Maga with an area of 36,000 ha to use the water for the irrigation of 5,300 ha of <i>sawah</i> fields. The Kousseri project is located near Lake Chad. One thousand ha of <i>sawah</i> fields is irrigated by pumping water from Logone River with a head of 8-10 m. The problem lies with the declining water supply and the gradual disappearance of Lake Chad due to the rainfall declining.</p> <p>(6) Barigon Plain: Model <i>sawah</i> fields constructed by Nippon Koei; irrigation with weirs; 100 ha model <i>sawah</i> fields; potential development of 3,000 ha at the piedmont of a volcano; cold damage due to the high elevation above 1,000 m; infertility caused by peaty soil</p> <p>(7) Ndop Plain and Mbo Plain: development potential of 20,000 ha of irrigated <i>sawah</i> field with dams and weirs</p> <p>(8) South Lake Chad Irrigation Project: A large pumping project covering 50,000 ha failed because of the lowered water level of Lake Chad, losing more than ¥10 billion (Nigerian oil money). Technical assistance was provided by Pakistan.</p> <p>(9) Makurdi: Pumped irrigation of some 200 ha. The pump is broken.</p> <p>(10) Abakaliki: The traditional rice cultivation method is described in Okigbo (Ruthenberg, 1980). Mounds of several meters in diameter and 1 m in height are made to plant yams, cassava, maize, etc. at the upper part of these mounds while rice and cocoyams are cultivated on low land between the mounds (an extreme case of mixed cultivation).</p> <p>(11) Bende: The population density is higher than 500/km². Traditional rice cultivation commences around June when natural rainwater begins to accumulate in the bottom of valleys and harvesting is conducted around November in the dry season when the water recedes. The farming method is basically similar to the flood plain farming method. Accordingly, rice is cultivated in inland valley bottom areas without <i>sawah</i> fields. At the end of the 1970s, the World Bank implemented a small-scale irrigated rice cultivation project, creating a total of some 1,000 ha of <i>sawah</i> field supported by weirs and irrigation channels. These facilities have not been sufficiently repaired.</p> <p>(12) a) Adani-Adarice: The development of 500 ha of <i>sawah</i> fields by the World Bank and another 500 ha of <i>sawah</i> fields by Nihon Koei had been completed by the mid-1980s. These are irrigated <i>sawah</i> fields using weirs. b) Uzo Uwani: A yen loan project of a Japanese consortium consisting of Nihon Koei, Taisei Corporation and C. Itoh Corporation (around 1984 – 1988), followed by project-type technical cooperation of JICA (1989 – 1994). The large pumps became unmanageable after some 10 years although farmers were expanding the planting area, mainly for rainy season cropping (observed in 1998). The total area of <i>sawah</i> field development is 4,000 ha.</p> <p>(13) Gashua and Sokoto: Traditional cultivation areas of African rice varieties. The cultivation of African rice varieties has a long tradition at the huge flood plain formed at the confluence point with Niger River. Sokoto is the central city on the said flood plain while Arugungu is the center for rice cultivation. The recent construction of several dams in the upstream has had the effect of suppressing a rise of the river water level, resulting in loss of income in traditional African rice cultivation areas using natural flooding.</p> <p>(14) Kaduna: Inland valley bottom rice cultivation sites (non-<i>sawah</i> paddy field) are located around Kaduna and fonio can be grown on degraded land.</p> <p>(15) WIN (Watershed Institute of Nigeria, 2001)/Hirose Project/AICAF Inland Valley Bottom Project: The project sites are located in key rice cultivation areas by Nupe and are the central areas for rice cultivation in West Africa. The cultivation methods are inland valley bottom quasi-<i>sawah</i> and ridged rice cultivation on flood plains. The rice cultivation sites cover a total area of some 200,000 ha. A traditional irrigation system also exists. The oldest weir irrigation system in West Africa and the oldest rice research institute are located at Badeggi. The Head Office of the Nigeria Crop Research Institute is also located at Badeggi.</p>
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- (16) Weired reservoirs and irrigated *sawah* fields of the IITA exist and a high yield of 5-10 tons/ha is possible due to the high soil fertility level.
- (17) Between Birnin Konni and Dogondoutchi: Although the area is generally a plain in the Sahel zone, water accumulates in minor concave areas (both the circumferential length and relative height are less than 1 m) to allow the semi-cultivation of an African rice variety.
- (18) Niamey: Taiwan provided the original technical guidance (1964 – 1974; 1,569 ha) for an irrigated rice cultivation project involving medium size pumps to irrigate several hundred to several thousand ha of *sawah* fields. Some 100 ha of irrigated *sawah* fields developed with Japanese grant aid are managed at Koutoukale.
- (19) Near Gao: Traditional deep water cultivation of an African rice variety on the flood plain of Niger River
- (20) Mopti: Major areas of traditional deep water cultivation of African rice on the flood plain of Niger River
- (21) San: The traditional cultivation of an African rice variety on the flood plain is now facing a crisis as the construction of the Marukara Weir near Segou has prevented the occurrence of natural flooding.
- (22) At the peak time, 100,000 ha of land was irrigated to produce rice and sugar cane. By 1989, the irrigated rice cultivation area had declined to slightly less than 40,000 ha with a poor unit yield. Guidance on rice cultivation was provided by some 50 continental Chinese. After that, a Dutch team successfully introduced plowing using oxen and the yield had subsequently increased to 5 tons/ha by the time of a revisit in 1998, as seen in Table 4-4, constituting a successful example of large-scale *sawah* field development. However, it took more than 30 years to reach this successful stage. The variety used was obtained from Sri Lanka rather than WARDA of which the contribution to this project was small because of WARDA's weakness in terms of irrigated *sawah* rice cultivation projects in general.
- (23) Banfora: Burkina Faso has a rice cultivation area of some 30,000 ha, most of which is accounted for by inland valley bottom sites without *sawah* fields. An irrigated rice cultivation area of some 1,000 ha exists at Vallee de Kou near Banfora. Irrigation uses the gravity system with weirs. Originally constructed with Taiwanese aid, the weirs were rehabilitated and maintained by a Dutch team in 1987 following the withdrawal of the Taiwanese team in 1973. In 1996, Taiwan resumed its assistance for rice cultivation techniques. At Vallee de Kou, plowing using oxen has become a standard practice and the *sawah* fields were well managed when visited in 1998.
- (23') Taiwanese team assisted the development of 1,100 ha of irrigated *sawah* fields (supported by weirs and reservoirs) at Bagre near the border in the northeastern corner of Ghana (completed by 2000).
- (24) Tono Irrigation Project: Upland rice is cultivated at most of Ghana's rice cultivation area of some 130,000 ha. The combined area of irrigated *sawah* fields and inland valley bottom rice cultivation sites is 10,000 ha which is far smaller than the potential area for irrigated *sawah* fields. The Tono Project was initially a typical example of failure of irrigated rice cultivation with the technical assistance of Westerners (1987). Korea has subsequently provided technical guidance and the present management is good (2000). While Ghana has the huge Lake Volta created by the Akosombo Dam to the north of Accra, the lake water has hardly been used for irrigation up to the present. The African Development Bank is currently implementing a project to develop 5,000 ha of *sawah* fields (2000). Another project to develop 5,000 ha of *sawah* fields in inland valley bottom areas with a total budget of US\$ 20 million is searching for a donor. JICA is implementing a rehabilitation project under its grant aid scheme. JICA has also been implementing project-type technical cooperation, (the Small-Scale Irrigated Agriculture Promotion Project) since 1997.
- (25) (26) Daloa/Sakasso/Katiola/Mbe/Djebonoua: Although there is hardly any tradition of rice cultivation in inland valley bottom areas in these areas, efforts to develop *sawah* fields have been continuing since the *sawah* field farming extension activities of Taiwan. The inland valley bottom project site of AICAF is located in the Djebonoua Dam Irrigation Zone to the south of Bouake. JICA is implementing an inland valley bottom irrigated *sawah* field and small-scale irrigated farming improvement project under its grant aid scheme. From 1990 to 1995, JICA provided project-type technical cooperation for mechanized irrigated *sawah* rice cultivation.
- (27) Guedkdou: Guinea has the largest area for inland valley bottom rice cultivation among West African countries. In many cases, *sawah* rice is cultivated next to upland rice. As Guinea has a long history of rice cultivation, African rice varieties are still cultivated in some areas. The Guedkdou area located in the headwater area of Niger River is a center for rice cultivation in West Africa. Unlike Nupe in Nigeria, rice cultivation basically relies on rainfed fields. The Programme Agricole du Guedkou (PAG) has been in progress since 1987 with the assistance of the World Bank. There is a high potential for inland valley bottom *sawah* field farming and grassroots cooperation should prove effective in Guinea.
- (28) Kindia: There are model *sawah* fields assisted by North Korea (1988).
- (29) Makeni: Sierra Leone is more of a rice-eating country than Guinea. Inland valley bottom *sawah* fields developed by Taiwan are still seen in many places although some have been destroyed. A *sawah* rice

- experiment station called the Chinese Farm exists at Bo. Volunteers from the US Peace Corps have been dispatched throughout the country. However, their efforts to assist *sawah* rice cultivation in some areas were unsuccessful because of their lack of experience (observation made in 1988 and 1989). There is strong concern in regard to the adverse impacts of the civil war that started in 1990 on rice cultivation in the country.
- (30) Gharnga: Liberia is similar to Sierra Leone in terms of rice cultivation. However, peat soil is found in some inland valley bottom areas, presumably because the decomposition of organic matters is suppressed by fresh water, reflecting the relatively high level of annual rainfall. The Central Agricultural Research Institute (CARI) is located at Suakoko near Gbarnga. CARI plays a central role in rice research in Liberia and a representative of WARDA has successfully bred Suakoko-8 for local planting albeit on a small-scale. Like Sierra Leone, there is concern in regard to the adverse impacts of the long civil war on farming. Taiwan recommenced its cooperation for rice cultivation in 1998.
- (31) Zinguinchor/Kounkane: Casamance is a long-established rice growing area. Since the elevation is low, seawater invades fairly deep inland during the dry season. The SODAGRI irrigation project is located near Kounkane and has several hundred hectares of irrigated *sawah* fields. Irrigation uses the gravity system with a weir across a medium size river.
- (32) Debi: There are large-scale pump-irrigated *sawah* fields on the flood plain of Senegal River. The project has been financially assisted by the World Bank, USAID, France, etc. and Vietnamese engineers and agronomists are playing an important role as employees. The project is characterized by direct planting, salinization and high soil fertility. In addition, many medium-scale pumped irrigation projects covering an area of 100 – several hundred ha have been implemented by Japan, Korea, Taiwan, France, etc. A Japanese project is located at Ndjago. As the stable political situation has allowed continuous ODA, Senegal appears to be the only country in West Africa where pumped irrigation has been successful.
- (33) Fanaye: There is an irrigated rice cultivation experiment station of WARDA near Richard Toll. Small pumps are mounted to rafts floating on Senegal River so that pumping can continue regardless of fluctuations of the river water level. Each village manages one pump to irrigate several 10 ha of *sawah* fields and vegetable fields.
- (34) Kuntuar/Wassu: This tidal irrigation project in Gambia is assisted by Taiwan. Local farmers made capital contribution to the village bank which provides a small loan together with fertilizer, seeds and pesticides. Nine families of Taiwanese *sawah* rice cultivation engineers live in this village located 250 km from Banjul, the capital. In the house of Taiwanese experts, electricity is generated by an independent generator. Gambia resembles a rice growing country in Asia.
- (35) Biemso No. 1/No. 2: These are inland valley bottom project sites of JICA under the research cooperation scheme (1997 – 2001).
- (36) Ashiaman: A small-scale irrigated farming development project site of JICA (1999 – 2002 – 2004)
- (37) Rokupr: A mangrove rice cultivation experiment site of WARDA in Sierra Leone (closed down since 1990)

References:

- Hsieh, Sung-Ching, Agricultural Reform in Africa - With Special Focus on Taiwan-Assisted Rice Production in Africa, Past, Present and Future Perspective, *Tropics*, Vol. 11, No. 1, pp. 33-58, 2001.
- Hirose, S. and Wakatsuki, T., *Restoration of Inland Valley Ecosystems in West Africa*, Tokyo: Association of Agriculture and Forestry Statistics, March 2002.

Table 4-8 Comparison of Soil Fertility of *Sawah* Soils in West Africa, Tropical Asia and Japan

Location	Total C (%)	Total C (%)	Available P (ppm)	Exchangeable Cation (cmol/kg)				Sand (%)	Silt (%)	Clay (%)	CEC/Clay (%)
				Ca	K	Mg	eCEC				
West African Small Inland Lowland Area	1.3	0.11	9	1.9	0.3	0.9	4.2	60	23	17	25
West African Flood Plain Area	1.1	0.10	7	5.6	0.5	2.7	10.3	48	23	29	36
<i>Sawah</i> Field in Tropical Asia*	1.4	0.13	18	10.4	0.4	5.5	17.8	34	28	38	47
<i>Sawah</i> Field in Japan	3.3	0.29	57	9.3	0.4	2.8	12.9	49	30	21	61

Source: Kawaguchi and Kyuma, 1977.

(3) Fertility of Lowland Soil in West Africa

As shown in Figure 4-3 and Table 4-7, Wakatsuki studied lowland agriculture in entire West Africa up to 1998, starting with his assignment to IITA as a JICA expert on *sawah* pedology (soil science) for two years from 1986 to 1988 and subsequent short-term assignments as well as various academic studies in West Africa. Sample soil was collected from 185 inland valley bottom sites and 62 flood plain sites, both types of which had strong potential for *sawah* field development, and the fertility of these soil samples was compared with the study results of Kawaguchi and Kyuma on *sawah* soil fertility in tropical Asia and Japan (Table 4-8).

The results of this comparison show that while the total nitrogen content of West African soil is similar to that of tropical Asia, the level of available P and the exchangeable cations are much lower than those in tropical Asia, illustrating the progress of artificial soil degradation in addition to strong weathering and leaching. In addition, the wide distribution of soil lacking such trace elements as sulfur and zinc in West Africa is substantiated. Traditional cultivation in West Africa that commenced with African rice varieties is an extension of the cultivation of miscellaneous grains and rainfed upland rice cultivation and *sawah* rice cultivation techniques have not yet been fully established. The above soil analysis results suggest the distribution of extremely poor soil even by world standards because of the accelerated degradation of soil by the slash and burn cultivation which destroys forests and non-*sawah* field-type rice cultivation in lowland areas.

4.3.3 Trends of Agricultural and Forestry Production and Rice Cultivation in West Africa in Last 30 Years

(1) Rapid Increases of Rice Production, Consumption and Imports

In the last 30 years, rice production in West Africa has increased by 280%, far exceeding the rate of increase of maize, sorghum and millet for the same period. Cassava is the only crop other than rice which has recorded an increase rate above 200% during this period (240%) (Table 4-9). As described in Chapter 3, the rapid increase of per capita consumption has resulted in a rapid increase of rice imports despite the production growth, forcing many West African countries to spend precious foreign currency. This increase of rice production, however, has been brought about by the expansion of rainfed upland rice cultivation in Côte d'Ivoire, Guinea and many parts of Nigeria. In other words, increased rice production has been accompanied by the destruction of the forest environment. Although in the past 30 years, a major increase in rice production came from the expansion of forest destruction and upland rice cultivation, as seen in Tables 4-2 and 4-5, *sawah*-style rice cultivation of various levels of water controls, especially in inland valleys, are continuously increasing in recent years. Irrigated *sawah*-based rice cultivation has been expanding in Mali, Senegal, Ghana, Niger and Mauritania. Côte d'Ivoire has also recently expanded small-scale *sawah* fields. This trend accelerates if recent civil war will end soon. Guinea, too, has signs to increase similar *sawah* development after the end of civil war in Liberia and Sierra Leone.

To prevent environmental deterioration, the development of sustainable paddy fields is essential to replace upland rice cultivation. However, there is a problem of how to accelerate *sawah* rice cultivation originating in the Asian monsoon zone to West Africa of which the ecological, cultural, historical and socioeconomic conditions vastly differ. It will be now be

important to target the gross root extension and technology transfer of *sawah*-based lowland rice farming based on the various precious experiences, both successes and failures, of the past 30 years. The WFP method (Section 5.4) and the inland valley bottom farming method (Section 4.3.4) are examples of such new methods. Rice is now becoming an important crop of which the production rivals that of such traditional crops as millet, sorghum and maize. Despite its growing status as a main staple food, rice is the only local crop recording massive imports, reducing the food supply self-sufficiency rate.

(2) Deforestation and Increase of Wasteland

The historical changes of land use in the last 24 years in West Africa are shown in Table 4-10. While the agricultural area has increased by some 12 million ha, the forest area has decreased by some 22 million ha. Wasteland has increased by 9 million ha. The plantation area growing tree crops has increased by 2.5 million ha in Côte d'Ivoire, but no significant change has taken place in other countries. Deforestation and the increase of wasteland are the most conspicuous in Côte d'Ivoire at 3 million ha and 6.7 million ha respectively, followed by Nigeria at 3.2 million ha and 3.1 million ha, Guinea at 4.8 million ha and 1.2 million ha and Ghana at 3.2 million ha and 0.3 million ha. The ratios of the deforested area and wasteland in the national land area are particularly large in Côte d'Ivoire and Guinea, both of which have seen a major increase of rice production. Benin has also seen the large-scale deforestation of 1.7 million ha and an increase of wasteland of 1.1 million ha. While West African countries have achieved increased food production, they are facing increasingly severe environmental problems, including forest destruction, farmland degradation and an expansion of wasteland. There is a definite need for cooperation and assistance with a balanced approach for increased food production and environmental conservation.

4.3.4 Establishment of Inland Valley Bottom Farming Method: Main Achievements of Hirose Project (1992 – 2000) and JICA Joint Study on “Integrated Watershed Management of Inland Valleys in Ghana and West Africa 1997 – 2001”

(1) International Cooperation for *Sawah*-Based Farming Development up to the Present

Although various ODA projects have been implemented by Taiwan and Japan for the transfer of *sawah*-based farming technologies, conventional efforts to develop irrigated *sawah* fields at a high cost with ODA have currently stalled. Apart from the difficulty of technology transfer, the biggest problem is that the producer price of rice of US\$ 1,000/ha based on a high yield of 5 tons/ha cannot pay the development cost which is as high as US\$20,000-30,000/ha (Table 4-3). Neither the large-scale irrigation method in the past nor the small-scale irrigation method which is the mainstream of *sawah* field development at present has been able to overcome this problem. What is required is a new development method and a farming method which can achieve a yield of 3-5 tons/ha with a development cost of some US\$3,000/ha. Meanwhile, the spontaneous development of *sawah* fields by the grassroots efforts of farmers and others is widely spreading even though the management level of these *sawah* fields is still low.

Table 4-9 Production and Yield of Main Crops in West Africa in Years 1970-1998 (FAO, 1981, 1990, 1998, 1999, Hsieh 2001)

(Unit: 10, 000tons. The figures in parentheses show the yield (tons/ha).)

	1969/1971						1989/1991						1997/99						Increase		
	Rice (Paddy rice)	Maize	Sorghum	Millet	Root/ tuber crops	Legumes*	Rice (Paddy rice)	Maize	Sorghum	Millet	Root/ tuber crops	Legumes*	Rice (Paddy rice)	Maize	Sorghum	Millet	Root/ tuber crops	Legumes*	(10,000 ha)	(10,000 tons)	(tons/ha)
Benin	tr	20	5	1	113	3	1	41	11	2	185	6	3	74	14	3	378	10	0.1	2	20
	...	(0.6)	(0.6)	(0.4)	(7.0)	(0.3)	(1.4)	(0.9)	(0.8)	(0.7)	(8.5)	(0.6)	(2.1)	(1.2)	(0.8)	(0.7)	(10.7)	(0.7)			
Burkina Faso	4	6	53	35	10	15	4	22	92	60	11	17	9	36	117	89	6	7	0.3	5	17
	(0.9)	(0.7)	(0.5)	(0.4)	(4.2)	(0.4)	(2.1)	(1.0)	(0.7)	(0.5)	(5.9)	(0.4)	(1.9)	(1.4)	(0.8)	(0.7)	(30.3)	(0.8)			
Chad	4	1	39	23	30	6	6	3	28	17	64	6	10	15	60	33	63	6	...	6	...
	(1.0)	(1.9)	(0.7)	(0.6)	(3.9)	(0.4)	(3.0)	(0.6)	(0.6)	(0.5)	(5.5)	(0.4)	(1.3)	(1.2)	(0.7)	(0.4)	(4.4)	(0.6)			
Cote d'Ivoire	34	26	1	3	229	1	69	48	2	4	425	1	122	57	2	7	504	1	21	88	4.2
	(1.2)	(0.8)	(0.5)	(0.5)	(4.1)	(0.6)	(1.2)	(0.7)	(0.5)	(0.6)	(5.7)	(0.7)	(1.6)	(0.8)	(0.3)	(0.7)	(5.7)	(0.7)			
Gambia	4	tr	1	3	1	tr	2	2	1	5	1	tr	3	1	1	7	1	0	...	-1	...
	(1.4)	(0.6)	(0.9)	(1.0)	(3.8)	(0.3)	(1.6)	(1.5)	(0.8)	(0.9)	(3.0)	...	(1.5)	(1.3)	(0.9)	(0.9)	(3.0)	(0.3)			
Ghana	6	42	15	12	367	1	8	55	14	8	520	2	20	102	34	16	1,182	2	1.4	14	10
	(1.0)	(1.1)	(0.7)	(0.5)	(6.4)	(0.1)	(1.6)	(1.2)	(0.6)	(0.6)	(6.1)	(0.1)	(1.6)	(1.5)	(1.1)	(0.9)	(10.5)	(0.1)			
Guinea	36	7	1	57	65	3	50	10	3	6	72	6	74	9	1	1	104	6	50	38	0.8
	(0.9)	(1.2)	(0.7)	(0.87)	(7.1)	(0.5)	(0.8)	(1.1)	(1.4)	(1.5)	(6.3)	(0.9)	(1.5)	(1.0)	(0.7)	(0.8)	(6.2)	(0.9)			
Guinea-Bissau	3	tr	tr	1	4	tr	16	2	4	2	4	tr	13	1	2	3	8	0	...	10	...
	(1.0)	...	...	(0.5)	(5.6)	...	(2.2)	(0.9)	(0.9)	(0.8)	(6.2)	...	(1.9)	(1.0)	(1.0)	(0.9)	(7.1)	(0.5)			
Liberia	18	...	...	...	30	tr	24	...	...	...	35	tr	20	...	...	...	36	0	...	2	...
	(1.2)	...	...	...	(3.7)	...	(1.07)	...	...	...	(6.7)	...	(1.3)	...	...	...	(6.8)	(0.6)			
Mali	16	7	587	78	8	3	38	21	75	70	14	7	58	34	55	89	4	11	14.6	42	2.9
	(1.0)	(0.9)	(1.07)	(0.8)	(8.9)	(0.4)	(1.5)	(1.5)	(1.0)	(0.8)	(8.5)	(0.4)	(1.8)	(1.8)	(1.0)	(0.95)	(4.2)	(0.4)			
Niger	3	tr	26	97	19	12	7	1	42	113	25	37	9	1	42	100	24	54	1.1	6	5.5
	(2.1)	...	(0.4)	(0.4)	(9.6)	(0.1)	(2.3)	(1.6)	(0.3)	(0.4)	(7.1)	(0.2)	(1.8)	(1.6)	(0.2)	(0.5)	(6.8)	(0.1)			
Nigeria	55	369	435	326	2,502	85	300	553	479	467	4,960	146	331	542	761	577	5,982	207	121	276	2.3
	(1.3)	(0.9)	(0.7)	(0.6)	(9.6)	(0.2)	(2.1)	(1.1)	(0.7)	(1.0)	(12.8)	(0.8)	(1.6)	(1.3)	(1.1)	(1.1)	(9.7)	(0.5)			
Senegal	12	4	137	54	17	2	16	13	15	51	9	3	18	6	13	45	6	3	1.6	6	3.8
	(1.3)	(0.8)	(0.87)	(0.5)	(4.4)	(0.3)	(2.1)	(1.1)	(0.8)	(0.6)	(4.1)	(0.3)	(2.5)	(0.9)	(0.7)	(0.5)	(3.6)	(0.4)			
Sierra Leone	47	1	1	1	12	3	45	1	2	2	16	4	33	1	2	1	32	4	0	-14	...
	(1.4)	(1.0)	(1.3)	(1.1)	(4.3)	(0.5)	(1.4)	(0.7)	(2.37)	(1.3)	(3.2)	(0.7)	(1.2)	(1.1)	(0.8)	(0.9)	(4.6)	(0.7)			
Togo	2	16	15	12	88	2	3	22	11	5	92	3	9	38	14	4	129	4	1.2	7	5.8
	(0.7)	(1.1)	(1.0)	(0.6)	(13.1)	(0.3)	(1.2)	(1.0)	(0.9)	(0.7)	(7.9)	(0.2)	(1.9)	(1.0)	(0.7)	(0.5)	(7.1)	(0.3)			
West Africa	244	499	663	651	3,495	135	580	794	779	812	6,433	328	732	916	918	976	8,458	316	204	488	2.4
	(1.2)	(0.9)	(0.7)	(0.6)	(8.1)	(0.3)	(1.6)	(1.0)	(0.7)	(0.8)	(10.6)	(0.6)	(1.7)	(1.3)	(0.9)	(0.9)	(9.2)	(0.4)			
Africa	734	2,171	911	968	6,840	478	1,145	3,379	1,278	907	11,963	678	1,686	4,084	2,018	1,292	14,993	780			
	(1.8)	(1.2)	(0.7)	(0.6)	(6.7)	(0.4)	(2.0)	(1.6)	(0.7)	(0.7)	(7.9)	(0.6)	(2.2)	(1.6)	(0.9)	(0.7)	(8.0)	(0.5)			
South America**	957	2,567	405	17	4,662	300	1,622	3,615	354	9	4,463	289	1,863	5,379	463	5	4,517	365			
	(1.7)	(1.5)	(1.9)	(1.0)	(12.0)	(0.6)	(2.4)	(2.0)	(2.6)	(1.7)	(12.2)	(0.5)	(3.4)	(3.1)	(3.3)	(1.2)	(12.6)	(0.7)			
Asia	28,415	5,041	1,878	2,076	18,597	2,137	47,869	12,326	1,887	1,677	24,086	2,614	53,376	16,140	1,339	1,315	27,417	2,731			
	(2.4)	(1.6)	(0.7)	(0.7)	(11.3)	(0.6)	(3.6)	(3.1)	(1.0)	(0.8)	(12.4)	(0.7)	(3.9)	(3.7)	(10.3)	(0.9)	(16.1)	(0.8)			
Japan*	1,628	3	tr	1	68	22	1,312	tr	tr	0	56	15	1,173	...	...	...	491	10			
	(5.5)	(2.7)	...	(1.7)	(19.5)	(1.2)	(6.3)	...	...	(1.8)	(24.3)	(1.6)	(6.3)	...	...	...	(26.8)	(1.7)			

Notes: 1) Japan's output of wheat and barley was 1.25 million tons (yield: 2.7 tons/ha) in 1970 and 1.3 million tons (3.5 tons/ha) in 1990.

2) * The yields of root and tuber crops are very high. But in the case of cassava, whose output is high in tropical Africa, the calorie per unit weight is one-third and the protein content, one-eighth, that of rice and maize.

3) ** South America's wheat output sharply increased (by 1.7 times) from 11 million tons in 1970 to 19 million tons in 1999.

4) "tr" means that the output is trivial.

Table 4-10 Changes of Land Use Pattern in West Africa in Last 24 Years (FAOSTAT 2001, World Resources 1998-2000, Kokuseisha 2000/2001, FAO 1999)

(Unit: 10,000ha)

	1974*					1994					1998					Land area	Total afforestation 1990		Forest area 1998 (%)	Canopy closed original forest area (%)	1998-1974	
	Arable land	Permanent crops	Permanent pasture	Forest and Woodland	Others**	Arable land	Permanent crops	Permanent pasture	Forest and Woodland	Others**	Arable land	Permanent crops	Permanent pasture	Forest and Woodland	Others**		Area	Ratio***(%)			Others (万ha)	Deforestation (万ha)
Benin	133	9	44	497	424	166	14	55	402	469	170	15	55	330	536	1,076	12	3.6	30.7	15.5	112	-167
Burkina Faso	243	2	600	474	1,417	338	5	600	427	1,366	340	5	600	427	1,366	2,736	2	0.5	15.6	0.0	-51	-47
Chad	292	tr	4,500	1,234	6,570	339	3	4,500	1,103	6,647	352	3	4,500	1,103	6,634	12,592	0.4	0	8.8	0.0	64	-131
Cote d'Ivoire	178	185	1,300	1,213	305	291	380	1,300	547	663	295	440	1,300	547	598	3,180	6	1.1	17.2	74.9	293	-666
Gambia	17	tr	19	10	54	18	1	20	9	53	20	tr	20	8	53	100	0	0	8.0	39.1	-1	-2
Ghana	170	160	840	1,100	5	280	170	840	902	83	360	170	833	880	33	2,275	5	0.6	38.7	65.9	28	-320
Guinea	69	43	1,070	756	520	82	60	1,070	670	575	89	60	675	637	997	2,457	0.4	0	25.9	75.6	477	-119 (?)
Guinea-Bissau	26	3	108	107	38	30	4	108	107	32	30	5	108	107	31	281	0	0	38.1	100.0	-7	0
Liberia	13	24	200	489	238	18	20	200	451	274	19	20	200	451	274	963	0.6	0.1	46.8	99.6	36	-38
Mali	177	3	3,000	1,321	8,064	316	4	3,000	1,165	7,717	461	4	3,000	1,125	7,612	12,202	1.4	0.1	9.2	0.0	-452	-196
Mauritania	20	tr	3,925	55	6,252	47	1	3,925	56	6,233	49	tr	3,925	56	6,222	10,252	0	0	5.5	0.0	-30	0
Niger	260	tr	1,018	250	11,139	449	1	1,100	250	10,867	499	tr	1,200	250	10,718	12,667	1.2	0.5	2.0	0.0	-421	0
Nigeria	2,742	248	4,000	1,694	424	3,017	254	4,000	1,378	460	2,820	254	3,920	1,378	736	9,108	15	1.1	15.1	45.1	312	-316
Senegal	235	tr	570	807	313	233	3	570	745	374	223	4	565	725	409	1,925	11.2	1.5	37.6	14.2	96	-82
Sierra Leone	42	5	220	202	247	49	6	220	131	311	48	6	220	131	311	716	0.6	0.5	18.2	100.0	64	-71
Togo	180	8	100	158	98	220	10	100	125	89	220	10	100	80	134	544	1.7	2.1	14.7	32.9	36	-78
West Africa	4,797	691	21,514	10,357	35,740	5,892	936	21,608	8,468	36,203	5,995	995	21,221	8,235	36,664	73,074	58	0.7	11.3	17.1	924	-2,122
Africa	15,212	1,784	89,386	61,400	128,579	17,481	2,340	89,648	52,399	134,489	17,773	2,423	88,767	50,900	136,493	296,357	442	0.6	17.2	2.9	7,914	-10,500
South America	7,473	1,440	46,576	99,095	20,707	9,128	1,995	50,194	88,969	25,007	9,612	1,972	50,298	85,625	27,785	175,293	726	0.8	48.8	55.6	7,078	-13,470
Asia	49,789	3,368	100,536	56,812	98,036	50,166	5,656	105,946	47,756	99,023	49,666	5,958	105,510	46,418	100,990	308,541	5,612	10	15.0	49.1	2,954	-10,394
Japan	498	64	19	2,529	655	466	42	9	2,514	734	454	37	8	2,512	754	3,765	1,130	45	66.7	91.4	99	-17

*Recalculated based on the total area of Asia was $3,085 \times 10^9$ ha instead of $2,757 \times 10^9$ ha because of the division of former USSR.

**Others include built on areas, roads and barren lands.

***Percentage of afforested area among Forest and Woodland area

(2) Introduction of Asian-type *Sawah* Concept to African Rice Farming

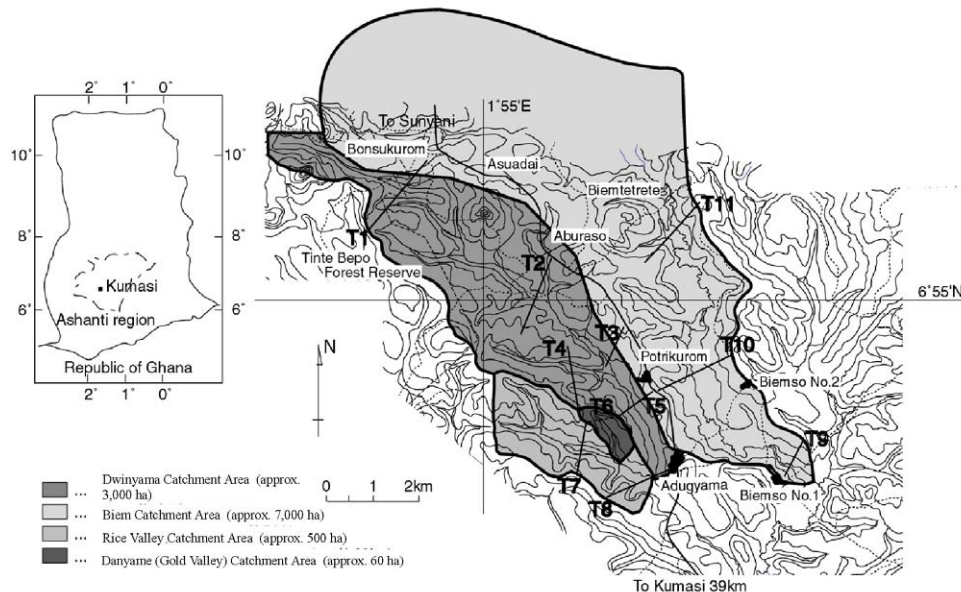
Since 1986, an on-farm demonstration project of *sawah* field farming in an inland valley bottom area has been taking place with the participation of farmers in a benchmark catchment area near Bida situated in the Guinea savannah zone in central Nigeria. This project has shown that a unit yield of 5-6 tons/ha can be achieved with the development of *sawah* fields and that proper management, the use of an available high yielding variety and the restoration of degraded catchment areas, including lowland soil areas in West Africa, are also possible with the development of *sawah* fields.

West Africa has no word or concept to express *sawah* field in an appropriate manner. There is much confusion regarding the word “paddy” which means both “paddy rice” and “paddy field”. Paddy is of Malay/Indonesian origin and means rice as a plant. It is understandable that Westerners without an indigenous rice culture were content to use the word “paddy” to mean “rice” from the original word “padi”. When Japanese who are supposed to have a good understanding of the importance of “suiden nogyou”, or paddy field farming (*sawah*-based rice farming), use the words “paddy”, “paddy field” and “paddy soil” in the belief that they mean “rice growing paddy field”, “paddy rice cultivation site” and “soil of a rice growing paddy field”, respectively. They tend to be understood as “rough rice”, “upland rice cultivation field” and “soil of an upland rice cultivation site”, respectively. As English and French already use the word “paddy” originating from “padi”, it is proposed to use “sawah”, a Malay/Indonesian word, as the global common word to express “wetland paddy field”, i.e., “suiden” in Japanese.

(3) Integrated Watershed Management of Inland Valleys with Farmer Participation: Demonstration of Eco-Technology Approach for Sustainable *Sawah* Development Method (Inland Valley Bottom Farming Method)

In 1996, Wakatsuki’s group commenced the implementation of a research cooperation project with JICA assistance using catchment areas in the transitional forest zone near Kumashi, Ghana as benchmark sites in addition to those in Nigeria (Figure 4-6). Under this project, the creation of various types of *sawah* fields (rainfed-type, spring water-type, small-scale pump-type and simple weir-type) suitable for the diverse topographical, soil and water conditions was attempted with farmer participation, taking basic data on the vegetation, land use and, particularly, the hydrological conditions into consideration. It was demonstrated that a new eco-technology type *sawah* field development method enabling further self-reliant development by farmers was feasible to produce a yield of 3-5 tons/ha with financial input of US\$3,000-4,000/ha to be mainly provided by loans for farmers groups (Table 4-11 and Table 4-12). Here, “eco-technology” means soil and water management technology which can achieve sustainable crop production and environmental restoration and is suitable for the local ecological conditions as well as socio-economic conditions of local community. It is characterized by the simultaneous implementation of engineering work, including the layout design and construction of reservoirs, weirs, ridges and water canals, leveling, etc., together with cultivation techniques based on agricultural science by the farmers themselves. This inland valley bottom farming method of which the viability has been demonstrated can be further developed in the following manner.

- 1) The provision of such inputs to assist increased food production as power tiller, fertilizers and pesticides for farmers groups can be combined with *sawah* field development based on the inland valley bottom farming method to create a new agricultural development method.
- 2) With the sufficient transfer of technology for this inland valley bottom farming method, self-reliant *sawah* farming development programs can be created for the first time in Africa as projects with loans to be provided the African Development Bank, the International Fund for Agricultural Development, etc.



Note: T1 through T11 indicate the transect lines for the monitoring survey on land use, soil and water

Figure 4-6 Project Sites of JICA Research Cooperation “Integrated Inland Valley Bottom Development with Farmer Participation 1997-2001” Using Catchment Areas of Ashanti Region in Ghana as Benchmark

Table 4-11 Proposal for Loan-Based Self-Reliant, African-Type Inland Valley Bottom Farming Method

1. Invitation to participate to sawah (paddy) field development units (10 farmers each).
2. Setting up of US\$6,000 loan: US\$4,000 goes towards a power tiller, US\$1,000 towards the purchase of farming tools, materials to construction irrigation facilities and irrigation pump and US\$ 1,000 towards the operation cost (fertilizer, pesticides, germicide, part, fuel, etc.).
3. Free technical assistance (although the development and cultivation of *sawah* fields are conducted entirely by farmers).
 - 1st – 5th years: Development at a rate of 1 ha/year, totaling 5 ha. No loan repayment during this period. The target is the development of 10 ha in 10 years.
 - 6th year onwards: Commencement of repayment at an annual interest rate of 5%. Annual repayment of US\$1,380 to be completed in five years.
4. 1st – 6th years: The annual income from *sawah* fields, etc. increases to US\$ 1,300-7,500 (unit yield of 3-5 tons/ha).
5. After 6th year: US\$7,500 -1,380 (annual repayment) = approximately US\$5,000 (net profit).
6. Renewal of the power tiller in the 5th year for which repayment commences after a further five years.
7. Development of new *sawah* fields continues in the 6th year onwards: The annual income is US\$ 1,000 per household provided that each household develops 1 ha of new *sawah* fields.
8. With the increased income, the planting of multi-purpose trees and fish culture are conducted.
9. Once on the right track, this method can recover the *sawah* field development cost.

Table 4-12 Estimation of *Sawah* Field Development Cost (Dollar Basis per Hectare)

Type of <i>Sawah</i> Field	Rainfed			Pump	Spring Water	Pump + Spring	Weir and Water Canals
	0.29	0.16	0.61				
Trial area (ha)	0.29	0.16	0.61	0.078	0.6	0.62	1.80
Estimation based on labor input (man/day) (1)	5,100	4,800	3,800	5,900	4,100	2,400	2,000
Estimation based on soil movement by topographical survey (2)	4,040	3,000	3,400	5,040	3,100	2,400	2,700
Average of (1) and (2)	4,570	3,900	3,600	5,500	3,600	2,400	2,350
Cost of agricultural equipment	1,080	1,080	1,080	1,080	1,080	1,080	1,080
Total costs (US\$/ha)	5,650	4,980	4,680	6,580	4,680	3,480	3,430

Note: Costs of agricultural equipment (the lives of pumps and power tiller are assumed to be five years.)

1. Power tiller: US\$ 4,000/5 ha US\$ 800/ha
 2. Small pump: US\$500/5 ha US\$ 100/ha
 3. Miscellaneous cost is 20% of purchase cost: US\$900/5 ha US\$ 180/ha
- Total US\$1,080/ha

The total development costs above are estimated based on the average cost of the cost based on the soil movement volume and the labor cost in the actual experiment (man/day) plus the cost of agricultural equipment (power tiller, etc.)

Although this JICA research cooperation project ended in FY 2000, farmers groups steadily developed new *sawah* fields by means of self-reliant work in FY 2001 and FY 2002 as shown in Figure 4-7. Dr. Nwanze, the Director General of WARDA, who visited the site in August 2002, highly evaluated the large potential of this method for self-reliant development.

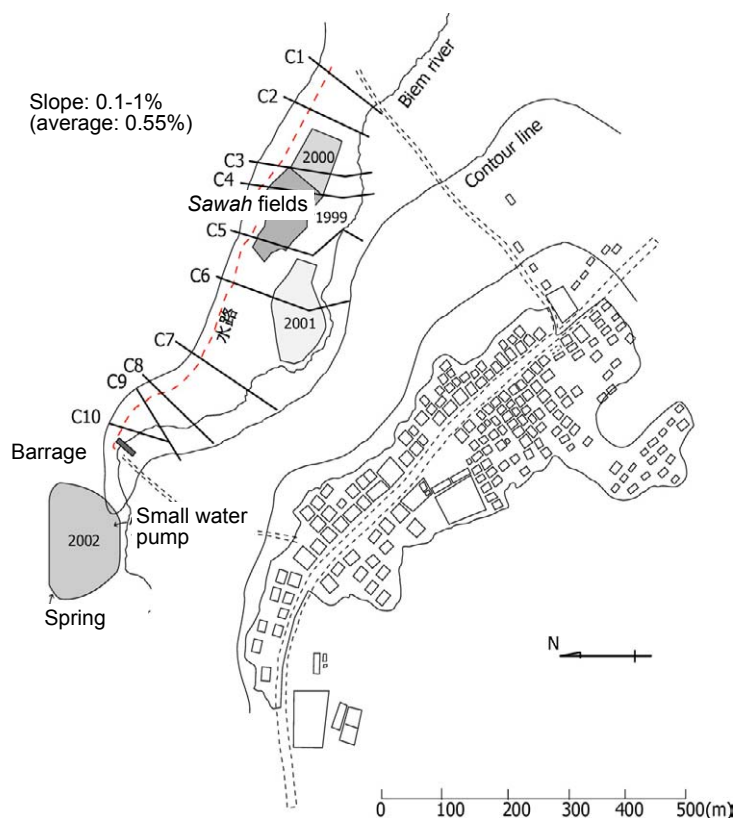


Figure 4-7 Voluntary Development of *Sawah* (Paddy) Fields by Farmers in Biemso No.1 Village

Note: C1 through C10 indicate the transect lines for the topographical survey. The gradient of lowland in the parallel direction to the water channel is 0.0-0.2% while the gradient of lowland in the direction traversing the water channel is 0.2-1.0%. In areas above the water channel, the gradient is more than several percent. A farmers group with some 10 members steadily developed new paddy fields from 1999 to 2002. The potential area for this paddy filed system with a simple dam and water channel is approximately 10 ha beyond Transect Line C7. In 2002, a different farmers group opened up some 2 ha of new paddy field that uses a small water pump as well as spring water from a fountain.

CHAPTER 5 CASE STUDY 1: RICE FARMING IN COTE D'IVOIRE

5.1 Political and Economic Conditions and Agriculture

Côte d'Ivoire is one of the countries in West Africa to enjoy political and economic stability. Since its independence in 1960 until the end of the 1970s, it achieved economic development which can be described as a “miracle” and which was partly attributable to France, its former suzerain state. The “miraculous” average annual economic growth rate of almost 10% in these 20 years was based on “a miracle of agriculture” achieved by the policy of emphasizing agriculture under the leadership of President Houphouët-Boigny (1960 – 1993).¹

Unlike almost all other African countries which have tried to achieve industrial development by keeping the prices of agricultural products artificially low, the Houphouët-Boigny regime promoted agricultural production through price support for agricultural products and subsidies for agricultural inputs. Consequently, the country became the world's largest cocoa exporting country in 1979 and also became a major African exporting country of pineapples and palm oil. The country practically achieved self-sufficiency in rice in the mid-1970s.

In the early 1980s, however, the country faced an economic crisis due to deteriorating international prices of primary products and severe drought. During this period, the country's external debt sharply increased and the government declared default to the Paris Club as well as the London Club in May 1987. As a result, a structural adjustment program commenced in September 1989 under the auspices of IMF and the World Bank. The government implemented a reduction of its annual expenditure, the reorganization of state enterprises and a reduction of the producer price of cocoa, among others, in subsequent years and the economic growth rate was restored to the 6-7% level in the second half of the 1990s (Appendix 3). In early 1999, however, the IMF loan was suspended on the grounds that the economic improvement measures were insufficient, followed by the suspension of an EU loan as a result of the discovery of corruption involving about FCFA 1.8 billion by EU.

In December 1999, a military coup d'état led to the establishment of an interim government headed by General Guei, a former Chief of Staff, replacing President Bedié and causing total confusion in domestic politics. Laurent Gbagbo was elected as the new president by a general election in October 2000 and the domestic situation was stabilized for a while until September 2002 when armed conflict restarted. Because of the current instability, many development projects have been delayed.

Agriculture is still the key industry in Côte d'Ivoire as it accounts for 80% of the workforce and some 30% of the GDP. Having experienced a crash of the international price of cocoa in the 1980s, successive governments have tried to diversify agricultural products in a departure from the previous over-dependence on cocoa and coffee. However, the situation of agriculture has little improved because of the insufficient progress of privatization and market liberalization that have been taking place under the structural adjustment program. Cocoa and coffee are still the main export products supporting the economy of Côte d'Ivoire. The main

¹ Else, D. et al., *West Africa*, Melbourne: Lonely Planet Publications, 1999, p. 273. According to the annual *World Development Report* of the World Bank, the average growth rate was 7.1% from 1965 to 1973 and 6.8% from 1965 to 1980.

food crops consist of maize, rice, yams, cassava, taro, bananas, sorghum and millet. While rice has traditionally been the main staple food in the western mountain area and part of the savannah zone, its consumption has been expanding nationwide, particularly in urban areas, because of its longer storage period, easier transportation and greater versatility for processing and cooking than other food crops.

5.2 Rice Supply and Demand Trends

Among West African countries, Côte d’Ivoire enjoys a relatively high level of rainfall and its natural conditions are favorable for rice cultivation. The government has, therefore, encouraged rice cultivation and self-sufficiency was practically achieved in the mid-1970s under the guidance and supervision of the Rice Cultivation Development Corporation (SODERIZ).² In subsequent years, however, rice imports increased because of the decline of systematic production assistance, in turn caused by the reorganization of SODERIZ and an increase of the urban population.

The liberalization of agricultural products in 1995 flooded the domestic market with cheap imported rice, seriously denting the willingness of farmers to produce rice. This situation was exacerbated by the termination of the government’s financial support for the fuel cost of pumped irrigation, pesticides/fertilizer (distributed free of charge) and the collection, threshing and marketing of rice. As shown in Figure 5-1, even though rice production continually increased during the 1990s, it failed to meet the rapidly increasing domestic demand, resulting in the annual import of 300,000-500,000 tons at a cost of US\$100-160 million.³ The average self-sufficiency rate from 1991 to 2000 was 60%. Rice is beginning to have important implications in regard to the question of Côte d’Ivoire’s food self-sufficiency.

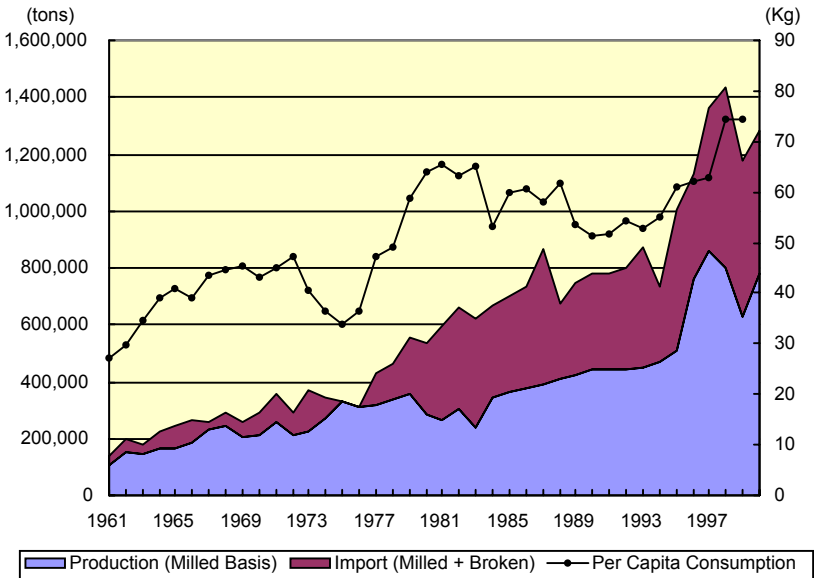


Figure 5-1 Trends of Rice Production and Import in Côte d’Ivoire (Milled Basis, 1961 – 2000)

Data Source: FAOSTAT Database (<http://apps.fao.org/>).

2 Ajiro, K., “Agriculture in Côte d’Ivoire, Part 2, Agricultural Products”, p. 10.

3 FAOSTAT Database (<http://apps.fao.org/>). The value of rice imports was equivalent to one-eighth to one-fifth of Côte d’Ivoire’s total export value of cocoa.

One serious problem faced by the government in the promotion of increased rice production is the competition with cheap imported foreign rice. In recent years, the price gap between domestic rice and imported rice (normal rice) in the Abidjan market has been widening (Table 5-1) because of the sluggish international market price (see Chapter 3). Although the people of Côte d'Ivoire are said to prefer the taste of domestic rice, low priced imported rice is an attractive option for low-income people who comprise the majority of consumers. According to the National Rice Program (PNR), domestic rice cannot compete with cheap imported rice even though the domestic transportation cost is hardly a consideration because of the better developed national road network in Côte d'Ivoire compared to other West African countries.

Table 5-1 Recent Changes of Retail Price of Milled Rice in Abidjan Market in Côte d'Ivoire

Year/Month Type	2000												2002					
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Domestic Rice	282	286	286	290	298	310	324	319	297	275	272	270	284	273	273	276	280	289
Imported Rice: Normal Grad	250	252	252	251	237	244	240	227	229	241	248	240	223	208	203	201	200	205
Imported Rice: High Grade	497	506	522	355	592	600	600	600	594	574	553	548	581	540	503	503	500	498

Note: Euro 1 = FCFA 655.957 as of August 2002.

Source: National Institute of Statistics (INS)/National Rice Program (PNR), *Riz Infos*, 1^{er} Trimestre, 2000, 2^{eme} Trimestre, 2000 and 2^{eme} Trimestre, 2002.

The main rice exporting countries to Côte d'Ivoire are major rice exporting countries in Asia, e.g., Thailand, Vietnam, China, India and Pakistan, though their ranking appears to vary from one year to another (Table 5-2). In the first half of 2002, Myanmar became the second exporting country of rice to Côte d'Ivoire. As described in Chapter 3, all of these Asian countries aim at increasing their rice exports to Africa and other regions to compensate for their sluggish domestic consumption. Their productivity is far higher than that of Côte d'Ivoire (the yield is 3-5 tons/ha on a rough rice basis, see Chapter 2). If the declining trend of the production cost continues, it will pose a great threat to the development of rice cultivation in Côte d'Ivoire.

Table 5-2 Main Rice Exporting Countries to Côte d'Ivoire

January – December, 2000			January – June, 2002		
Country	Volume (tons)	%	Country	Volume (tons)	%
China	182,386	41.1	Thailand	99,039	37.9
Thailand	88,621	20.1	Myanmar	63,581	24.3
Pakistan	62,592	14.2	India	41,291	15.8
South Vietnam	39,255	8.9	China	29,026	11.1
North Vietnam	33,685	7.6	Taiwan	11,681	4.5
USA	26,835	6.1	USA	6,046	2.3
Taiwan	4,000	0.9	Pakistan	5,208	2.0
Japan	3,275	0.7	South Vietnam	3,986	1.5
Egypt	100	0.0	West Indies	1,000	0.4
India	60	0.0	Egypt	225	0.1
Others	50	0.0	Others	60	0.0
Total	440,859	100.0	Total	261,141	100.0

Source: National Institute of Statistics (INS)/National Rice Program (PNR), *Riz Infos*, 1^{er} Trimestre, 2000, 2^{eme} Trimestre, 2000 and 2^{eme} Trimestre, 2002.