

## **PART 5**

### **CASE STUDIES ON TECHNOLOGY TRANSFER FOR RICE PRODUCTION TO AFRICA**



## **CHAPTER 9. TRANSFERRING RICE PRODUCTION TECHNOLOGY FROM TAIWAN TO AFRICAN COUNTRIES**

During the period between 1950-1965, the Republic of China on Taiwan was greatly benefited by the aid of the US, which laid the foundation for economic growth. After enjoying considerable economic growth, the ROC on Taiwan started to think about how to help other developing countries. Taiwan currently maintains extensive international economic cooperation programs. Taiwan's most widely celebrated international economic cooperation programs are the Agricultural Technical Missions, with a history of 40 years in some sixty nations. This unprecedented program for agricultural cooperation was initiated on the purpose of helping friendly nations to increase food production to feed their ever-increasing populations. It also aimed to transfer the technology of agriculture production to small farms.

The first Agricultural Technical Missions began in the early 1960s in Africa under a program entitled "Operation Vanguard". The program was supervised by an executive group of four standing members from the Ministry of Foreign Affairs, the Ministry of Economic Affairs, the Council on U.S. Aid, and the Joint Commission on Rural Reconstruction. Starting from November 1972, all official technical assistance programs were transferred to the Committee of International Technical Cooperation (CITC), a semi-autonomous agency financed by the ROC government. The CITC was reorganized into the International Cooperation and Development Fund (ICDF) in July 1996. The ICDF is continuing the CITC's work of international technical cooperation.

After receiving a request of technical assistance from a country, the ROC first sends a survey team of experts to visit the country to assess feasibility. The study mission works together with the officials of the host country to study various subjects including agricultural policy, environmental and climatic conditions, and status of agricultural production, limitations, and possible solutions. A preliminary recommendation for possible areas and the scope of cooperation would then be drafted by the study mission.

The officials of the host country carefully study the recommended proposal. If both parties agree, the drafted proposal would be written in the form of an "Agreement" or "Memorandum of Understanding (MOU)" which will be signed by representative officials of both parties. After the signing of the "Agreement" or

"MOU", the ICDF will dispatch a team of experts to that country to set up a technical mission. A budget for project operations, including machinery, equipment, and other supplies will be sent to the cooperating country from Taiwan by ICDF to support the project. The Taiwanese Agricultural Technical Mission usually works hand in hand with the local counterpart. In this way, the project can be carried out smoothly. The mission is required to submit a written report from time to time to the authority of the host country and also to the ICDF.

Generally speaking, agricultural project is performed in four steps: (1) field experimentation, (2) field demonstration, (3) transfer of technology through training, and (4) extension of selected varieties of crops and methods of culture. Special emphasis is given to the promotion of rice, corn, sorghum, fruit tree, and vegetable production.

This Chapter is to focus on the Taiwan assisted rice production in eleven African countries, including Burkina Faso (Upper Volta), Benin (Dahomey), Central African Republic, Chad, Cameroon, Gambia, Guinea-Bissau, Ivory Coast, Liberia, Malawi, Mauritius, Niger and Senegal. The impact of Taiwan assisted rice production on cooperating countries, and the factors contributing to their success or failure were analyzed. The future perspectives of technical cooperation in rice production between the ROC on Taiwan and these African countries are also discussed.

## **9-1. Scope and method of agricultural technical cooperation**

In the early days of CITC, enhancing rice production by using improved varieties and adopting the modern methods of cultivation was the primary goal. Production of rice was soon expanded to include many locally important food crops (sorghum, maize, soybean, and sweet potatoes), vegetables, and fruit trees. The process of local adoption of new crops involved a series of experiments to determine the best-suited varieties, planting dates, cultural and pest control methods. The work was soon extended to build necessary infrastructures such as irrigation systems, storage houses, land reclamation, etc.

The number of countries cooperating with Taiwan grew from 2 in 1961 to the accumulated number of 68 until 1996. A total of 2,094 experts and technicians under 105 missions worldwide at various times were involved. The accumulated number of specialists during the period of 1961-1996 totaled 11,799. Currently 291 experts under

41 missions are working in 34 countries in Africa, Central America, South America, the Caribbean, Middle East, Asian Pacific and European areas.

## **9-2. General description of Africa**

Africa is the largest continent in the southern hemisphere, spanning across the equator from 37 degrees north latitude to 35 degrees south latitude and covering 70 degrees in longitude at its widest point. It has enormous ecological diversity, embracing two temperate zones, two subtropical regions and a tropical zone. It covers 30.27 million square kilometers of land mass, including the immense Sahara desert, several large lakes, vast savannas, timber land, bottom land, tropical rain forests, and mangrove swamps.

The 655 million Africans are largely agriculturally based. The caloric sources consist of coarse grains (sorghums, millets), maize, wheat, rice, root and tuber crops (yam, cassava, sweet potato, and taro). Asian rice is the preferred cereal and it now replaces indigenous African rice species. Rice also brings in cash income for the farmers. Industrial crops include cocoa, coffee, cotton, rubber, and sugarcane. Most farm families keep livestock. Local industries are generally associated with exportable commodities.

Land wise, limited cropland on one hand, and poor soils on the other handicap Africa. Rainfall is unreliable most years, adding instability to food production. While irrigation projects have been implemented in many countries in recent decades, their benefits cannot cope with the increasing demand for more food on limited croplands. Government authorities have given high priority to food production. Nearly one half of the 54 independent nations are devoting one quarter of their national budget to agriculture and two-thirds of them allow the local market to set food prices. However, improved health has led to a rapid rise in human population. With scarcity of croplands, the competition for land has encouraged the migration of able-bodied workers to urban areas. These developments have further strained the efforts to increase food production.

Thus, Africa presents great challenges and at the same time, offers magnificent opportunities for Taiwan agriculturists and other technologists to transfer their expertise and experience of rice culture to their African friends in a genuine effort to enhance their livelihood. The Taiwan-assisted rice productions in 13 African countries

in the past 39 years are described in the following paragraphs. Activities of some other African nations, due to limited space, were not included in this Chapter.

### **9-3. Taiwan cooperative rice production with regard to technology transfer in African countries**

#### **9-3-1. Burkina Faso (BF)**

##### **9-3-1-1. General situation**

The land area of BF is 274,000 sq. km. Tropical wet-dry climate in south, and semi-arid climate in north with rainy season in May-October. BF is a land locked Sahelian, low-income food deficit country. Sorghum, millet, pulses and maize are main food crops. Rice is also an important crop in the area where water is available. According to FAO (2001), previous five years average production of rice was 94,000 tons, coarse grains 2,338,000 tons and 2,432,000 tons in total. Previous five years import of wheat was 58,000 tons, rice 99,000 tons, coarse grains 18,000 tons and 175,000 tons in total. Estimated per capita consumption of wheat was 5 kg/year, rice 17 kg/year, coarse grains 180 kg/year and 202 kg/year in total. Share of cereals in total calorie intake was 73 %.

With the reduced crop production, the overall food supply situation was always tight in several deficit areas. Price of food increased sharply in the north. The government planned to distribute 34,000 tons of food aid to 527,000 vulnerable people in 25 provinces. Self-sufficiency of 34,000 tons of food by enhanced food production program is currently the main target of the government.

##### **9-3-1-2. ROC-BF technical cooperation**

The first phase of ROC-BF cooperation began in May 1965 and ended in September 1973. The initial activities included: surveying of project sites, planning irrigation facilities that would improve water use efficiency, land reclamation, experimental planting of rice, field demonstration, training of local extension workers and farmers, and extension of farming techniques to new settlers. Four projects were implemented in successive stages covering 2,167 hectares of projected land area (Table 9-1).

*(1). Boulbi and Louda areas*

The main operations were to rehabilitate and strengthen the rock-filled earthen dams built during colonial days, line the irrigation channels with concrete, add lateral canals, build drainage channels, and add farm roads. Rice, coarse grains, beans and cotton were planted on the new land. Field trials of introduced rice varieties led to the selection of better-adapted and more productive varieties under proper fertilization. Irrigation water was distributed under a rotational irrigation scheme developed in Taiwan. Rice yields reached between 3 to 6 t/ha. The acreage of rice culture extension at Boulbi and Louda areas totaled 513.70 hectares, with a total production of 2,475 tons of rice during the period of 1965-1970 (Table 9-2).

**Table 9-1. Projects in Burkina Faso (Upper Volta).**

Location	Project	Duration	Reclaimed acreage (ha)	Settled farmers families	Farm family members
Boulbi	1. Land reclamation				
	2. Develop irrigation systems for paddy rice cultivation	4/65-8/69	87	250	1,000*
Louda	1. Land reclamation				
	2. Develop irrigation systems for paddy rice cultivation	12/66-6/70	120	465	1,860*
Kou	1. Land reclamation				
	2. Building a dam at upper stream of Kou River				
	3. Construct irrigation infrastructure	1/67-9/73	1,260	913	5,480**
	4. Move farmers to upstream zones of the Black Volta				
Bagre	1. Land reclamation				
	2. Irrigation canal construction to take water from Bagre water reservoirs	1/96-12/2000	1,150	1,100	4,400
	3. Move farmers to the newly reclaimed land				
Total			2,617	2,728	12,340

\* Calculated based on 4 persons/family.

\*\* Actually recorded number.

**Table 9-2. Acreage of extension and yield of rice in Boulbi and Louda in Burkina Faso during years of 1965-1970.**

Location	Year	Acreage of extension (ha)	Unit yield (kg/ha)	Total production (kg)
Boulbi	1965	16.43	3,288	54,006
	1966	70.84	3,450	244,390
	1967	65.80	3,517	231,378
	1968	70.63	5,180	366,013
	Total	223.70		895,787
Louda	1968	63.00	4,968	313,000
	1969	112.00	5,429	608,000
	1970	115.00	5,723	658,200
	Total	290.00		1,579,200
Grand total		513.70		2,474,987

*(2). Kou project area*

At the Kou project area, the site was selected to make best use of the abundant water flow of the Kou River. A diversion dam with a water inlet was built below the Diordougou Village. Water channels consisted of 11 km of canals, 10 km of laterals, 11 km of sub-laterals and 73 km of branched sub-laterals. Farm roads measuring 15 km with 84 km of side roads were constructed. The facilities served 1,260 hectares of reclaimed land. Of the three project areas, this is the largest reclamation operation, serving 913 families and 5,480 people. Rice yields of above 5 t/ha were obtained on the 1,260 hectares of reclaimed land.

Through the above efforts, rice yields were raised to 12 t/ha on a double-cropping system, raising production level by nearly 20 times. Six rice crops were grown during 1970-73 with water resources fully utilized. As the result of extension work done by the Taiwanese mission, a total of 12,058.21 tons of rice were produced from the Kou area covering 2,078 hectares of land. The total income earned from the selling of rice was amounted to 278,707,641 CFA, which brought in 134,123 CFA for each rice farmer (Table 9-3).

**Table 9-3. Acreage of extension and yield of rice in Kou, Burkina Faso in 1970-1973.**

Years and crops	Acreage of extension (ha)	Average yield (kg/ha)	Total yield (kg)	Total income (CFA)
1970 (II)*	100	6,813	68,262	16,350,288
1971 (I)	104	6,610	687,480	16,499,520
1971 (II)	316	6,842	2,161,979	49,725,517
1972 (I)	322	6,968	2,243,764	51,606,572
1972 (II)	607	6,014	3,650,396	83,959,108
1973 (I)	629	4,187	2,633,332	60,566,636
Total	2,078	5,803	12,058,213	278,707,641

Note: (1) \* I, II: 1st and 2nd crops respectively.

(2) Average price of rice per kg is 23.11 CFA.

(3) Average income of each household is calculated to be 134,123 CFA.

The unprecedented returns from this project not only impressed the top officials of the country, but also the foreign staff of other international organizations stationed there. The U.S. Embassy donated a school and an infirmary. The Food and Agriculture Organization (FAO) of the United Nations, provided food and crop production subsidies at the beginning of the first planting season. The World Bank also indicated willingness to provide soft loans to the country, if technical assistance from the Taiwanese Mission could be made available. With the greatly increased income (calculated by French journalists at US\$ 871 per farmer), farmers built rice milling plants and market places. They were also able to buy motorcycles, radios, and furniture. Some built new houses, and others bought draft cattle.

Phase I of the Taiwan-BF cooperation ended in September 1973, when diplomatic relation took a sudden turn. The Taiwanese Mission turned over the management of the irrigation facilities to the local authorities, before it left the country.

Phase II of the Taiwan-BF cooperation resumed in 1994. At the Kou project area, assistance was extended to the renewal of seeds of improved rice varieties and guidance on improved cultural practices. Such work was disrupted after 1973. Nevertheless, past efforts greatly upgraded the local economy and the local population has grown to 55,000 people. When the Taiwan delegation led by the author (Hsieh, 1994) visited the project area, we found that our former headquarters had been

converted to a farmer's cooperative. About 500 local residents came to greet the Taiwanese visiting team – a moving experience by the author

*(3). Bagre area*

The second-phase of the Taiwan-BF collaboration was resumed in 1994. Both countries were anxious to continue the fruitful cooperation of the earlier years. Before a formal agreement was drawn up, Taiwan sent a team headed by the author (Hsieh, 1994) to survey the Bagre area for an irrigation-and-reclamation scheme. Further field visits and studies by the Taiwan delegations have agreed to honor the host country's desire to increase annual rice production from 40,000 to 70,000 tons.

**Table 9-4. Land reclamation project of Taiwan-ATM at Bagre area of Burkina Faso (1996-2000).**

Year	1996	1997	1998	1999	2000	Total
Length of main irrigation canal (km)	1.5	3.5	4.0	4.0	2.5	18.0
Reclaimed acreage (ha)	23	227	300	300	150	1,150

1. Expected annual rice production 10,000 MT.

2. Expected No. of households benefited 1,000

3. Expected No. of population benefited 7,000

**Table 9-5. Rural development plan for newly reclaimed Bagre area in Burkina Faso.**

1. Establishment of new village:

Ten villages (about 100 households each) were established to accommodate a total of 1,100 households of new immigrants from other districts.

2. One Farmer's Association was established at each village

3. Infrastructure building

(1) Establishment of four primary school to accommodate 1,440 children.

(2) Three Health Centers were established.

(3) Ten warehouses were built.

(4) Numerous underground wells were dug to supply drinking water.

(5) Road construction.

(6) Reforestation was enforced.

**Table 9-6. Taiwan assisted upland rice extension work in Burkina Faso between 1996-2000.**

Year	1996	1997	1998	1999	2000
Reclaimed acreage (ha)	300	500	800	1,000	1,150
No. of farmers benefited	1,200	2,000	3,200	4,000	4,000

1. Expected acreage of extension: 3,600 ha.

2. Expected Annual production of rice: 9,000 Mt.

### 9-3-1-3. Method of upland rice extension work

1. Variety used: FRK33.
2. Supply of rice seeds and fertilizer: In 1996 free seeds of rice were supplied to farmers together with free fertilizer (one bag of urea and 2 bags of mixed compound fertilizer per hectare of rice field). Micro-lending was extended to farmers to buy fertilizers starting from 1997.
3. Yield 1.5 t/ha – 4.0 t/ha.

The Nakanbe River will help to improve the irrigation capabilities at the Bagre dam in Kenkodoko County. The dam was designed to irrigate 30,000 hectares of land, but the gravity-fed irrigation water served only 80 hectares, and crop yields are low. The host country needs to develop 3,000 hectares of irrigated land per year in order to attain the production goal of a 30,000-ton increase. After careful studies and seeing the effects of a recent flood, the mission initially developed 1,150 hectares of land on the right bank of the river (Table 9-4). Meanwhile, a consortium of eleven international organizations plans to develop 2,165 hectares on the left bank in cooperation with the Taiwanese Mission.

Currently, a rural development plan has been made for the local government to develop the newly reclaimed Bagre area into a community center. The project included the establishment of new villages, schools, health centers, etc. (Table 9-5).

Thirteen members of the mission are concentrating their efforts not only on the lowland paddy rice, but also on the extension of upland rice in the water deficient dry areas. Free seeds of rice and fertilizer have been provided to the farmers during the initial stages. The project of upland rice extension covers 1,150 hectares of land, which benefits 4,000 farmers. The target acreage of extension will be 3,600 hectares with an expected annual rice production of 9,000 tons. To attain this goal, the Taiwanese technicians also trained 29 local cadre and 2,989 farmers to adopt

improved varieties and cultural practices. The mission staff also spent time in the Banfora reclamation area in the southwest region of the country to improve the irrigation facilities at Tapea, Banfora, and Dakiri.



Fig.9-1. Construction of irrigation canal as a part of land reclamation project at Bagre, Burkina Faso.



Fig.9-2. Irrigation water intake control gate at Kou built by Taiwanese Mission. Fifteen-km long irrigation canal takes water through this gate to irrigate the newly reclaimed rice field of 1,260 ha at Kou, Burkina Faso. The author (second from left) posed with the farmers at the water gate.



Fig.9-3. A part of 1,100 hectares of rice field at Bagre. On this field, rice yielded 6 tons per hectare for one crop. Two crops are grown in a year, bringing 12 tons of rice yields per hectare per year.



Fig.9-4. The author (second from right) and Mr. Ing-Yenn Fang, Leader of the Taiwanese Mission (first from right) posed with the farmers in celebrating a good harvest of rice at the Bagre plantation, Burkinas Faso.

## 9-3-2. Chad

### 9-3-2-1. General situation

Chad is a land-locked Sahelian country. The area of Chad is 1,284,000 sq. km. Chad has arid, semi-arid and tropical wet-dry climate with rainy season from May to October. Road condition is usually inadequate during rainy season. Millet, sorghum, roots and tuber crops and tree nut are the main food crops produced. Like Burkina Faso, rice is grown during rainy season. According to FAO (2001), previous five years average production of wheat was 3,000 tons, rice 111,000 tons, coarse grains 957,000 tons and 1,071,000 tons in total. Previous five year average import of wheat was 56,000 tons, rice 9,000 tons, coarse grains 9,000 tons and 74 tons in total. Share of cereals in total calorie intake was 52 percent. Estimated per capita consumption of wheat was 9kg/year, rice 9 kg/year, coarse grain 111 kg/year and 129 kg/year in total. Food production is far behind the need of 7.56 million population (2001 estimate) of the country. Following a below average harvest in 2000, the food supply situation was tight in the chronically deficit areas of the Sahelian zone. In the Sudanian Zone, the food situation was also tight in rice producing areas sharply. A World Food Program is providing 27,000 tons of food aid to 355,000 people in the Sahelian area.

### 9-3-2-2. Taiwan-Chad Technical cooperation

In April 1964, the ROC signed an agricultural technical cooperation agreement with Chad, and sent a team of specialists to help improve agricultural production in May 1965. The members of the mission increased to 43 in 1972 with the expanded extension work.

#### *(1). Phase I (1965-1972)*

Irrigation facilities were built to irrigate an area of 350 hectares. They included 3,667 m of main canal, 5,500 m of lateral canal and 16,800 m of sub-lateral canal. A total of 46 checking gates of irrigation canals and 57-drainage conduit were also built during the years 1965-1972 (Table 9-7). Farm demonstrations and extensions were conducted primarily on two demonstration farms; one in Fressou (Bongor) on five hectares of land, and the other in Nya (Doba) on four hectares of land. A training center was built at Doba, and 500 hectares of highland was reclaimed with local farmers. A total of 1,347 farmers received training organized by the Taiwanese mission. An average of 6 t/ha of rice was produced as the result of the extension work.

**Table 9-7. Irrigation facilities built by Taiwan-ATM in Chad (1965-1972).**

Items	Amount	Items	Amount
Irrigated area	350 ha	Checking box	168
50-horsepower pump	4	Lateral conduit	18
Pumping station intake	1	Drainage conduit	57
Pumping station structure	1	Main canal	3,667 m
Bridge	1	Lateral canal	5,500 m
Siphon for main canal	2	Sub-lateral canal	16,800 m
Main conduit	1	Main roads	10,700 m
Lateral siphon	5	Rural roads	13,200 m
Gate	5	Measuring frame	5
Checking gate	46		

*(2). Phase II (1997-Onward)*

The new mission's work was targeted on the development of upland rice production on the 2,000 hectares of dry land, and 500 hectares of paddy rice on the irrigated land. A deep underground well was dug and irrigation facilities were constructed to irrigate the land based on rotational system of irrigation. Training programs for extension farmers are organized from time to time by the mission. Seeds of rice will be further multiplied for the increasing need of farmers in Chad. The targeted annual production of rice is 15,000 tons. It is expected that the continued service of the Taiwanese mission will allow an increase in job opportunities for 5,000 households. Taiwanese Technical Mission are doing a very interesting work on egetable production and marketing in Djadeya area near from N'Djamena. Farmers earned lot of money; they had their own account in the bank. It is an interesting case of technology transfer from Taiwan.

### **9-3-3. Cameroon (1964-1971)**

#### **9-3-3-1. General situation**

Cameroon has a land area of 465,000 sq. km. It has tropical wet-dry weather in the north and tropical wet climate in the south. Length of rainy season declined from 11 months in south to 4 months in extreme north. Population size was 15.49 million (2001 estimate). It is a low income (G.N.P. per capita income US\$ 580 in 1999) food deficit coastal country. Major crops are roots and tuber crops, coarse grains and fruit.

Share of cereals in total calorie intake is 39 percent. The overall food supply situation is satisfactory except in the extreme north.

According to FAO (2001), previous five years average production of rice was 81,000 tons, coarse grains 1,181,000 tons and 1,262,000 tons in total. Previous five years average import of wheat was 182,000 tons, rice 94,000 tons, coarse grain 13,000 tons and 289,000 tons in total. Estimated per capita consumption of wheat was 12 kg/year, rice 9 kg/year, coarse grain 82 kg/year and 84,000 tons in total. FAO/WFP estimated food aid needs were at 19,000 tons for 80,000 families affected by poor crops due to drought, flooding and pest attacks in the north and extreme north provinces. Cereal import for domestic use and re-export was estimated by FAO to be 310,000 tons mostly wheat and rice. The amount of rice import was 98,000 tons annually (FAO 2001). Rice production thus is the major task of the government of Cameroon.

#### 9-3-3-2. Taiwan-Cameroon Agricultural Technical Cooperation

A ten-member mission was sent to Cameroon in November 1964 to help develop agriculture with a special emphasis on rice production. The mission introduced rice varieties from Taiwan and began testing their adaptabilities and field potential in 1965. The experimental results indicated that Taiwan variety Tainan 1 and Taichung Native 1 yielded 5.6 t/ha and 5.8 t/ha respectively. They were grown 3 crops a year, bringing a total annual yield of 16.8 t/ha and 17.8 t/ha respectively. IR 4-2 from the International Rice Research Institute in the Philippines gave a much higher yield (7.12 t/ha) with an annual production of 21.3 t/ha on a 3-crop-year basis (Table 9-8). Field demonstrations and extension work were conducted to teach farmers to grow the selected high yielding varieties of rice (Table 9-9). During the period of 1966-1970, a total of 2,317 farm households were under the program of extension for rice production, covering a total acreage of 1,128.34 hectares. Annual production of rice in those areas was 617.4 tons in 1966, and increased to 3,136.8 tons in 1970. The total production of rice in the area under this extension program totaled 7,021.24 tons during the period between 1966-1970 (Table 9-10). Training courses were organized to train the skill of rice production (Table 9-11).

**Table 9-8. Yield trials of rice varieties introduced from Taiwan to Cameroon (1965).**

Category	Variety name	Yield (t/ha)	Crops / year	Total yield /year (t/ha)
Paddy rice	Tainan 1	5.6	3	16.8
	Taichung Native 1	5.8	3	17.4
	IR 4-2	7.12	3	21.3
Upland rice	Tung-Lu 2	3.0	2	6.0
	Tung-Lu 3	2.5	2	5.0
	Tainan 2	2.0	2	4.0
	Local variety	0.5	1	0.5

**Table 9-9. Total acreage of demonstration and extension in Cameroon, (1965-1970).**

Location	Demonstration (ha)	Extension (ha)
Nanga Eboko	24.50	237.20
Nuti	5.63	193.69
Bamenda	3.81	307.51
Bafung	-	96.01
Tonga	-	334.74
Bibey	-	224.26
Mbandjok	-	11.86
Total	33.94	1,405.27

**Table 9-10. Annual production of rice in the extension areas of Cameroon (1966-1970).**

Year	Farm households	Acreage (ha)	Annual production (t)
1966	98	87.40	617.40
1967	84	62.52	437.64
1968	103	165.90	1,161.30
1969	1,420	238.30	1,668.10
1970	612	574.22	3,136.80
Total	2,317	1,128.34	7,021.24

**Table 9-11. Training subjects organized by the ROC-ATM in Cameroon (1964-1970).**

Subjects of course	No. of trainees	Duration
1. Rice culture	20	1964.12.01-1965.04.01
2. Operation of farm machinery	20	1963.06.01-1965.10.01
3. Post harvesting treatment of rice	12	1966.03.01-1966.07.01
4. Field design and management	40	1967.11.06-1968.03.06
5. Pest control of rice field	20	1968.08.25-1968.12.30
6. Method of fertilization and weeding	20	1969.06.01-1969.09.30
7. Maintenance of farm machinery	13	1970.02.28-1970.03.31
8. Irrigation and drainage of rice fields	16	1968.11.18-1970.03.18

### **9-3-4. Central African Republic (CAR)**

#### **9-3-4-1. General situation**

Central African Republic has a land area of 623,000 sq. km. The northern area has a tropical wet-dry climate, while southern area has a tropical wet climate, and rainy season falls in May - November. The country has 3.68 million population (2001 estimate) with a low per capita income of \$290 (1999). It is a land locked country, and road condition is poor in rainy season.

Roots and tubers, tree nuts, coarse grain, fruit are the main food crops. Rice and wheat are also grown. According to FAO (2001), previous five years average production of rice was 16,000 tons, coarse grains 121,000 tons and 137,000 tons in total. Previous five years average import of wheat was 2 6,000 tons, rice 4,000 tons , coarse grains 3,000 tons and 33,000 tons in total. Estimated per capita consumption of wheat was 8 kg/year, rice 4 kg/year, coarse grains 29 kg/year and 41 kg/year in total, which was far from the needed amount.

#### **9-3-4-2. ROC-CAR agricultural cooperation**

In June 1965, the ROC signed an agreement on agricultural technical cooperation with the Central African Republic (CAR), and sent an agricultural technical mission in January 1969. As a first step, the mission built irrigation facilities on the barren lands of Bangui, Sakae, Bozoum, Bambari and Alindao. A total of 24.4 km of irrigation and drainage canals were built over a 4-year period (1969-1973).

Eight pumping stations and 4 dams were constructed during that time. A total of 17.98 hectares of demonstration plots were set up. Extension work for rice culture expanded 186.89 hectares. A total of 554 farmers and 43 local extension officers received training over the 4-year period (Table 9-12).

**Table 9-12. Irrigation facility building and extension of paddy rice by Taiwan-ATM in Central African Republic in 1969-1973.**

Site	Date	Acreage demonstration (ha)	Acreage extension (ha)	No. of trainees		Irrigation facilities		
				Agric. Ext. staff	Farmers	Dam	Pump station	Irrigation (a) & drainage ditches(b)
Bangui	May 1969	4.21	12.79	35	33	-	1	a: 3005 m b: 150 m
Sakay	Aug. 1969	6.47	47.35	2	124	2	4	a: 11390 m b: 2470 m
Bozoum	July 1972	2.00	67.30	2	298	1	1	a: 3230 m b: 1515 m
Bambari	Dec. 1973	2.00	15.00*	2	12*	1	1	a: 960 m
Alindao	Dec. 1973	2.70	44.45	2	87	-	1	a: 900 m b: 780 m
Total		17.38	186.89	43	554	4	8	24,400 m

Note: \*: upland rice.



**Fig.9-5. Demonstration for operation of farm machinery in a rice field of Central African Republic.**

### **9-3-5. Benin (1963-1973)**

#### **9-3-5-1. General situation**

Benin was formerly called Dahomey. It has a total of 111,000 sq. km of land. It also has tropical wet-dry climate; two rainy seasons in south (March-July) and one in north (May-October). Benin is a low income food deficit country and needs enhanced food production to feed 6.26 million population (2001 estimate). G.N.P. per capita income was US\$ 390 (1999). Roots and tubers and maize are the major food crops. Rice, wheat and coarse grains are the main cereals grown in the country. According to FAO (2001), previous five years average production of rice was 27,000 tons, coarse grains 798,000 tons and 825,000 tons in total. Previous five years average import of wheat was 48,000 tons, rice 121,000 tons, coarse grains 5,000 tons and 174,000 tons in total. Estimated per capita consumption of wheat was 8 kg/year, rice 13 kg/year, coarse grains 100 kg/year and 121 kg/year in total. Under this situation, enhanced food production is essential to meet the demand of local consumption.

#### **9-3-5-2. ROC-Benin Agricultural Technical Cooperation**

Agricultural cooperation between Benin and the ROC began in March 1963 with a two-year farming demonstration mission. In April 1966, a new agreement on agricultural technical cooperation was signed. The ROC agreed to send technicians to reclaim land for growing rice, and also to train farmers in Benin. In 1963, the mission began the work of land reclamation at 6 sites (Zou, Cove, Natitingo, Malanville, Mono, Godemey and others). The largest piece of reclaimed land was situated at Zou with 540 hectares, followed by Malanville with 516 hectares. The total acreage of reclaimed land increased to 1,289 hectares by the end of 1973.

With financial support from Taiwan, the mission built various irrigation facilities in the reclaimed lands. A total of 62,690 meters of irrigation canals and 83,480 meters of drainage canals were built by the mission. A total of 13,139 meters of riverbank, 48,200 meters of road were also built. The irrigation facilities covered a total of 782 hectares of reclaimed land for rice culture (Table 9-13).

**Table 9-13. Acreage of reclaimed land and irrigation facilities built by ROC-ATM in Benin (1963-1973).**

Sites	Acreage of reclaimed land (ha)	Irrigation facilities							
		A	B	C	D	E	F	G	H
Zou	540.00	40,050	77,000	1	-	279	7,319	40,000	540.00
Cove	102.50	9,040	1,500	-	2	-	-	-	102.50
Natitingou	35.00	4,000	2,430	1	1	5	-	-	35.00
Malanville	516.00	2,900	-	1	-	6	5,820	-	29.00
Mono	75.00	6,500	2,500	2	-	13	-	8,200	75.00
Godomey	0.50	200	50	1	-	-	-	-	0.50
Other	20.00	-	-	-	-	-	-	-	-
<b>Total</b>	<b>1289.00</b>	<b>62,690</b>	<b>83,480</b>	<b>6</b>	<b>3</b>	<b>303</b>	<b>13,139</b>	<b>48,200</b>	<b>782.00</b>

A: irrigating canals (meters); B: drainage canals (meters); C: pumping stations;  
D: dams; E: buildings and shelters; F: river band (km);  
G: rural roads; H: irrigated area (ha).

**Table 9-14. Performance of Taiwan varieties of rice in a yield trial in Benin (1963-1964).**

Variety name	Yield (kg/ha)	Percentage (%)	Ranking
I-Pau-Co	4,616	176	6
Kaohsiung 27	4,404	168	7
Kaohsiung 68	4,912	186	3
Taichung 65	4,912	186	2
Taichung 183	3,388	129	10
Kaohsiung 64	5,759	219	1
Taichung 181	4,065	155	8
Chianung 242	3,388	129	11
Tainan 1	4,743	180	5
Tainan 3	4,912	186	4
617	3,622	138	9
Soavina (ck)	2,625	100	12

**Table 9-15. Rice production related extension and training work in Benin (1963-1964).**

Sites	Acreage of extension and demonstration (ha)			Number of trainees		
	Ext.	Demo	Total	Ext. workers	Farmers	Total
Zou	-	540.00	540.00	35	860	895
Cove	0.50	102.00	102.50	5	160	165
Natitingou	0.20	35.00	35.20	6	78	84
Malanville	4.50	24.50	29.00	6	270	276
Mono	3.00	60.00	63.00	4	140	144
Godomey	0.50	-	0.50	2	8	10
Others	-	3.80	3.80	-	-	-
Total	8.70	765.30	774.00	58	1,516	1,574

The Taiwanese mission introduced several varieties of rice from Taiwan to Benin for trials. Under the irrigated condition, the average yield of rice was 4-5 t/ha in both first and second crops. This figure was two times higher than the yields of the pre-mission times (Table 9-14). In the dry highland areas, the rice yield declined by 50% and lower. When upland rice was cultured under rain fed conditions, an average of 2.5-3 t/ha of rice was produced. Demonstrations and extension work were concentrated in the reclaimed area covering 774 hectares. A total of 1,574 trainees including 58 local extension workers and 1,516 farmers received training organized by the mission in 1963-1964 (Table 9-15). Financial difficulties and poor cooperation between Benin's Ministry of Economic Affairs and Ministry of Agriculture hindered extension work of rice culture.

### **9-3-6. The Gambia**

#### **9-3-6-1. General situation**

The Gambia is a small West African country with a land area of 10,000 sq. km. It has tropical wet-dry climate, and rainy season in May-October. Population size was 1.44 million (2001 estimate). G.N.P. per capita income was US\$340 (1999). Rice, millet and sorghum are the main food crops produced. Share of cereals in total calorie intake is 63 percent. According to FAO (2001), previous five years average production of rice was 27,000 tons, coarse grains 92,000 tons and 119,000 tons in

total. Previous five years average import of wheat was 31,000 tons, rice 81,000 tons, coarse grain 3,000 tons and 115,000 tons in total. With two successive bumper crops in 1999 and 2000, the overall food supply situation was satisfactory. Markets were well supplied. Prices of cereals remained low and stable. Per capita consumption of wheat was 17 kg/year, rice 61 kg/year, coarse grain 71 kg/year and 148 kg/year in total.

#### 9-3-6-2. ROC-Gambia Agricultural Technical Cooperation

##### *Phase I: August 1966-December 1974*

In August 1966, the ROC signed an agreement on technical cooperation with the Gambia; an agricultural technical mission was then dispatched to the Gambia in June 1967, to help boost rice production. Up to 1974, the mission members increased to 38.

Crop experimentation and demonstration took place in Sankuli Kunda, Sapu, and Yord Beri Kun. Taichung Sen 2 yielded 7.1 t/ha to 7.8 t/ha with an average value of 7 t/ha. Hsinchu 61, Tainan 5, Kaohsiung 136, Kaohsiung 137, Kaohsiung-yu 420, and Taitung 24 and Taitung 25, all yielded more than 7 t/ha. Four recommended varieties of upland rice, Nung-lu 1 and 2, Tainung-Sen 2, and Taichung-Sen 2, produced more than 3 t per hectare. The mission found that the most appropriate rainy season period for paddy rice transplanting was before the end of July. The most appropriate time for dry season transplanting was from December to March.

Based on the results of the fertilizer experiments, the mission recommended 12 bags of urea (46%) and 2 bags of compound fertilizer NPK (15-15-15) per hectare. During the period between 1966-1974, 1,644 hectares of rice were cultivated through the mission's extension service (Table 9-16). The mission also improved and reconstructed irrigation facilities throughout the rice growing areas.

During the period between 1965-1974, the mission trained 5,490 farmers and 186 agricultural staff members in rice production technology and the maintenance of farm machinery such as power tillers, water pumps, power sprayers, rice milling machines, etc. The mission also helped establish the Rice Growers' Association, through which the harvested rice could be sold on the market.

**Table 9-16. Paddy rice extension, the Gambia, 1966-1974.**

Starting date	Site	Acreage (ha)	Farm families settled
Dec. 1966	MacCarthy province	410.0	2,918
Dec. 1966	MacCarthy province	184.0	257
Nov. 1968	MacCarthy province	184.8	1551
Dec. 1968	Bathurst province	232.4	1,073
Oct. 1969	Lower river city	104.0	242
Aug. 1970	Lower river province	103.6	-
June 1971	MacCarthy province	86.8	860
July 1971	MacCarthy province	222.0	1,260
June 1966	MacCarthy province	116.8	610
Total		1,644.4	8,771

***Phase II. November 1995-Onward***

After the restoration of diplomatic ties between the ROC and the Gambia, a five-member delegation led by the author (Hsieh 1995) visited the Gambia in September 1995. The delegation found that the national rice production dropped drastically from 29,610 tons in 1983 to 12,500 tons in 1993, a reduction of 125% in total rice production. The delegation agreed to send another agricultural technical mission to help boost rice production to former levels, and also to ensure the sustainability of rice production.

The Taiwanese agricultural technical mission (ATM) has been involved heavily in the Gambia rice production since November 1995. The ATM received funding from the Taiwan-ICDF for the improvement of infrastructures at Jahally/Pacharr, as well as land development under low cost tidal irrigation systems at Sapu and Sukuta. In addition, various activities such as rice breeding, screening promising rice varieties, and training have also been conducted.

**1. Infrastructure improvement and land development**

- (1) Completion of Jahally pump repair.
- (2) Cleaning of main irrigation canals of 3,500 meters, reconstruction of 28 broken concrete sections (each piece, 3m x 1.8m).
- (3) Construction of 7 sets of control gates in Jahally, which enabled to convert about 320 hectares of land to adopt the tidal irrigation system.

- (4) Cleaning of about 88,000 meters of both tidal and pump canals at Jahally and Pacharr.
- (5) Construction of 4 sets of control gates in Pacharr enabled to convert about 80 hectares of pumping irrigated land to tidal irrigation.
- (6) Land development at Sapu swamp area (south bank of C.R.D.) and Sukuta (north bank of C.R.D.).
- (7) Completion of repairing a total of 42,000 meters of farm roads at Jahally/Pacharr.

## 2. Implementation of extension farms

The extension farms for the 1999 dry season included 240 hectares and 80 hectares under tidal or converted tidal irrigation systems at Pacharr and Jahally respectively. On the north bank, an area of 340 hectares of land in Wassu and Kuntaur was under the extension service by the Mission. The total area of extension farms was 770 hectares in the dry season.

The ATM provided a total of 3,040 bags of chemical fertilizers worth about D 570,000 to the farmers, in the dry season of 1999. The mission prepared 6,000 bags of fertilizer worth about D 1,123,200 for the farmers to use in the wet season. In addition, the mission provided 25 sets of power tillers and 6 sets of tractors to help prepare farmers' rice fields.

## 3. Land Development

The mission is presently reclaiming 30 hectares of swampland at Sapu. The mission and the Kuntaur Agriculture Station jointly selected land in Sukuta for development. With the support of the Land Development Section of Integrated Rice Development Project (IRDP), all heavy equipment was sent to the project site for construction work in April 1999. The mission also spent about D10,530,000 to purchase additional equipment in January 1999. The mission personnel worked hand-in-hand with IRDP and the Kuntaur Agricultural Station at the project site.

The ATM was very pleased to convert about 340 hectares of pump irrigated land to tidal irrigation land in Jahally and Pacharr. The cleaning of irrigation canals at Pacharr and Jahally enabled nearly 700 hectares of land for rice growing under the tidal irrigation system in the dry season. More farmers are now able to grow rice all year round under this tidal irrigation practice.

#### 4. Screening for promising rice varieties

Mr. Chen-Chang Chen, a rice breeder from Taiwan Agricultural Research Institute introduced more than 800 lines or cultivars of rice from Taiwan to the Gambia for trial at Sapu Branch Station of the National Agricultural Research Institute. Certain promising varieties, such as ITA 212, IR 64, Tainung-Sen 14, Tainung-Sen yu 19 aromatic rice, Tainung-Sen 20 have been selected for planting (Table 9-17). These promising varieties have been multiplied through a seed production program. More than 50 tons of certified seeds can be produced in each crop season to support at least 1,000 hectares of extension rice field

**Table 9-17. Average yields of promising rice entries tested at Sapu during the period between 1996 –1998.**

Entries	Minimum yield (kg/ha)	Maximum yield (kg/ha)	Number of test	Average yield (kg)
Tainung Sen 14	7,143	11,780	5	8,819
Tainung Sen 18	6,304	7,612	3	6,776
Tainung Sen 20	6,909	6,991	2	6,950
Tainung Sen Yu 19	6,375	9,554	3	7,874
Tainan Sen 15	7,384	7,933	2	7,659
ITA 212	7,558	11,970	5	9,248
ITA 222	7,509	12,660	5	9,279
BG90-2	7,625	8,286	3	8,015
RP2095-22-78-9	8,254	8,558	2	8,406
Rasi	5,755	8,786	2	7,271
IR64	6,290	10,170	5	7,988
HPU5010-plp21-2-1h	5,339	8,482	2	6,911
Peking	4,696	7,973	3	6,000
Parasana	2,410	6,750	4	4,877
IR58800-302-3-1-3	7,857	8,103	2	7,980

#### 5. Soil fertility analysis conducted to optimize the amount of fertilizer application on the rice fields in the Gambia.

Under the funding from the ICDF, the Taichung Agricultural Improvement Station cooperated with the National Agricultural Research Institute of the Gambia, in

carrying out a research project on soil survey and soil analysis on the major rice fields in the Gambia. This 2-year project was commenced in October 1998.

In 1999, a group of scientists headed by Dr. Te-Cheng Kao visited the experimental sites in the Gambia several times to collect data from the field trials. The following results were obtained from this joint research project:

- (1) Soil maps of the major rice fields in the Gambia were made.
- (2) The practical formula of fertilizer application for lowland and upland rices in the Gambia were formulated.
- (3) Ideal rice based cropping systems for the Gambia were established.
- (4) Training courses for effective ways of fertilizer application were organized.
- (5) Training courses for compost making to supply cheap organic fertilizers to the rice fields were organized.

This project was jointly carried out by the Research Institutes in Taiwan and in the Gambia, in cooperation with the existing Taiwanese mission. We believe that this model of cooperation will contribute greatly to rice production in the Gambia.

#### 6. The tidal irrigation scheme to promote rice production in the Gambia

Tidal irrigation depends on the Atlantic tide movement which pushes the water through the inlet gates or small creeks to both banks of the Gambia River and distributes the water into the rice fields. Seasonally-fresh-water tidal areas and ever-fresh water areas are two potential areas for rice production. At present, about 57,798 hectares of the seasonal-fresh-water area and 3,876 hectares of ever-fresh-water area can be developed for rice culture (Table9-18). If rice is planted at the right time, it will be more economical than using pump irrigation. As the result of surveys made in 1997, six locations covering a total of 600 hectares of land were identified to be good for rice production under the "tidal irrigation scheme". The ROC government approved a sum of about D10, 000,000 (US\$833,333.33) for the purchasing the heavy equipment (tractors etc.) and fuel for land reclamation. As a result of land reclamation in Sapu and Sukuta of the CRD in 1999, a total of 100 hectares of newly developed land were eligible to grow rice.

The recent important task of the Taiwanese mission was to convert a total of 400 hectares of pump irrigated rice field in Jahally/Pacharr to the low cost tidal irrigation systems. This will save fuel costs of about D300,000 (US\$25,000) annually.

Several old tidal irrigated rice fields adopted the new simple method of rice culture devised by the Taiwan mission with very good results.

In the dry season of 1997, a total of 1,100 hectares of land in Jahally/Pacharr adopted the tidal irrigation method. The yields of rice increased from 2.5 t/ha to 5 t/ha. In the dry season, Wassu/Kuntaur farm (320 ha) adopted the tidal irrigation, increasing its rice yield from 1 t/ha to 5 t/ha. In the dry season of 1999, the extension farms in Jahally/Pacharr planted a total of 320 hectares of rice fields using tidal irrigation with good results. The surrounding farmers were encouraged to plant rice using similar methods on 880 hectares of farm. The yields have been increased from 2.5 t/ha to 6 t/ha (Table 9-20).

When using the tidal irrigation methods, the rice growth was not be very uniform at the earlier stage; but it soon grew normally later. This is a good example to prove that even a simple technology, if used properly, it will greatly increase the rice yield.

**Table 9-18. Potential area for tidal swamp development in the Gambia (2001).**

Type of swamp	Total acreage (ha)	Cultivated in 1983	Potential for development (ha)
Seasonally fresh water	66,742	8,944	57,798
Ever fresh water	5,720	1,844	3,876
Total	72,462	10,788	61,674

Source: Soil and Water Management Unit, Banjul.

**Table 9-19. The acreage adopted tidal irrigation methods in the Gambia (2000).**

Location	Acreage (ha)	Source of development fund
1. SSWCP*	482	IFAD
2. Jahally	167	IFAD/KfW, Dutch Government
3. Pacharr	682	IFAD/KfW, Dutch Government
4. Sukuta	60.12	Taiwan
5. Sapu Swamp	37.30	Taiwan
6. Jahally**	320	Taiwan
7. Pacharr **	80	Taiwan
Total	1,828.42	

\* Small Scale Water Control Project.

\*\* Conversion of pump irrigation to tidal irrigation.

**Table 9-20. Estimated yields and additional profits after adoption of tidal irrigation methods (1998 dry season, and wet season, 1999 dry season).**

Year	Extension farm	Area (ha)	Yield t/ha			Additional Yield (ton)	Dallas' increase	US\$
			*Before	**After	Increase difference			
1998	Kuntaur	210	1.0	4.97	3.97	833.7 <sup>(1)†</sup>	1,458,975	121,581.25
Dry	Wassu	110	1.0	5.26	4.26	468 <sup>†</sup>	820,050	68,337.50
Season	Small Scale	70	1.15	4.78	3.63	254.1 <sup>†</sup>	444,675	37,056.25
	J/P	155	2.5	5.0	2.5	387.5 <sup>†</sup>	678,125	56,510.42
1998	Kuntaur	181.2	1.0	3.5	2.5	453 <sup>†</sup>	792,750	66,062.50
Wet	Wassu	176.8	1.0	4.5	3.5	618.8 <sup>†</sup>	1,082,900	90,241.67
Season	Small Scale	103.2	1.15	3.5	2.35	242.5 <sup>†</sup>	424,375	35,364.58
	J/P	147	2.5	4.5	2.0	294 <sup>†</sup>	514,500	42,875.00
1999	Kuntaur	151	1.0	4.5	3.5	528.5 <sup>†</sup>	924,875	77,072.91
Dry	Wassu	176	1.0	4.5	3.5	616 <sup>†</sup>	1,078,000	89,833.33
Season	J/P	320	2.5	6.5	4.0	1,280 <sup>†</sup>	2,240,000	186,666.66
	RIDEP	110	2.0	5.5	3.5	385 <sup>Δ</sup>	673,750	56,145.83
	Wassu	13	1.0	4.8	3.8	49.4 <sup>(2) Δ</sup>	121,030	10,085.83
Total		1923.2					11,254,005	937,833.73

Exchange Rate=1 US\$: 12 Dallas

\*\* After Project Implementation

<sup>(2)</sup> Aromatic Rice -- D2.45/kg

<sup>†</sup> Tidal Irrigation

\* Before Project Implementation

<sup>(1)</sup> Ordinary Rice - D1.75/kg

<sup>Δ</sup> Pumping Irrigation

**Table 9-21. Costs and benefits for land development using tidal/pump irrigation systems (ha).**

Items	Tidal irrigation		Pump irrigation	
	Before *	After **	Before *	After **
Yield (ton)	1.29	9.00	0	10.00
Value (US\$)	188.40	1,315.50	0	1,458.00
Production cost (US\$)	179.00	508.00	0	618.00
Land development (US\$)		440.00		1,199.00

\* Before land development.

\*\* After land development.

As the results of the efforts made by both the government of the Gambia and the ROC-ATM, the total production of rice in the Gambia increased to 244,930 tons in 1997 which was two times higher than that of 12,500 tons in 1993. Rice production in the Gambia continued to increase to 266,360 tons in 1998, and reached to the highest record of 316,530 tons in 1999. Even though the Gambia still needs to import 60,000-80,000 tons of rice every year to meet the ever-increasing population (1.3 million). Post harvesting loss due to the traditional methods of milling is quite serious; the mission is now helping the farmers to establish rice-milling centers by providing milling machines. The traditional way of handling harvested rice is to pile up the harvested rice plants along the roadsides for a long period of time. It is hoped that through this additional effort, it will help further reduce the harvest loss and maintain the quality of rice in the Gambia.



Fig. 9-6. Extension of high yielding rice variety Taichung Sen 10 from Taiwan to the farmers at the Jahally/Parcharr area in the Gambia.



Fig. 9-7. Demonstration of operating a small rice combine harvester to the farmers in the Gambia.

### 9-3-7. Guinea – Bissau (GB)

#### 9-3-7-1. General situation

Guinea-Bissau has a land area of 28,000 sq. km. It has tropical dry-wet climate and rainy season falls between May and October. Its population size was 1.18 million (2001 estimate). Guinea-Bissau was a low income (G.N.P. per capita income US\$ 160 in 1999) food deficit coastal country. Road condition was usually not adequate

especially during the rainy season. Major food crops are rice, coarse grains, oils and fats, root and tubers. Share of cereal in total calorie intake is 64 percent.

The overall food supply is satisfactory. Markets remain generally well supplied country wide. However, some population groups with low purchase power are facing food shortage. According to FAO (2001), previous five years average production of rice was 97,000 tons, coarse grains 61,000 tons and 158,000 tons in total. Previous five years average import of wheat was 8,000 tons, rice 65,000 tons, coarse grains 2,000 tons and 75,000 tons in total. Estimated per capita consumption of wheat was 6 kg/year, rice 94 kg/year, coarse grains 45 kg/year and 144 kg/year in total. Rice production remained to be the most important task for the government of Guinea-Bissau.

#### 9-3-7-2. ROC-Guinea Bissau Agricultural Technical Cooperation

After signing an agreement on agricultural technical cooperation between the ROC and Guinea-Bissau, a 12- member agricultural technical mission was dispatched to Guinea-Bissau in September 1990. The mission was withdrawn after the severance of diplomatic relations in 1998. During the 8-year stay in Guinea-Bissau, the Taiwan mission worked on a 5-year project targeted to develop 5,000 hectares of land for rice production. This was a very ambitious project

##### *(1). Land reclamation*

The mission began to reclaim abandoned land in 1991. By 1996 a total of 743 hectares of land in Bafata and Mansoa regions were successfully reclaimed (Table 9-22). In this reclaimed land, a total of 20.5 km of irrigation canals and a total of 18 km of drainage canals were built

Due to the financial limitations and lack of support from the local government, reaching the primary goal of reclaiming 5,000 hectares of land seemed to be not an easy task. Under this situation, the mission decided to apply the method used in the Dara region (Dara model) to other regions. The So-called "Dara model" is to guide farmers to reclaim the land with their own hands, without using the expensive machinery. The farmers dug simple irrigation ditches and leveled off the land with simple farm tools. The land in Guinea-Bissau is generally flat, and there are abundant hard working farm workers available. The land reclamation of the Dara district took only six and one half months to complete and ready for rice culture. On World Food

Day (Oct. 16, 1994), President Joao Bermrdo (Nino) Veira officially opened the new farm at the Dara district.

Later, each member of the Taiwan mission was assigned a responsibility to reclaim 200 hectares of land every year. In this way, the land reclamation could speed up. By the end of 1994, a total of 1,000 hectares of land were reclaimed. In 1995, an additional 360 hectares of land was reclaimed, and by the end of 1997, the reclaimed land increased to 3,707.5 hectares.

The main characteristics of "the Dara Model" was economical. The cost was about US\$ 200 for one hectare of land. Secondly, during the first year, farmers were provided with free seeds, fertilizers, and pesticides; however, starting from the following year, all costs of rice culture were paid by the farmers themselves. Thirdly, farmers followed the simple farm management practices formulated by the mission and were able to get good harvests (4-5 t/ha). They usually earned the profits 5-8 times higher than what they earned from the traditional ways of farming (0.8-1 t/ha). This was really a very successful project in Africa.

**Table 9-22. Acreage of reclaimed land in Guinea-Buissau (1991-1996).**

Location Bafata region	Acreage (ha)	Location Munsoa region	Acreage (ha)	Total
Bambadinca	44.0	Mansaba	21.0	
Galomaro	66.5	Manhau	41.0	
Djana	39.0	Waria	40.0	
Bafata	20.0	Cussarfanca	40.0	
Jabacunda	30.0	Nhapasare	30.0	
Mafanco	50.0	Jai Sambalo	120.0	
Amedalai	30.0	Paunca	90.0	
Missira	30.0	Paiama	60.0	
Cula	21.5	Camquilifa	10.0	
Total	331.0		412.0	743.0

In order to attain the set goals, the Taiwan mission wished to cooperate with the local extension officers who were paid US\$200 in subsidies by the mission, to speed up the land reclamation using the Dara Model in other regions. Unfortunately, those government officers were unable to supervise the work of the farmers. A great amount of fertilizer annually donated by the Japanese government each year was not properly utilized because of the inefficient dispensation of the local officers.

*(2). Seed multiplication*

Rice seeds were in great demand; therefore, seed multiplication was one of the essential tasks for the Taiwanese mission. The amount of rice seeds produced at Carantaba totaled 71.95 tons in 1995-1996 (Table 9-23) and 45.91 tons in Balata in 1994 (Table 9-24). This amount was not enough to meet the needs of the vast area of rice fields. The seeds multiplied by farmers themselves often mixed with other source of seeds.

**Table 9-23. Amount of rice seeds multiplied by the ROC-ATM at Carantaba, Guinea-Bissau (1995-1996).**

Variety name	Field size (ha)	Yield (kg)	Year
Taichung Sen 10	0.60	1,890	1995
Bouake 189	3.00	12,480	1995
C-4	5.00	18,100	1995
IRAT 170 *	0.90	2,880	1995
IRAT 314 *	0.50	1,360	1995
Taichung Sen 10	5.90	30,700	1996
C-4	5.90	30,700	1996
Total	16.65	71,958	

\* Upland rice.

**Table 9-24. Amount of rice seeds multiplied by the ROC-ATM at Balata, Guinea-Bissau (1994-1995).**

Variety	Field size (ha)	Yield (kg)	Year
Taichung Sen 10	1.50	8,350	1994
Bouaké 189	0.28	1,200	1994
	0.08	350	1994
	1.00	4,800	1994
C-4	1.00	5,300	1994
Bouaké 189	3.05	12,480	1995
C-4	2.64	11,900	1995
ITA-132	0.25	503	1994
IRAT-170	0.25	531	1994
IRAT-314	0.25	501	1994
Total	10.27	45,915	

### *(3). Training of farmers*

Training courses were organized by the Taiwan mission regularly with regards to methods of land reclamation; methods of rice cultivation, methods of fertilization, methods of pest control and farm management. A total of 3,681 farmers received training in 1996 (Table 9-25).

**Table 9-25. Numbers of farmers trained in Guinea-Bissau in 1996.**

Subjects	No. of farmers
Paddy rice production	3,196
Upland rice production	486
Total	3,681

### *(4). Extension work for rice production*

Extension work was targeted at 5,000 hectares of rice field in five years. In 1993, the extended areas totaled 877 hectares with a total of 1767 households. The area produced a total of 3,040 tons of rice in 1993. The average yield of rice ranged from 3 tons to 5 tons per hectare. This yield was 5-8 times higher than that produced by traditional ways of migration culture. By the end of 1997, the area increased to 3,707.5 hectares. The rice production was increased tremendously through this method of production. In recognition of the Taiwan mission's achievement in rice production, the farmer renamed a village in the Dara region to Wu-tzeun (Mr. Wu's Village) to honor Mr. Wu's contribution to rice production in Guinea-Bissau. In 1996, a total of 3,681 farmers receive training on rice production (Table 9-26). In spite of successful operations of the rice projects, the Taiwan mission withdrew from its operation due to the severance of diplomatic ties between the ROC and Guinea-Bissau in 1998.

**Table 9-26. Numbers of farmers trained in Guinea-Bissau in 1996.**

Subjects	No. of farmers
Paddy rice production	3,196
Upland rice production	486
Total	3,681



Fig.9-8. Extension of Taichung Sen 10 on the newly reclaimed rice field in Guinea Bissau.



Fig. 9-9. Mr. Sung-Seng Wu (first from left) is helping farmers, hands in hand, transporting the harvested rice to the village. The name of the village has been changed into Wu-tsuen (Wu's village) to honor Mr. Wu's contribution to the village in Dara region of Guinea-Bissau.

### 9-3-8. Ivory Coast (Côte d'Ivoire)

#### 9-3-8-1. General situation

The Ivory Coast has a land area of 318,000 sq. km. It has tropical wet-dry climate with two rainy seasons (March –July and September-December) in south and one in north (May-Oct.). It has a population size of 15.1 million (2001 estimate). It is

a low-income (G.N.P. per capita income US\$ 710 in 1999) coastal country. It is the gateway to Burkina Faso and Mali with an adequate port and roads. Shares of cereals in total calorie intake is 40 percent. Overall food supply is satisfactory. According to FAO (2001), five years average production of rice was 1,000,000 tons, coarse grains 748,000 tons and 1,748,000 tons in total. Previous five years average import of wheat was 272,000 tons, rice 474,000 tons, coarse grains 13,000 tons and 759,000 tons in total. FAO (2001) estimated that per capita consumption of wheat was 18 kg/year, rice 69 kg/year, coarse grain 39 kg/year and 126 kg/year in total. Rice remained to be the most important grain crop in Ivory Coast.

#### 9-3-8-2. ROC-Ivory Coast Agricultural Technical Cooperation

The Ivory Coast and the ROC signed an agreement on agricultural technical cooperation in September 1962. The headquarters were set up at Bouake and Korhog in 1966. The number of technical personnel rose from 14 in 1963 to 160 in 1966, making the Ivory Coast the largest mission abroad at that time. The mission activities ended in March 1983, after the severance of diplomatic ties between the Ivory Coast and the ROC.

Rice production was the primary task of the mission. Prior to the mission's arrival, the average yield of paddy rice was 870 kg/ha and 450 kg/ha for upland rice. This was primarily due to lack of irrigation supply and good varieties of rice.

##### *(1). Construction of irrigation facilities*

To solve the problem of irrigation water, the mission started constructing irrigation facilities in 1966. During the period of 1966, the Taiwanese mission constructed a total of 1,000.83 km of irrigation canals, 619.87 km of drainage canals and 161 dams (Table 9-27). Because of the increased irrigation water, yields of paddy rice increased to 5-6 t/ha during 1964-1968, however, during the period of 1969-1973, yields decreased to 3-4 t/ha due to a dry spell (Table 9-28).

**Table 9-27. Yearly constructed irrigation facilities by the Taiwan-ATM in the Ivory Coast (1966-1973).**

Year	Irrigation canals (km)	Draining canals (km)	Dams constructed
1966	-	132.66	-
1967	283.09	6.60	-
1968	132.00	72.35	16
1969	154.13	138.78	17
1970	160.06	111.83	5
1971	67.31	54.01	11
1972	33.96	27.91	17
1973	170.28	75.73	95
Total	1,000.83	619.87	161

Source: CITC (1986).

**Table 9-28. Average yields of rice in the Ivory Coast (1964-1973).**

	Paddy rice (kg/ha)	Upland rice (kg/ha)
Pre- ROC-ATM operation	870	450
1964	5,581	-
1965	5,110	-
1966	6,000	2,500
1967	-	-
1968	6,999	2,000
1969	3,779	912
1970	3,939	1,628
1971	3,375	1,510
1972	3,200	1,776
1973	2,875	-

Source: CITC (1987).

*(2). Yield trial of newly introduced varieties of rice*

The mission introduced several varieties of rice from Taiwan and the Philippines and tested their adaptability and yielding potential in the Ivory Coast. Ten promising varieties were selected for extension to farmers. The average yield of Tainan 8, Kaohsiung 27, Kaohsiung 10 and Taichung Native 1 gave yields of 3.3-4.4 t/ha depending on the availability of irrigation water during different years (Table 9-29). The figure was 4-6 times higher than the yields of local varieties (870 kg) (Table 9-30).

**Table 29. Yield performances of selected varieties of rice in the Ivory Coast (1970-1972).**

Variety name	Yield (kg/ha)		
	1970	1971	1972
Tainan 8	4,200	3,400	3,600
Kaohsiung 27	4,200	4,050	3,600
Kaohsiung 10	4,047	-	4,400
Taichung Native 1	4,000	3,290	-
Hsinchu 56	2,480	3,080	-
IR 8	3,867	3,500	3,980
IR 20	-	4,000	4,150

Source: Taiwan Agricultural Technical Mission to Ivory Coast.

**Table 9-30. Average yields of rice in the Ivory Coast (1964-1973).**

	Paddy rice (kg/ha)	Upland rice (kg/ha)
Pre- ROC-ATM operation	870	450
1964	5,581	-
1965	5,110	-
1966	6,000	2,500
1967	-	-
1968	6,999	2,000
1969	3,779	912
1970	3,939	1,628
1971	3,375	1,510
1972	3,200	1,776
1973	2,875	-

Source: CITC (1987).



**Fig. 9-10. The happy moment of rice harvest by the farmers in Ivory Coast.**

### *(3). Rice seed multiplication project*

Supplies of certified rice seeds to farmers were essential in boosting rice production in the Ivory Coast. The Taiwanese mission started multiplying rice seeds on 2.3-hectares of land in 1968. A total of 2.8 tons of rice seeds were produced. 40.7% of rice seeds were supplied to the farmers in 1968. The seed production project continued every year until 1982. The total amount of rice seeds produced between 1968-1982 was 1,243.4 tons, 58.9% of which was supplied to farmers for growing (Table 9-31).

**Table 9-31. Rice propagation and supply in the Ivory Coast (1968-1982).**

	Seed propagation		Seed supply	
	Acreage (ha)	Amount produced (kg)	Amount supplied (kg)	% of produced amount
1968	2.30	2,800	1,140	40.7
1969	1.20	3,347	840	25.0
1970	16.81	38,413	25,743	67.0
1971	27.65	60,151	10,175	16.9
1972	35.20	121,774	57,009	46.8
1973	34.80	119,117	94,507	79.3
1974	37.29	112,753	95,374	84.6
1975	40.00	121,412	119,050	98.0
1976	40.00	131,448	124,875	95.0
1977	40.00	112,719	110,464	98.0
1978	40.00	122,407	65,163	53.1
1979	38.00	27,755	-	-
1980	48.80	85,990	-	-
1981	44.40	118,191	-	-
1982	22.00	65,120	28,300	43.0
Total	468.45	1,243,397	732,640	58.9

Source: Taiwan Agricultural Technical Mission to Ivory Coast.

### *(4). Field demonstrations and extension work*

In the early years, the mission's work was to culture paddy rice in the north, and to grow both paddy and upland rice in the central part of the country. In the east and southwest, upland rice was grown. Technology transfer for rice culture from Taiwan to the Ivory Coast was the main task of the mission. Between 1963 and

1972, a total of 155,119 tons of rice was produced as the result of the extension work by the ROC-ATM (Table 9-32).

**Table 9-32. Acreage of rice demonstration and extension farms in Ivory Coast (1963-1972).**

Year	Number of farmers households	Acreage of field under extension program			Annual production (Mt)
		Paddy rice (ha)	Upland rice (ha)	Average yield (tons/ha)	
1963	5	1.20	-	1.20	13
1964	220	46.00	-	46.00	310
1965	2,515	601.24	-	601.24	4,540
1966	9,560	2,387.00	-	2,387.00	12,560
1967	10,533	5,327.00	406.99	5,734.58	10,266
1968	14,312	8,461.98	-	8,461.98	17,785
1969	15,795	5,949.06	3,053.32	9,002.38	22,138
1970	20,626	6,752.44	929.97	7,682.41	21,497
1971	25,926	8,332.34	-	8,332.34	34,562
1972	24,956	6,472.08	-	6,472.08	23,804
1973	4,487	2,126.35	-	2,126.35	7,644
Total	128,935	46,457.28	4,390.28	50,847.56	155,119

Source: CITC (1987).

### 9-3-9. Liberia

#### 9-3-9-1. General situation

Liberia has a land area of 96,000sq. km. The southern half of the country has a tropical wet climate while the northern half of the country has tropical wet-dry climate. Rainy season falls in March-November. Present population size is 2.95 million (2001 estimate). It is a low-income food deficit coastal country. Rice, root, tubers and oil crops are mainly grown. Shares of cereals in total calorie intake is 48 percent. According to FAO (2001), there were a total of about 80,000 Sierra Leonean refugees and 380,000 Liberian returnees, mainly in Lofa county, one of the major rice producing areas. Increased population prompted the government to increase food production in recent years. Previous five years average production of rice was 98,000 tons. Previous five years average import of wheat was 62,000 tons, rice 80,000 tons,

coarse grain 31,000 tons and 173,000 tons in total. Estimated per capita consumption of wheat was 17 kg/year, rice 72 kg/year, coarse grain 3 kg/year and 92 kg/year in total. Rice remained to be the most important staple crop in Liberia.

#### 9-3-9-2. ROC-Liberia Agricultural Technical Cooperation

An eleven-member agricultural technical mission was dispatched to Liberia after signing an agreement on agricultural technical cooperation in November 1961. The agreement was renewed in 1965, 1967, and again in 1970. In response to the request of the host country to expand the activities of technical cooperation, the number of the ROC-ATM increased from 11 in 1961 to 60 in 1973. The mission had to be withdrawn after a separation of diplomatic ties in 1977.

With the reestablishment of diplomatic ties between the ROC and Liberia, a new mission consisting of 10 members was sent to Liberia from Taiwan in February 1990. The mission had to cease operations in May 1990 because of the civil war in Liberia. After the civil war ended, a new mission was sent to Liberia again in November 1997, to rehabilitate the destroyed farming facilities during those 7 years.

#### *Phase I (1961-1977)*

The initial task of the Taiwanese mission was to conduct yield trial of crop varieties, including rice. A new rice variety, Chia-nan 3, produced 4,700 pounds of rice per acre, breaking the previous record for a dry season rice yield. Results of the experiments indicated that Taichung Native 3, Kaohsiung 27, IR-5, IR-20 and IR 22 performed very well under the environmental conditions of Liberia.

A total of 2,498 farmers participated in various training courses in rice production organized by the Taiwanese mission. Extension work on the rice production covered a total of 7,257 hectares of rice fields, in Faya, Gbana, Chiehn, Cape Mount and Gdedin (Table 9-33). Under the instruction of the Taiwanese mission, farmers could harvest 12,096 pounds / acre of rice per year. This amount was 18 times higher than the yield of rice by the traditional migration system of agriculture. Each farmer's household could earn an amount of US\$ 210-286 from each acre of land. This mission also implemented the ROC-Basa project, reclaiming 500 hectares of land for rice culture.

**Table 9-33. The acreage of the Taiwan-ATM assisted extension work for rice production in Liberia (1961-1977).**

Locations	Extended area (ha)	Number of farmers household
Foya	5,209.5	117
Gbanka	926.0	70
Chiehn	596.0	100
Cape Mount	229.0	125
Gdedin	296.5	75
Total	7,257.0	370

***Phase II (September 1998-Onward)***

Goals of the 5-year project (1998-2003)

1. 2,050 hectares of upland rice extension.
2. 260 hectares of paddy rice extension.
3. Seed multiplication on 93 hectares of land to produce enough rice seeds for extension.
4. Increase job opportunities for 5,000 farming households to improve the livelihood of 25,000 people who suffered during the civil war.
5. Efforts should be made to achieve the goal of producing 4,600 tons of rice annually.

Due to the sever damage of infrastructures, farm roads, and irrigation facilities by the civil war, the execution of the project is rather slow.



**Fig. 9-11.** The water reservoir constructed by the Taiwan-ATM. The reservoir provided abundant water to irrigate rice field in Liberia. The author (center) posed with the local farmers at the project site.

## 9-3-10. Malawi

### 9-3-10-1. General situation

Malawi has a land area of 118,481 sq. km. It has tropical wet-dry climate with rainy season in November-May. The population size was 12.96 million (2000 estimate). It is a low-income country with G.N.P. per capita income of US\$ 190 (1999). It is a food shortage country which needs to import food every year. Major food crops grown are rice, maize, pulses, root and tuber crops. Shares of cereals in total calorie intake is 70 percent. Previous five years average production of wheat was 2,000 tons, rice 78,000 tons, coarse grains 2,085,000 tons and 2,165,000 tons in total. Previous five years import of wheat was 44,000 tons, rice 1,000 tons, coarse grain 78,000 tons and 123,000 tons in total. Wheat needs to be imported at an amount of 35,000 tons annually. Estimated per capita consumption of wheat was 3 km/year, rice 3 kg/year, coarse grain 134 kg/year, and 141 kg/year in total.

### 9-3-10-2. Taiwan-Malawi Agricultural Technical Cooperation

The ROC-Malawi technical cooperation began with the arrival of a 12-member of Taiwanese Agricultural Mission in the Karonga Province of Northern Malawi in December 1965. The team planted 2 hectares of demonstration fields and obtained rice yield of 7 t/ha by growing Taiwan variety, a figure that was nine times greater than the yield of a local variety, Faya. The results greatly impressed the local authorities. Upon their urging, the work sites were increased to 12 during the years between 1965-74.

#### *(1). Land reclamation and irrigation infrastructure building*

In order to expand the area of rice culture, the mission began reclaiming lands located at Kapora, Mwentiete, Wovwe, Bua, Domasi, and Tangazi / Mouna etc. The area reclaimed during 1965-1985 totaled 2,288.29 hectares. Domasi was the largest single piece of land reclaimed with a size of 500 hectares, and Tangazi/Mouna came next with an area of 400 hectares. Following the land reclamation, various irrigation facilities, including waterways, dam and drainage systems were built to facilitate gravity irrigation. The area of reclaimed land with completed irrigation facilities totaled 2,188.29 hectares during 1976-1986 (Table 9-34). The extension work for rice production also covered an area of 2,188.28 hectares during the same period (Table 9-35).

**Table 9-34. Gravity irrigation projects in Malawi (1976-1986).**

Reclamation zone	Location of irrigation facilities	Irrigated acreage (ha)		Date of completion
		Projected	Completed	
Kaporo	Karonga	52.86	52.86	Nov 31, 1967
Mwenitete	Karonga	31.40	31.40	Nov 15, 1968
Limphasa	Nkhata bay	340.00	183.00	Dec 31, 1972
Mpamantha	Nkhotakota	76.00	76.00	Dec 31, 1971
BUA	Nkhotakota	300.00	300.00	Dec 31, 1978
Dedza	Dedza	8.23	8.23	Sept 30, 1971
Domasi	Machinga	500.00	500.00	Dec 31, 1975
Njala	Zomba	40.00	40.00	Nov 31, 1972
Segula	Zomba	40.23	40.23	Dec 31, 1968
Mwambo	Zomba	17.57	17.57	July 31, 1967
Tangazi/Mouna	Nsanje	122.80	122.80	May 30, 1969
Tangazi/Dombo	Nsanje	400.00	400.00	June 30, 1972
Masenjere	Nsanje	23.20	23.20	Dec 31, 1972
Nkhate	Chikwawa	243.00	243.00	Dec 31, 1980
Wovwe	Karonga	250.00	150.00	Dec 31, 1986
Total		2,288.29	2,188.29	



Fig. 9-12. Inexpensive rice thresher from Taiwan was introduced to Domasi rice plantation in Malawi. The small motor operated semi-automatic rice thresher is not only cheap in price, but also very efficient in grain threshing.

**Table 9-35. The Taiwan-ATM assisted extension work for rice production on the reclaimed land in Malawi, 1965-1985.**

Name of ATM sub-mission	No. of mission member in 1985	Location	Farm size (ha)
Karonga	10	(1) Kaporo	52.86
		(2) Mwenitete	31.4
		(3) Wovwe	250
Nkhotakota	6	(4) Limphasa	183
		(5) Mpamantha	76
		(6) BUA	300
Dedza	2	(7) Dedza	8.23
Machinga	6	(8) Domasi	500
		(9) Njala	40
		(10) Segvla	40.23
		(11) Mwanbo	17.57
		(12) Ntonda farm	
Blantyre	1	(13) Naperi	
Chikwawa	4	(14) Tangazi/Mouna	400
		(15) Tangazi/Dombo	122.8
		(16) Masenjere	23.2
		(17) Nkhate	243
<b>Total</b>	<b>29</b>		<b>2,288.29</b>

Main activities: (1) Crop experimentation; (2) Field demonstration;  
 (3) Crop cultivation; (4) Agricultural extension; and  
 (5) Farmer's training

*(2). Field demonstrations and extensions of rice production for farmers*

Between 1965 and 1968, demonstration sites were located in Chirumba, Kaporo, and Njaca. The work fell into four categories: establishing, managing and the extending the demonstration farms, implementing irrigation facilities, and training farmers in paddy rice culture. Between 1965-1985, the extension work by the 29 members of the Taiwan mission covered a total area of 2,288.29 hectares, which was the entire area of reclaimed land by the mission. The extension work was aimed at increasing rice production for domestic use as well as for exportation. Blue Bonnet was selected to be the most productive variety among the tested varieties of rice introduced. It yielded 8 tons in the Domasi extension farm in 1972. It produced 5.3 tons of rice per hectare on the farmer's field in Domasi. The rotational irrigation scheme developed in Taiwan was widely practiced to maximize water use.

*(3). The Taiwan assisted farm machinery centers*

To facilitate rice production, farm machinery centers were established in Malawi in 1978. Eighty-farm machines were donated to 11 farm machinery centers by the ROC government through the Taiwanese mission in 1978. The mission's machinery expert organized training courses with regards to handling and maintaining the machines. The trained technicians worked at 11 centers to maintain the machinery. Ten machines in 1978, increased to 80 machines to serve an area of 1,056.60 hectares of rice fields in 1985 (Table 9-36).

**Table 9-36. Operation of Taiwan-ATM assisted farm machinery centers in rice areas of Malawi between 1978-1985.**

Year	1978	1979	1980	1981	1982	1983	1984	1985
Area served (ha)	133.20	380.00	565.20	1,006.44	1,126.00	838.00	1,056.60	1,056.60
No. of machinery used	10	15	20	40	60	60	60	60

*(4). Establishment of seed multiplication systems in Malawi*

Production of certified seeds is essential for the increased production of rice. With a joint effort, a seed multiplication system was established in 1978. The Taiwanese mission produced stock seeds, which were distributed to the selected progressed farmers to reproduce the certified seeds. The certified seeds were sold to ordinary rice farmers for planting. The Taiwanese mission maintained an area of 2-40 hectares of fields for stock seed production and 18-57 hectares for production of certified seeds (Table 9-37).

**Table 9-37. The Taiwan-ATM assisted rice seed multiplication project at Dormasi rice plantation in Malawi (1978-1981).**

Year	1978		1979		1980		1981	
	A	B	A	B	A	B	A	B
1st crop	-	-	2.40	24.80	2.40	42.00	2.40	40.00
2nd crop	2.40	-	2.40	57.20	2.40	18.00	2.40	40.00
Total	2.40	-	4.80	82.00	4.80	60.00	4.80	80.00

A: stock seed. B: certified seed.

*(5). The Taiwan assisted rice production in Malawi up to 1995*

The reclaimed area at Domasi became a model for present-day rice production. The author (Hsieh, 1996) visited Domasi in 1996, and was impressed by its sustained operation of rice production with assistance of two rice experts from the Taiwanese mission. In 1975, it expanded rice culture to cover 5,000 hectares of land. The southern areas became the main rice regions in Malawi.

Inputs of the mission, coupled with government efforts, greatly boosted rice production. The rice production area under the mission's supervision soon grew to 5,470 hectares. The quantity of rice turned over to governmental agencies was 4,461 tons in 1966. The amounts available for export grew each year by two to five times a year except in years of draught. The amount reached 23,030 tons in 1974. The rice export to South Africa then greatly boosted Malawi's foreign currency exchange.

During the dry season of 1994 and wet season of 1995, a total of 18,665.00 tons of rice were produced from an area of 7,027 hectares of fields under the assistance of the Taiwanese mission, through extension work jointly conducted with local extension specialists. This accounted for one third of total rice production in Malawi on 8% of the cultivated land. This is another success story for rice production in Africa (Table 9-38).

**Table 9-38. The Taiwan-ATM assisted rice production at dry (1994) and wet seasons (1995) in Malawi.**

Rice field	Area (ha)	Dry season		Wet seasons		Grand total (MT)
		Yield (kg/ha)	Total production (MT)	Yield (kg/ha)	Total production (MT)	
Reclaimed by ROC-ATM	2,278	4,927	6,730.00	4,458	6,089.00	12,819.00
Originally owned by farmers	4,749	-	-	1,231	5,864.00	5,846.00
Total	7,027	-	6,730.00	-	11,935.00	18,665.00

*(6). Performance of reclaimed land after transferring it from the Taiwan mission to Malawi*

Reclaimed land is usually handed over to the host country after it operates normally in rice production. It is a common phenomenon that the performance of field management will degrade gradually after an assisting unit leaves the farm, and

sustainability becomes a big problem. At present, only Domasi farm (500 ha) continues to be served by the Taiwanese mission regularly, and other reclaimed farms have been handed over to the local governments. According to a recent survey, the performance of transferred farms tended to degrade gradually due to a lack of support from the local government in terms of supplies such as fertilizer, pesticides and other expenses. Some were close to stopping operation. Yielding capacity has declined due to lack of money to repair irrigation facilities, road, etc. However, the majority of the rice fields were maintained with fairly good conditions such as those in Limphasa, Mpamantha, Njala, Domasi, Dedza, Bun, Nkhate, etc. (Table 9-39). In order to maintain the normal operation of the farms, the mission continues to provide assistance with various methods.

**Table 9-39. Performance of reclaimed land after being turned over to the Malawi government.**

Zone name	Experience since management transfer
Kaporo	(1) Poor maintenance of farms (2) Cultivation of paddy-rice on rain-fed base
Mwenitete	(1) Poor maintenance of irrigation canal (2) Cultivation of paddy-rice on rain-season only
Limphasa	(1) Land utilized well
Mpamantha	(1) Land utilized well (2) Sandy sediments influenced dam irrigation
Njala	(1) Better land utilization
Segula	(1) Better land utilization
Mwanbo	(1) Better land utilization
Tangazi/Dombo	(1) Much sandy sediments in the dam (2) Poor irrigation canal maintenance
Tangazi/Mouna	(1) Most of lands abandoned cultivation irrigation problems and flood damage
Masenjere	(1) Due to irrigation canal is partly damaged (2) Water shortages during dry season (3) Shifted from paddy to upland rice cultivation
Dedza	(1) Better general farm management
Domasi	(1) Farm maintained well
Bua	(1) In good condition
Nkhate	(1) In good condition
Wovwe	(1) In good condition

Since then, the ROC-Malawi collaborative agreements have been renewed several times. The structure of the mission was re-organized after the well-integrated Domasi reclamation district was turned over to the Malawi government in 1980. The mission staff members were re-assigned to 4 sub-mission sites. Collaborative activities were extended to include vegetable production at Bvumbwe district, Natural Resources College Teaching Service, Bunda College of Agriculture of the University of Malawi, and other experiment-extension units, totaling 13 units in 1999.

### **9-3-11. Mauritius**

#### **9-3-11-1. General situation**

Mauritius has a land area of 1,850 sq. km. It has tropical climate without dry month. Most of the rainfall is concentrated in November-July. The population size of the country was 1.15million (2001 estimate), G.N.P. per capita income was US\$3,590 (1999), and cereal consumption covered almost entirely by imports. Vegetables are the major food crop produced. Shares of cereals in calorie intake is 48 percent. The bulk of the cultivated land is normally devoted to sugar cane and most of the remainder of the land to fruits and vegetables. Cereal import requirements is estimated at 248,000 tons. Estimated per capita consumption of wheat is 90 kg/year, rice 68 kg/year, coarse grain 2 kg/year and 160 kg/year in total.

#### **9-3-11-2. Taiwan-Mauritius Technical Cooperation**

An agricultural technical mission was sent to Mauritius to improve rice production and inter-crop farming after the signing of a technical cooperation agreement between Mauritius and the Taiwan. Mission activities ended in October 1974.

During the period between 1969-1971, the Taiwanese mission established a half-hectare demonstration farm in Belle Vae for the experimentation of crops. Based on the results of the experiment, the mission recommended a high-yielding variety (6.8-10 t/ha) for farmers to grow there (Table 9-40).

**Table 9-40. Results of yield trials for the introduced varieties of rice in Mauritius in 1970-73.**

Variety name	1970-1971		1971-1972		1972-1973
	First crop (ha)	Second crop (ha)	First crop (ha)	Second crop (ha)	Second crop (ha)
YRL-1	4,626	7,050	4,835	7,623	6,703
Begami	3,989	3,660	-	-	-
IR-8	7,172	8,514	3,646	-	-
IR 532-E 208	-	-	5,888	7,943	7,553
IR 532-E 208	-	-	6,293	8,116	8,069
Blue Bonnet	-	-	4,832	6,409	-
MK 6383	-	-	-	7,248	5,697
Saturn	6,469	9,422	-	-	-
Taichung-native 1	6,839	10,033	7,031	9,201	8,510

### 9-3-12. Niger

#### 9-3-12-1. General situation

Niger is a land locked Sahellian country with a land area of 1,267,000 sq. km. Climatic condition in the northern part is arid, while in the southern part is semi-arid with rainy season in June-October. Niger has a total of 10.34 million population (2001 estimate), and one of the low-income food deficit countries in Africa. G.N.P. per capita income was US\$ 190 (1999) only. Road condition was poor during the rainy season.

Major food crops include millet, sorghum, pulses, roots and tubers. Share of cereal in total calorie intake is 70 %. Previous five years average production of wheat was 7,000 tons, rice 63,000 tons, coarse grain 2,313,000 tons and 2,383,000 tons in total. Previous five years average import of wheat was 44,000 tons, rice 100,000 tons, coarse grain 231,000 tons and 375,000 tons in total. Estimated per capita consumption of wheat was 6 kg/year, rice 15 kg/year, coarse grains 221 kg/year, and 242 kg/year in total. Since the country is in serious shortage of food supply, the government launched an appeal for international food aid and technical assistance.

#### 9-3-12-2. Taiwan-Niger Agricultural Technical Cooperation

Taiwan-Niger collaboration began in 1964. Initial efforts focused on developing rice cultivation in the Daijikina village of Tillabery State where

government officials owned farms and were willing to cooperate. After one year, effective land reclamation activities were extended to cover 116 hectares of land. Installation of irrigation facilities, mainly with the opening of channels and setting up of water pumps, increased the water supplies of vital water. Rice yields with introduced IR varieties rose to 4 t/ha.

The next project was to develop 1,000 hectares of rice land in the Saga area. The operations consisted of developing both irrigation and drainage facilities along the Niger River close to Niamey at four sites: (29,007 total meters), Tillabery, Saga, Kolo and Tera. A water reservoir was planned for Tera, an area, which suffers from chronic water shortage. Other efforts included experimental plantings of introduced varieties of rice

Up until 1974, reclaimed land totaled 970 hectares in the Saga area. Five hundred hectares were added to other areas. Over 3,000 farm families were taught to use improved cultivation practices and modern rice varieties. Trained workers were estimated at 8,620. The use and maintenance of modern farm machineries was also an important component in the training program.



Fig. 9-13. On behalf of CITC, the author (fifth from left) donated the Taiwan-made rice harvesting sickles to a group of rice farmers of Saga area in Niger.

### 9-3-13. Senegal

#### 9-3-13-1. General situation

Senegal is a coastal Sahellian country with a land area of 193,000 sq. km. It is a gateway to Mali with adequate port capacity. The climate in the north is semi-arid, tropical wet-dry in south, with rainy season in June-October. The size of population was 9.74 million (2001 estimate). It is a low-income food deficit country with G.N.P. per capita income of US\$ 510 (1999). Millet, sorghum, rice, maize and wheat are the major food crops. Share of cereals in total calorie intake is 61 percent.

According to FAO (2001), previous five years average production of rice was 189,000 tons, coarse grains 753,000 tons and 942,000 tons in total. Previous five years average imports of wheat was 217,000 tons, rice 452,000 tons, coarse grains 47,000 tons and 716,000 tons in total. Estimated per capita consumption of wheat was 24 kg/year, rice 65 kg/year, coarse grain 79 kg/year, and 167 kg/year in total. Price of rice remained mostly stable due to the supply of imported rice. Self sufficiency of rice is the target of the government's enhanced rice production program.

#### 9-3-13-2. Taiwan-Senegal Agricultural Technical Cooperation

Following the signing of an agreement on agricultural technical cooperation between Senegal and the ROC, in 1963, an eight-member agricultural technical mission was sent to Senegal to help develop local agriculture. The agreement was renewed to enlarge the scale of technical cooperation in rice production. The number of specialists increased from eight in 1964, to 56 in 1972. The past (Phase I) and present (Phase II) activities of the Taiwan-ATM in Senegal are reviewed.

##### *Phase I (1964-1973)*

#### 1. Land reclamation and irrigation facilities

Water supply is essential in rice production. As the first step of the technical cooperation, the mission started building up various irrigation facilities on the abandoned lands near Dakar. After the completion of 300 meters of irrigation canals and 200 meters of drainage canals, a land of 88.5 hectares could be irrigated for rice production. The work continued in the following years and by 1973, a total of 34,330 meters of irrigation canals together with a total of 19,908 meters of drainage canals were built in the northern and southern parts of Senegal. In addition to this, 18 pumping stations and 650 meters of riverbank were built. The water taken up by the pumping stations could irrigate a total of 817.32 hectares of reclaimed land. A total of

4,362 concrete drying grounds were set up to dry the harvested rice grains under sunshine in Goundomp and seven other locations (Table 9-41).

**Table 9-41. Irrigation and drying facilities constructed in the newly reclaimed lands in Senegal (1964-1973).**

Sub-team location	1	2	3	4	5	6	7	8	9
Dakar	300	200	1	-	-	-	40	-	88.50
Bambylor	-	-	2	-	-	-	-	-	12.00
Toubakouta	5,775	6,926	2	1	1	35	66	1*	22.50
Kaolack	-	-	-	-	1	-	-	3	-
Kandialang	9,230	4,915	-	2	-	-	900	-	161.20
Djibelor	650	280	6	1	7	-	160	-	34.35
Goundomp	9,240	5,519	1	1	-	610	1,742	-	32.20
Tanaff	900	288	-	2	2	-	350	1	8.00
Diaroume'	2,456	1,455	1	3	-	5	544	-	151.77
Kolda	359	-	-	-	-	-	560	1	65.00
Podor	1,700	325	3	-	-	-	-	-	200.00
M'bane	3,500	-	1	-	-	-	-	-	40.60
St.-Louis	150	-	1	-	-	-	-	-	1.20
Total	34,330	19,908	18	10	11	650	4,362	6	817.32

Numbers: 1: irrigation canals (meter); 2: drainage canals (meter)

3: pumping station; 4: dam; 5: buildings and shelters;

6: riverbank (meter); 7: concrete drying ground; 8: others;

9: area under irrigation (ha); \*: bridge.

## 2. Yield trials of newly introduced rice varieties

Various varieties of rice introduced from Taiwan and other sources were tested at Dakar in 1964. The yield trials of rice were continually grown at the selected locations every year there after. The results of yield trials conducted at Doder in 1972 are shown in Table 45. Taichung Sen 2 and Kaohsiung 138 produced 10 t/ha and 7 t/ha in the first and second crops respectively on the experimental field under special care during the growing seasons. Taichung Native 1, Taichung 178 and Ai-chio-chien produced 9 tons/ha and 6.6-7.3 t/ha of rice, respectively, in the first and second crops under irrigated conditions. Japanese variety Ohbatawase 123 produced 3.98 t/ha of rice in the second crop. This means that the temperate zone variety was not very suitable to grow under the hot climatic conditions in Africa (Table 9-42).

**Table 9-42. Performance of Taiwanese rice in the yield trial by Podor Sub-Mission in Senegal (1972).**

Variety	Yield (kg/ha)	
	1st crop (Feb.-June)	2nd crop (July-Nov.)
Taichung N. 1	9,409	7,180
Taichung Sen 2	10,224	6,700
Taichung 178	9,454	7,300
Kaohsiung Sen 2	10,000	7,380
Kaohsiung 138	8,138	7,160
Nung-sel. 1	5,681	4,680
Nung-sel. 3	5,431	6,480
Ai-chio-chien	9,181	6,600
CAM-selection 1	5,431	6,480
IR 24	-	6,690
Ohbatawase 123	-	3,980

### 3. Extension work for rice culture

The high yielding varieties screened through the above mentioned field experiments were then recommended to the farmers through field demonstration, training and extension work. The extension work was generally carried out by the mission together with the local extension officers. Without the participation of the local extension agents, the extension work would be very difficult because of the language barrier. During the period of 1967-1973, a total of 3,870 people received training on rice culture, regularly organized by the staff of the mission. A total of 293 local extension agents from various locations also received training in extension work from the mission. A total of 1,876.48 hectares of rice fields were under the extension work of the Taiwanese mission. A total of 6,338 farmer's households benefited from the extension work in 1967-1973.

### *Phase II*

The ROC and Senegal resumed diplomatic ties in 1996. Based on an agreement signed by both countries in July 1996, the ROC immediately dispatched a new Agricultural Technical Mission (ATM), consisting of 14 staff members to Senegal. The mission set up its headquarter in Ziguinchor and began to work the major rice producing zones at Casamance, Ziguinchor, Bignona, and Kolda (the former extension in Phase I.).

Since the departure of the Taiwan-ATM in 1973, rice production of some of the extension fields gradually declined and others even abandoned rice culture due to the lack of supporting resources. Therefore, the 1999 target of mission work was to help farmers replant rice in the 2000 hectares of abandoned lands (Table 9-43).

**Table 9-43. Target of the Taiwan-ATM's work in 1999.**

1. Reclamation in southern Senegal	400 ha
2. Upland rice culture in new and old plantations	750 ha
3. Seed multiplication in southern Senegal	14 ha
4. Replanting rice on the abandoned paddy field in northern Senegal	2,000 ha
5. Total	3,164 ha

### 9-3-13-3. Execution of the project

#### *(1). Field demonstration and seed multiplication*

At Kolda, three newly chosen varieties, Taichung Sen 10, IR64, and Sahell 108 were subjected for field demonstration on 1 hectare of land. 24 tons of seeds were produced from a 50 hectares of fields to supply the needs of 350 hectares of rice field.

#### *(2). Extension of upland rice in southern Senegal*

Reclamation of lands on both sides of the Casamance River from Ziguinchor to Kolda was made during the time period between January-June 1999. Field demonstrations for the selected varieties were made during the second crop (July-Dec.) of 1999. Each farmer was allocated with 0.25 hectares of reclaimed land together with free seeds (70 kg/ha), free fertilizer (200 kg/ha of composite fertilizer N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O=15:15:15), free urea (100 kg/ha) and free pesticides. Small farm tools (sickles, hoes etc) were donated to farmers, while power tillers and grain threshers were on rent basis. The upland rice yield increased to 4 t/ha, which is 3.3 times higher than the amount (1.2 t/ha) produced previously. The extension work for upland rice will be carried out in an additional 400 hectares of land in 2002.

#### *(3). Extension of paddy rice*

St-Louis in northern Senegal is the main region for extension of paddy rice. The deep-water-direct sowing method introduced by the mission solved the problems

of soil salinity, bird damage of sown seeds, and weed control. The newly introduced Taichung-sen 10 from Taiwan produced 5-6 t/ha of rice, which is 25% higher than the previous yield of 4-5 t/ha. The extended area increased to 3,000 hectares, which exceeded greatly the planned area of 1,800 hectares in 1999. With the newly introduced variety Taichung sen 10 and deep water direct sowing method, the yield of rice in the northern part of Senegal became stable at a level of 5-6 t/ha. It is hoped that the total production of rice on a 70,000-hectare land will be further increased in the future.



Fig. 9-14. Deep-water-direct sowing of rice solved the problem of soil salinity and bird damage in St. Louis area of northern Senegal. The picture shows the good standing of directly sown rice at the mature stage.

## **9-4. Evaluations of Taiwan assisted rice production in the African countries**

### **9-4-1. Limitation of irrigation water provisions for rice culture**

Africa has an enormous ecological diversity, embracing two temperate zones, two subtropical regions, and a tropical zone. Central African countries like Burkina Faso and Niger are very dry; therefore mostly low yield upland rice (1-1.5 t/ha) is grown. In the coastal Western Africa (Senegal, the Gambia, etc.) abundant water during rainy seasons (August-October) created deep-water swamps. The deep-water rice grown in this area produces 1.5 t/ha of rice only.

Although there is plenty of water in the Niger River and Malawi Lake, the countries do not have enough funds to construct irrigation facilities for rice production.

Farmers have to use the limited underground water from the artificial deep wells for irrigation. To solve this problem of high cost underground water irrigation, the countries constructed many irrigation facilities with the financial support from the World Bank, FAO, UNDP, IFAD, and the US, England, France, Japan, Taiwan and other countries. The common problems faced in most African countries are the sustainability of the projects after the termination of funds from the other countries. For instance, in the past, the European Colonial Development Cooperation (CDC) reclaimed the Jahally/Pachrr area with pumping stations in the Gambia. In 1970 it was able to produce 5-6 t/ha of rice under the aid project. However, after the evacuation of the CDC from the Gambia, the condition gradually deteriorated in terms of the maintenance of pumping station and irrigation facilities. The yield of rice has dropped sharply from 5-6 t/ha to 3-4 t/ha, and even stops growing in some areas, because of poor management. This has also been the case in the northern part of Senegal, Malawi, and in other African countries. Sustaining the established systems of rice culture is a big challenge for people in these African countries.

To cope with this problem, the Taiwan Agricultural Technical Mission for many years began by rehabilitating the abandoned land as the first step of technical cooperation. Our engineers built small dams, pumping stations, irrigation and drainage canals over the years. For example, 160 technicians from Taiwan built 161 dams, 1,000.23 km of irrigation canals, and 619.0 km of drainage canals, which irrigated a total of 5,475.41 hectares of rice field in the Ivory coast, in the past years. In Niger, the Taiwanese mission built 25 pumping stations to take water from the Niger River through newly constructed 680.73 km of irrigation canals and 44.67 km of drainage canals to the newly reclaimed rice field of 1,569.90 hectares of rice fields. In Malawi, the Taiwanese mission built one dam, and four pumping stations as well as 132.17 km of irrigation canals to irrigate the newly reclaimed 1,382.74 hectares of rice fields. In the Gambia, the Taiwanese mission constructed 171 pumping stations to take water from the Gambia River to irrigate a total of 1,372.38 hectares of rice field through 130.32 km of irrigation canals.

In Burkina Faso, in addition to finishing the construction of one dam, irrigation facilities were also established to irrigate the reclaimed 1,298.92 hectares in 1965-1973 (by 49 technicians). The Taiwanese mission has reclaimed a total of 1,200 hectares of abandoned desert land with irrigation and drainage facilities at the Bagre project site from 1996, to present time.

A total of 335 pumping stations, 263 dams, 2,783,579 m of irrigation canals, and 1,523,436 m of drainage canals constructed by the Taiwanese missions has contributed greatly to rice production in 23 African countries in the past 39 years (Table 9-19).

#### **9-4-2. Vast abandoned lands in Africa need reclamation before they can be used for rice production**

For many years, most African countries needed to reclaim their vast area of desert land into cropland. For instance, 86.57 percent of lands in Swaziland need to be reclaimed before it can be used to grow crops.

Land reclamation is usually the first step of work, after the arrival of a technical mission to a host country. Land reclamation needs technology, funding, and manpower. The ROC sent a total of 83 mission members to finish reclaiming a total of 1,325.32 hectares of abandoned land in Liberia between 1961-1977. In the Ivory Coast, a total of 160 technicians were sent to help reclaim an area of 9,669.95 hectares during 1963-1983. This was the largest human power sent to Africa from Taiwan, for the work of land reclamation and other activities in the ROC 's technical assistance history. The total area of reclaimed land in the African countries by the Taiwan-ATM has increased to 28,831.33 hectares in the past 39 years (Tables 9-44 and 9-45). We have experienced some difficulties in the course of carrying out land reclamation work, primarily due to the lack of close cooperation from the host country, in terms of working attitudes of local officers and equipment supply. However in Burkina Faso, the positive attitude of government officials and field workers helped a great deal in accelerating the construction work of irrigation facilities .The land reclamation work for 2000 hectares of land is going smoothly at present.

**Table 9-44. Acreage of reclaimed and cultured land and number of farmers trained by the Taiwan-Agricultural Technical Missions in the African countries (1961-2000).**

Country	Acreage of reclaimed land (ha)	Acreage of cultivated land (ha)	No. of farmers trained
Botswana	158.57	95.01	252
Burkina Faso	2,617.23	3,473.00	5,660
Cameroon	329.53	1,637.39	772
Central African Republic	368.98	1,056.11	775
Chad	411.32	904.53	1,756
Dahomey(Benin)	780.00	1,067.90	1,621
Gabon	832.33	1,240.92	571
Gambia	470.00	1,683.00	8643
Ghana	216.32	161.35	374
Guinea-Buissau	3,707.50	3,707.50	3,681
Ivory Coast	9,669.95	50,958.33	3,384
Lesotho	0	180.14	3,314
Liberia	1,325.32	9,801.22	2,790
Libra	12.00	12.00	102
Malagasy	523.40	476.47	97
Malawi	1,474.86	5,418.26	1,295
Mauritius	3.00	68.58	291
Niger	1,590.50	1,123.75	8,620
Rwanda	1,188.65	994.22	4,246
Senegal	100.48	1,929.36	3,870
Sierra Leone	630.31	1,443.93	1,307
Swaziland	112.65	160.62	0
Togo	801.85	2,122.15	3,124
Zaire	1,506.58	9,861.62	6,482
Total	28,831.33	99,577.36	63,027

**Table 9-45. Irrigation facilities constructed by the Taiwan-Agricultural Technical Mission in the African countries (1961-2000).**

Country	Irrigation canal (m)	Drainage canal (m)	Dam	Pumping station	Acreage of irrigated land (ha)
Botswana	6,650	3,701	5	10	44.40
Burkina Faso	89,345	57,860	1	0	2,446.96
Cameroon	28,611	16,282	36	1	209.07
Central African Republic	35,957	7,787	4	18	153.30
Chad	69,609	34,900	0	4	578.00
Dahomey(Benin)	62,690	83,480	2	6	782.00
Gabon	39,265	44,872	0	27	257.49
Gambia	130,322	20,083	1	172	1,372.38
Ghana	13,068	11,538	1	1	108.12
Ivory Coast	1,000,828	619,865	161	0	5,475.41
Lesotho	26,803	11,907	7	8	133.15
Liberia	93,136	139,235	10	5	844.70
Libya	1,000	0	0	1	2.00
Malagasy	12,599	16,250	7	1	189.97
Malawi	132,172	149,680	1	4	1,382.74
Mauritius	783	920	0	0	3.00
Niger	680,730	44,666	0	25	1,569.00
Rwanda	164,120	122,253	0	0	820.51
Senegal	34,330	19,908	10	18	817.32
Sierra Leone	18,106	11,056	6	12	116.62
Swaziland	16,683	9,737	0	2	103.20
Togo	48,200	33,660	3	8	284.34
Zaire	78,572	64,003	8	12	550.00
Total	2,783,579	1,523,643	263	335	18,243.68

#### **9-4-3. A simple economical measure should be developed for the use of farmers**

##### **9-4-3-1. The case in Senegal**

In St. Louis and Fleune areas of northern Senegal, the 7,000 hectares of rice land developed by the multilateral assistance program (England, France, U.S.A.,

Japan etc.) through the Delta Land Development Cooperation in the early years had to stop operation in 50% of the reclaimed land for many years. This was due to expensive land reclamation costs, and farmers lacked fund for farm investment. There are also other reasons; such as salinity of land, bird damage to the sown seeds and weeding requires too much labor and time. Because of these, the farmers eventually had to stop planting rice for many years.

To cope with this problem, the Taiwanese mission devised a very simple "deep-water-direct-sowing-method", after a series of experiments conducted on an experimental farm at St. Louis. The adoption of "deep-water-direct sowing" helps dilute soil salinity, inhibits the growth of weeds, and prevents the sown seeds from being eaten by birds. This labor saving method enabled a better yield of 5-7 t/ha, in comparison with 4-5 t/ha yielded from the conventional way of rice planting. Because of this, a total of 2,000 hectares of abandoned land returned rice production using this simple method. The high yielding variety, Taichung-Sen 10 introduced from Taiwan, was the major rice variety cultured with this simple method in northern Senegal today.

In the dry areas of southern Senegal (Bignona, Ziguinchor and Kolda), besides Taichung Sen 10, IR 64 and Sahell 108 were recommended for culture under the rain-fed conditions (800-1,200 mm of rainfall only). Because of early planting of the drought-resistant varieties, the rice yielded 4 t/ha. This is 3 times higher than the 1-2 t/ha yielded by the previous practice of planting of an old upland variety. As a result of the extension work, a total of 3,000 hectares of rain-fed upland are now practicing this method of early planting. The Taiwanese mission provided free seeds and fertilizer at the initial year of replanting rice. The acreage of rice at rehabilitated land continues to increase. Broken rice has been a big problem in this area. The traditional way of milling caused 30-50% of broken rice, which has no commercial value. The Taiwanese mission provided several sets of small milling machines for farmers to use. As the results, the rate of broken rice is now reduced to 25%. This helped farmers a lot, increasing the market value of rice, and giving farmers more incentives to grow rice in that abandoned field. The Taiwanese mission spent an amount of NT 54,028,000 (US\$ 1,800,933) for this project in 1996.

#### 9-4-3-2. The case in the Gambia

In 1996, the Taiwanese mission studied the economy of the pump and tidal irrigation systems in the Central River Division (CRD). Result of the study indicated

that the pump irrigation system is very costly in terms of equipment and fuel consumption. In contrast to this, tidal irrigation system costs much less. Therefore, the Taiwanese mission decided to help farmers to convert 400 hectares of pump irrigated rice field into tidal irrigation field in Jahally/Pacharr. As a result of this shift, an amount of US\$ 25,000 could be saved annually from the cost of fuel and other expenses. More importantly, the yield of rice could be increased from 1 t/ha to 5 t/ha under this newly adopted tidal irrigation system. In fact, during the dry season of 1999, the extension farm in Jahally/Pacharr was able to increase the yield of rice to as much as 6 t/ha.

In addition to the low cost, an important characteristics of tidal irrigation is that it permits year-round cultivation with simple technology. Although the tidal irrigation is considered to be very advantageous, however one should not forget to pay more attention to the following matters in the course of practicing the tidal irrigation.

Farmers should collaborate with each other to maintain the structures and to clean the irrigation and drainage channels

Water users need to work closely as a group. Appointed individuals must be "on call" in case of high tides occur at night, so that an appropriate measure can be taken immediately to prevent overflow of water into the rice field.

Farm machinery may be used for land preparation and harvesting. However, animal traction should be used on the muddy low land where machinery operation is difficult.

There are more than 5,000 hectares of tidal lands available for double cropping of rice in the Gambia. Of these, about 1,800 hectares of land is already used for rice production. If the rest of land is fully utilized to produce two crops of rice annually at a level of 4 t/ha, the total output of rice could reach 40,000 tons annually. In addition to this, there are about 60,000 hectares of seasonal fresh water area in which only a single crop could be grown during the rainy season. If 20,000 hectares are planted annually, yield of rice may reach up to 80,000 tons. If these two types of lands (ever-fresh-water area and seasonal fresh water area) are used properly, yields may reach 120,000 tons annually. This will be more than the amount of annual requirement of 80,000-90,000 tons. The excess amount of rice then could be exported to other countries in the future.

#### **9-4-4. Farmers are in short of capital for operation of their farms.**

Loans from local banks are usually very expensive. In Senegal, the rate of a loan could be as high as 20-25%. To solve this problem, the ICDF extended low interest loans (3.5-6%) to the needy farmers in African countries. The ROC-ICDF's loans are extended to farmers through local cooperatives or banks. Loans through the ROC mission are interest free. The mission could only recover 25-50% of the loaned funds. This situation will hinder the smooth operation of micro-lending systems now operating in several African countries.

#### **9-4-5. The education levels in Africa are generally low, and the majority of farmers are non-educated.**

This situation will affect the effectiveness of technology transfer. With the help of the local officers to serve as interpreters, the Taiwanese mission was able to train a total of 63,027 farmers in 24 African countries in the past years (Table 9-18).

Other difficulties include: (1) the high cost of imported chemical fertilizers and pesticides, (one bag of fertilizer costs US\$ 30-40 in Senegal and Liberia); (2) Lack of milling factories. Farmers depend on traditional ways of hand milling; (3) The high temperature and high humidity cause the stored brown rice to germinate quickly. Germinated rice seeds have no commercial value. To solve this problem, the Taiwanese mission is providing the small imported milling machines for farmers; and (4) Marketing of rice in competition with the imported cheap low-grade rice is also a problem.

## Conclusion

The main point of Taiwan's agricultural assistance program is technology transfer. The technology of rice production is transferred through a hands-on process, learning through practicing. Taiwan's teams of experts normally begin by selecting a piece of uncultivated land or desert for reclamation. At the same time, various kinds of rice are then introduced from Taiwan and other countries for adaptability trials. The methods of rice culture are then tested with the selected varieties at the demonstration fields. A special feature of the Taiwan's agricultural cooperation program is that team members are involved in every step of the cultivation process, from land preparation, rice planting, fertilizer and pesticide applications, irrigation, and drainage, to harvesting, milling, and packing of milled rice. They work side by side with the local counterparts and farmers on every detail of the operation and share with them the joy of harvest and the despair of failure. This "hands-on" approach is different from many foreign programs, which give financial support only and are seldom involved in other steps of rice production.

The "hands-on" approach, together with financial support, will ensure that the funds are well spent according to the original plans of land reclamation, construction of irrigation facilities, and extension work. The spirit of working together with the local farmers, not only develops a close partnership and friendship with farmers, but also enhances the efficiency of work. Naming a village as "Wu- Tzuen"(Wu's Village) in commemoration of Mr. Wu's contribution in the rice production in Guinea-Buissau is a good example of this friendly cooperation.

A successful rice production assistance program requires transferring appropriate technologies to a country. Free chemical fertilizers, free seeds and free pesticides in the initial year stimulated farmers' incentives to work harder. When yields of rice increased after adopting new measures, it will encourage farmers to continue culturing rice in the following crop seasons. When farmers were able to pay the costs of fertilizers and other farm supplies on their own; the subsidies from the mission are terminated. In this way, the sustainability of rice culture by farmers was maintained, as modeled in Burkina Faso, Senegal, and the Gambia. At times, however, this model of rice culture did not sustain, because the farmers did not have enough money to cover the costs of field operations. Micro-loan programs from the ICDF thus offered to help solve the problem. Approximately 70% of loans were returned in

Senegal, while only 20-25% of loans was recovered in the Gambia. This is a problem, which needs to be solved.

Field demonstration and extension work are the keys to successful rice production. Demonstration plots are usually set up in the major rice growing areas. The majority of farmers can easily see the performance of newly adopted varieties of rice with their own eyes. This is a very useful way of transferring technology to farmers, especially those who could not read and communicate in common national language. Training courses with regards to the use of fertilizers, pesticide, and handling of agricultural tools, etc., were often accompanied with activities held at the demonstration farms. More than 55,288 farmers received this kind of training organized by the Taiwan mission in 23 African countries in the past. This training will be continued by every Taiwan mission operating in the African countries. The extension officers in the host countries often were not very cooperative in this matter unless they were well paid by the mission. This situation slows down or prevents continuation of this kind of activity after the mission leaves the country.

The Taiwan assisted rice production has been very successful in most of the cooperating countries especially in Burkina Faso's Valle Du Kou project and Bagre project and rice projects in the Ivory coast, Niger, Liberia, etc. Halting of a mission is really a sad event that we do not want to see. For instance, the Taiwanese mission at one point was close to accomplishing the goal of reclaiming a land project of 5,000 hectares in Guinea-Bissau. We had to stop operations suddenly, even after finishing 3,500 hectares of land reclamation in Guinea-Bissau. This was a very unfortunate event for farmers in that country. The same is true in the cases of the Ivory Coast and Niger, where the scales of rice production projects were even larger.

It is felt that the existing agricultural cooperation programs should be strengthened by the financial resources and co-financing of projects of the ROC and other countries like Japan. The host country will hopefully facilitate the success of a project just like the on-going rice production project in Burkina Faso, the Gambia and Senegal. With co-financing and the cooperation of two or more parties, we may not only be able to enlarge current programs, but also further expand current production operations to post-harvesting treatments and the marketing of rice.

## **Perspectives of the Future**

The ICDF itself has periodically sent officers to the rice production project sites to evaluate the field mission approaches, activities, difficulties faced, and accomplishments. In the interest of seeking continuous improvements, African regional meetings for joint planning and assessment were held in the Gambia in May 2000. As a result of this introspective review, we have drawn up the following measures for further improvement.

Bilateral cooperation should be developed on a project-specific basis to address key problems confronted by the host nation in agriculture and associated developments within a certain time limit. The project should be within the realm of our expertise and the host nation's available resources. Project plans should follow scientific and management standards.

Technology transfers and extensions should be strengthened and expanded by moving from simple to complex programs and providing aid to local farmers and technical cadres. The missions should make the best use of the local organizations. Strengthening collaboration among field missions in a region will make full use of resources and increase the sharing of expertise and experience. Multilateral cooperation, such as that with FAO, the World Bank, and Japan, can be expanded to good advantage. Assistance to a friendly nation may be expanded to cover countrywide planning of its agricultural economy, from which appropriate areas of cooperation may be selected to suit Taiwan capabilities and matching the resources of the host country.

Mission staff should be carefully selected and upgraded from well-qualified resources in Taiwan. Mission leaders should have higher academic and scientific qualifications. In this connection, the members of the mission have been regularly sent back to receive "on-the-job-training" at the Institute of Tropical Research and International Cooperation, National Pingtung University of Science and Technology, to receive a post graduate education working toward Master of Science (MS) degree, and have taken professional and leadership courses for at least two years. After finishing their studies, they will be sent back to cooperating countries around the world, including Africa. We find that this type of "on-the-job-training" is very useful for our field experts working in foreign countries.

On-location-research by the mission has been expanded to a joint research program between the local research institutions and the research institutions in Taiwan. Currently, a research project on soil analysis in relation to yielding capacities of rice in the Gambia was jointly executed by the Taichung District Agricultural Improvement Station and the National Agricultural Research Institute of the Gambia. We find that this type of "on-location-research" helps develop new technologies, which can be better adopted in that specific country. The Taichung District Agricultural Improvement Station will conduct similar types of joint research at the research stations in Liberia, Chad and Burkina Faso to solve the problems encountered in the course of rice production. Increased participation of mission staff in international workshops and conferences, regionally coordinated programs, and related activities will broaden the mission's vision. The increased amount of foreign aid will accelerate the activities of international cooperation.

With these refinements in strategy and modes of operation, the ICDF can look forward to many new frontiers of international cooperation, extending from production to related market-oriented activities, such as the processing of local products for market. Fruitful returns can be assured from the program adjustments. Meanwhile, the ICDF will seek improvements to upgrade the efficiency of its operations. Our efforts are directed to improving our missions of sharing expertise with our friends on a partnership basis and by staying dynamic in this changing world.

## References

1. Chang, T. T. 1995. Technical Cooperation in Africa. International Cooperation Newsletter. Vol. 1. No. 2. pp. 1-24.
2. Chen, Y. S. 1999. The tidal irrigation in relation to rice production in The Gambia. pp. 1-13. Mimeographed.
3. Chen, Y. S. 1999. Three years rice promotion project report of the Agricultural Technical Mission of the Republic of China to the Gambia (in Chinese). pp. 13.
4. Chang, C. S. 1999. Report on development of tidal irrigation in the Gambia (in Chinese). The Agricultural Technical Mission of the Republic of China to the Gambia. pp. 12. Mimeographed.
5. Committee of International Technical Cooperation (CITC). 1995. Annual Report of C ITC, 1995, 1996, 1997 (in Chinese).
6. Committee of International Technical Cooperation. 1997. 36 years of International Technical Cooperation – In: Commemoration of the Committee of International Technical Cooperation after 36 years of distinguished service to the friendly countries of ROC. pp. 1-282. (in Chinese). Printed by CITC.
7. Euroconsult. 1986. Assessment of possibilities of tidal irrigation along the Gambia River – Kreditanstalt fur Wiederaufbau. pp. 59.
8. Euroconsult, 1989. Jahally/Pacharr Project – Tidal irrigation, experience and lessons, 1984-1989.
9. FAO 2001. Food supply situation and crop prospects in Sub-Saharan Africa. <http://www.fao.org/>.
10. Fang, I. Y. 1999. A brief report on the activities of ROC-ATM in Burkina Faso. pp. 1-12 (in Chinese). Mimeographed.
11. Hou, C. M. 1994. The Taiwan's Agricultural Cooperation in Africa and the Middle East. pp. 149-232. In: The Taiwan Model of Agricultural Assistance. Printed by Chung-Hua Institution for Economic Research, Taiwan, ROC.
12. Hsieh, S. C. 1994. Report of feasibility study on agricultural technical cooperation between the Republic of China and Burkina Faso and Niger (in Chinese). pp. 1-66. Mimeographed.
13. Hsieh, S. C., I. C. Liu, M. H. Tsai, P. P. Li, and S. C. Huang. 1995. Report of survey on agricultural technical cooperation between the Gambia and the Republic of China (in Chinese). pp. 1-104. Mimeographed.

14. Hsieh, S. C., and P. P. Li. 1995. Promoting and enhancing overseas agricultural technical cooperation - Problem faced and proposed measures of adjustment (in Chinese). pp. 26-59. Pub. By the Organizational Committee of 1995 Integrated Annual Meeting of Agricultural Societies of ROC, 1995.
15. Hsieh, S. C. 1997. Enhancing international agricultural cooperation in the Asia-Pacific region-Emphasizing the CITC approach on a world – wide scale. Proceed. Intl. Conference on Agricultural Cooperation in Southeast Asian Countries. pp. 1-27. Pub. By CITC.
16. Hsieh, S. C. 2001. Agricultural reform in Africa. <http://www.icdf.org.tw/>
17. Liu, C. H. 1999. A brief report on the activities of ROC-ATM in Senegal. pp. 1-7. (in Chinese). Mimeographed.
18. ROC-Liberia agricultural technical cooperation 2000. A report of ROC Agricultural Technical Mission. (in Chinese). pp. 1-19. Mimeographed.
19. ROC survey report on tidal irrigation systems and improvement for promoting rice production in the Gambia. 1997. pp. 69. Mimeographed.
20. Shi, L. C. 1999. A report of evaluation on agricultural technical cooperation activities of ROC-ATM in the Gambia and Senegal 1999. (in Chinese). pp. 1-113. Printed by ICDF.
21. Wakatsuki, T. 1998. Sawah systems for integrated watershed management of small inland valleys in West Africa. In: Institutional and technical options in the development and management of small-scale irrigation. pp. 45-60. Proceed of the third session of the Multilateral Cooperation Workshops for Sustainable Agriculture, Forestry and Fisheries Development, Tokyo, Japan 1998. Printed by Ministry of Agriculture and Fisheries, Japan.
22. Wakatsuki, T. 1999. Transfer of Asian experiences on the African Development in 21 century. In: Comparative study and evaluation on the Asian Collaborated Sawah based rice development projects in West Africa. pp. 1-16. Printed by FASIO (Foundation for Advanced Studies on International Development).