5 Farming Systems and Rice-Cropping Systems in West Africa

5.1 General

This chapter describes the main farming systems of West Africa. As, under the influence of climate and soils, the farming systems are area specific, they are described only in general terms. Rice-cropping systems within these farming systems are discussed in the second part of this chapter.

Many authors give information, at various levels of detail, about the farming systems in West Africa. The information compiled here is mainly derived from Webster and Wilson (1980), Ruthenberg (1980), Okigbo (1981), Moormann and Juo (1986), Harrison Church (1968), Morgan (1969), Gleave and White (1969), and Kowal and Kassam (1978).

Rice-cropping systems are described by, among others, Moormann and Juo (1986), Luning (1984), Buddenhagen (1978), Becker (1990), WARDA (1991), Bindraban (1991), Andriesse and Fresco (1991), de Rouw (1991), and Richards (1985, 1986, 1987).

A farming (or farm, or agricultural) system is defined by Okigbo (1979) as an enterprise or business in which sets of inputs or resources are uniquely orchestrated by the farmer in such a way as to satisfy needs and to achieve desired objectives in a given environmental setting. In West Africa, the farming system comprises the activity of one or more individuals, usually a family unit, with some or all members of the family participating for some or most of their time in farm work.

According to de Rouw (1991), the farming system functions as a decision-making unit as it transforms land, capital, and knowledge into useful products that can be consumed or sold.

A (rice-)cropping system refers to the kinds, combinations, and/or sequences of activities in time and space, in addition to the practices and technologies used in the production of the crop in a specific area to satisfy the needs of growers and users (Okigbo 1979).

The function of the cropping system is the transformation of plant material and soil nutrients into useful biomass. A cropping system is a component of the farming system (de Rouw 1991).

5.2 Farming Systems

Okigbo (1981) and de Jong (1989) summarize the main characteristics of the traditional farming systems in West Africa as follows:

- Crop production is mainly for home consumption;
- Farming systems are diverse and range from true shifting cultivation to permanent cultivation;
- Levels of mechanization, as well as of capital input, are low and the possibilities of external inputs are restricted;

- Farms are small but have a high diversity of crops;
- There is a clear division of labour and income between the sexes;
- Cropping patterns are strongly dependent on the prevailing rainfall regime. Rotational and mixed cropping are practised to spread the risk of crop failure;
- Traditional cropping systems take advantage of local topographic features and hydrological circumstances. There is much indigenous knowledge;
- In the humid areas (Equatorial Forest Zone) and in the tsetse-infested areas, farming is predominantly based on human labour and simple tools. Only goats, chickens, sheep, and pigs are kept as livestock;
- In the drier Savanna Zones, arable cropping and livestock production are integrated within the farming system. Oxen are used to work the fields, as a source of manure, etc.

Farming systems can be subdivided on the basis of the types of crops cultivated. Webster and Wilson (1980), for instance, distinguish four main types of crop-based or livestock-based farming systems. These are:
- Rain-fed arable farming systems other than those involving wetland rice;
- Rain-fed and irrigated systems based on wetland rice;
- Monoculture of perennial crops;
- Predominantly livestock systems (e.g. nomadic pastoralism and ranching).

Because rice cultivation in West Africa is the main subject of the present study, a more convenient subdivision of farming systems is given by Ruthenberg (1980). He distinguishes three main arable farming systems, based on the length of the fallow period and the input of labour, capital, and technology. These are:
- **Shifting cultivation:** Short periods of cropping are followed by long fallow periods. Less than 33% of the potential cropping area is under cultivation at any one time;
- **Fallow system:** Periods of cropping are followed by relatively short fallow periods. More than 33%, but less than 66% of the potential cropping area is under cultivation at any one time;
- **(Semi-)permanent cultivation:** Fallow periods are very short or do not occur at all. More than 66% of the potential cropping area is under cultivation at any one time.

In practice, the farming systems distinguished above are not distinctly separated. Within a certain area, different farming systems occur. Fields or gardens near the farmsteads are generally more permanently cultivated (short fallow periods) and more intensively than the fields further away from the villages (long fallow periods). Large floodplains, coastal plains, and inland valley bottoms can be cultivated more intensively, whereas the adjacent uplands are cultivated with short to long fallow periods.

5.2.1 Shifting Cultivation

Shifting cultivation is the characteristic agricultural practice in much of the humid part of West Africa (i.e. the Equatorial Forest Zone). This farming system is based on the natural soil fertility and the input of manual labour only. There is no input of capital, technology, manure, or fertilizers. It is characterized by short periods of

cropping (one to three years), alternating with long fallow periods which serve to restore the fertility of the soil. The fields under shifting cultivation are cleared by slashing and burning. Shifting cultivators, in general, have only a few domestic animals like goats, sheep, chickens, or pigs, which are kept near the farm yards. During the fallow period, the fields are not used for grazing.

Shifting cultivation is mainly associated with subsistence agriculture. The length of the fallow period is strongly correlated with the distribution and the density of the population (generally less than 10 per km^2). The shifting cultivator is skilled in adapting cropping practices to the environment in which he is working. Important aspects of adaptation are the selection of the field to be cultivated, the choice of crops, the organization of intercropping, mixed cropping, or phased planting, and the arrangement of short-, middle-, and long-term fallows.

Shifting cultivation creates only temporary boundaries between cultivated and non-cultivated land. The fields are well defined during the growing period, but they are lost in the subsequent fallow period.

Under shifting cultivation, the staple crop is of primary importance. These crops, however, differ per country. In Liberia, Sierra Leone, and parts of Ivory Coast, upland rice is the staple crop. In the other parts of the Equatorial Forest Zone, the main staple crops are maize and tubers, including cassava, yam, sweet potato, and taro.

The main problem of shifting cultivation lies in the fact that the productivity of labour and natural resources can hardly be increased. Shifting cultivation cannot absorb a growing population and does not allow increased cash production or the introduction of technical innovations (Ruthenberg 1980).

5.2.2 Fallow Systems

Under increasing population pressure and expanding cash production, shifting cultivation will be replaced by the fallow farming system. Within that system, the period of fallow is shorter than that under shifting cultivation, but in general the time in fallow still exceeds the time during which the land is cultivated. Ruthenberg (1980) defines the fallow system by the fact that between 33% and 66% of the potential area is under cultivation at any one time.

This farming system is widespread in the Guinea Savanna and Sudan Savanna Zones of West Africa and, to a much lesser extent, in the Equatorial Forest Zone. Based on the vegetational zonation, different names are used for this system (e.g. savanna fallow and bush fallow).

Under fallow systems, a regular system of fallows is created which are never permitted to revert to savanna woodland or equatorial forest. After several years of arable cropping, the field can be used for the cultivation of grasses and legumes and utilized for livestock production. This can be the natural fallow vegetation without management, or a more regulated fallow vegetation involving the planting of certain grasses, the application of manure, etc. More or less regulated fallow cultivation is called the ley system (Ruthenberg 1980).

Fallow farming is usually characterized by clearly defined farms with largely permanent field divisions and more or less permanent farm yards. Land occupied by fallow

cultivators is substantially modified by man's efforts to maintain and improve his living.

The most common staple crops cultivated in this way are rice, roots and tubers (cassava, yam, sweet potato) and mixed grains (maize, sorghum, millet).

Along the toposequences of the inland valleys, each (physio-hydrologic) segment has its specific agricultural potential and is used accordingly by the farmers (Ruthenberg 1980; Richards 1987).

In the West African Savanna Zones, for instance, the more drought tolerant crops are grown on the relatively dry uplands (millet, groundnut, cowpea, and cotton), while maize, sorghum, sweet potato, and rice are cultivated in the wetter lower parts of the slopes and in the valley bottoms. This strategy spreads the risks of crop failure from both droughts and floods (Vierich and Stoop 1990).

In a bush fallow farming system in Nigeria, described by Gembremeskel and de Vries (1985), almost all farmers cultivate fields in both the uplands and the valley bottoms. The upland farms are cultivated for about five years, followed by a fallow period of about ten years. During the rainy season, the most important upland crops are Guinea corn (sorghum), melon, maize, and yam, while on the valley bottoms only rice is cultivated. In the dry season, the valley bottoms are cultivated with cassava, sweet potato, okra, and sugarcane.

In addition to these physiographically-induced differences in land use, the distance from the village or houses to the fields also influences the cropping practices. The most intensive land use is found near the houses, and consists of permanent gardens with fruit trees and perennial crops, and on the dungland, the arable land close to the village. Both are permanently cultivated, with the use of household and farmyard manure.

Adjoining the dungland, intensive fallow systems occur in concentric circles of varying sizes. These fields are often used for staple-food and cash-crop production. The fallow is mostly used as pasture.

The intensity of the cropping cycle decreases proportionally with the distance from the farmstead. The fallow periods are of long duration far away from the village and are under regenerating natural vegetation (Ruthenberg 1980).

Because of the more intensive land use of the fallow system, as compared with shifting cultivation, the soils are more frequently fertilized with manure, green manure, and, in the case of cash crops, with mineral fertilizers. The fallow system also uses more advanced cultivation techniques.

Large stocks of cattle are integrated into the fallow farming systems, especially in the Savanna Zones outside the tsetse belt. The cattle are kept for traction power, for ox-plough cultivation, for meat and milk, to cover the risks of harvest failure, and for social functions (bride price). The manure is used to fertilize the fields.

A major problem in fallow farming systems is the declining fertility status of the soils because the fallow periods are too short generally, and the manure applications are insufficient to maintain the soils' natural fertility. Furthermore, fallow farming can cause a degradation of the soil structure, resulting in the sealing of the soil surface and the compaction of subsurface layers. This, in turn, leads to increased soil erosion.

Another problem of the fallow farming system, rather specific for West Africa, is

the labour shortage, especially in the rainy season. Because of the lack of means to pay hired workers and the general shortage of labour in the rural areas of West Africa (Kowal and Kassam 1978), most of the work has to be done by family labour. This is often too little to plant and weed according to a timetable that would optimize the yields.

A third problem occurs in the Savanna Zones where livestock is present. The increase of the area used for arable farming creates conflicts of interest between arable farmers and livestock herders. This can result in overgrazing of the lands and may cause severe soil degradation and erosion.

5.2.3 (Semi-)Permanent Farming Systems

Any intensification of the fallow farming system results in a further shortening of the fallow period, or, eventually, its absence. The farming system becomes more or less permanent. This is particularly the case in densely populated areas like the Mossi Plateau (Burkina Faso), Kano (north Nigeria), and the Ibo and Ibilio lands (east Nigeria). As early as 1969, Morgan had already described great problems of overcultivation, soil degradation, and soil erosion occurring in these areas. Vierich and Stoop (1990) found severe degradation of the soils along some toposequences in Burkina Faso, due to increased population pressure and protracted periods of low rainfall.

Ruthenberg (1980) distinguishes three different types of farming systems within permanent farming systems. These are:
- Permanent cropping of annual crops;
- Planting of perennials, especially tree crops;
- Irrigated farming.

Because of the strong leaching of the nutrients and the very fast alteration of organic matter under humid tropical conditions, permanent upland cultivation of annual crops may result in a severe decline in soil fertility and in very low yields. Technically-feasible solutions to these problems exist, but the economic returns are as yet still marginal. For these reasons, permanent annual crop production is hardly found in the Equatorial Forest Zone. In the drier parts of West Africa (i.e. the Savanna Zones), permanent cultivation is more common, but the major part of agricultural production is done in fallow farming systems.

In the humid areas of West Africa, perennial crops like oil palm, cacao, and coffee have long been cultivated on the uplands. If these crops are intensively cultivated, the requirements of fertilizer, management, capital, and technical knowledge are high. Generally, in West Africa, these crops are produced for the export market.

Irrigated farming must be divided into traditional and modern irrigation. Traditional irrigation is found in various parts of the inventory area. Mainly along the main rivers (Senegal, Niger, Benué), the annual flooding of the floodplains is used for the cultivation of (floating) rice and the production of flood-recession cereals (millet, sorghum). In the inland delta of the Niger River (Mali), an area of some 60,000 ha is cultivated

with rice (FAO 1986). All along the West African coast – from The Gambia to Liberia and, to a lesser extent further east (from Benin through Cameroon) – coastal swamps and estuaries are used for tidal rice production.

In the western part of West Africa, rice has long been grown by smallholders in the inland valleys, especially in the Guinea Savanna Zone, where rice is an important staple crop. According to Mohr (1969), this area comprises the upper catchments of the Casamance and Gambia Rivers, in south Mali, Burkina Faso, north and west Ivory Coast (Korhogo and Man), Guinea, north Liberia, Sierra Leone, and Guinea Bissau. In this region, valley rice cultivation is still widespread.

In Nigeria, smallholder traditional *fadama* development has taken place in the middle belt of the Guinea Savanna Zone, where it is estimated to have expanded from 100,000 ha in 1958 to 800,000 ha at present. Here, vegetables are an important crop, supplementing rain-fed cereals in the wet season (FAO 1986).

Over the last 50 years, large, modern irrigation schemes have been developed in several countries of West Africa: in Senegal, Mali, Nigeria, Ivory Coast, and Cameroon. Owing to the low yields, the high implementation costs, or the remote location of these projects, their performance has been disappointing and incommensurate with the large investments made (FAO 1986).

In recent years, small- and medium-scale irrigation schemes have been implemented, such as village irrigation schemes along the main rivers (e.g. the Senegal River) and schemes based on small dams in Burkina Faso. The success of some of these schemes has often been the result of good prices for rice or the impossibility of farmers obtaining their food requirements from rain-fed crops (FAO 1986).

Permanent rice production by irrigated farming, with or without water control, is mainly practised in the large floodplains and in the coastal areas. Recently, more attention has been given to rice production in the valley bottoms of the inland valleys (WARDA 1988; IITA 1990).

5.3 Rice-Cropping Systems

In literature, different kinds of rice-cropping systems have been defined. Buddenhagen (1978) distinguishes four main types of African rice culture, subdivided into several sub-types: upland rice (dryland and hydromorphic), irrigated rice, inland swamp rice, and flooded rice (riverine deep, riverine shallow, boliland, mangrove).

Nyanteng (1986) gives a slightly different subdivision:
- Upland rice;
- Inland swamp rice (including boliland);
- Mangrove swamp rice;
- Irrigated rice;
- Deep-water rice.

Table 5.1 shows the distribution of these categories of rice-cropping systems over the different countries of West Africa.

From these data, it can be concluded that, in the humid zone of West Africa, most

Table 5.1 Rice-cropping systems and their distribution (in % of total rice area) in West Africa, 1980-1985 (Source: Nyanteng 1986)

	Upland	Inland swamp (+ boliland)	Mangrove swamp	Irrigated	Deep-water floating riverine
Benin	6.7	92.0	–	1.3	–
Burkina Faso	0.3	85.9	–	13.8	–
The Gambia	15.4	63.7	14.2	6.7	–
Ghana	85.2	7.4	–	7.4	–
Guinea	47.0	30.0	15.0	5.0	3.0
Guinea Bissau	20.3	23.0	54.6	2.1	–
Ivory Coast	87.1	7.1	–	5.8	–
Liberia	94.0	6.0	–	–	–
Mali	5.0	–	–	34.4	60.6
Niger	–	–	–	27.9	72.1
Nigeria	60.0	10.0	5.0	5.0	20.0
Senegal	–	72.7	11.8	15.5	–
Sierra Leone	67.1	26.2	5.7	–	1.0
Togo	77.2	18.5	–	4.3	–

of the rice cultivation takes place on the uplands (Ivory Coast, Ghana, Liberia, Nigeria, Togo, and Sierra Leone). Inland swamp rice is prominent in Benin, Burkina Faso, The Gambia, and Senegal. In Niger and Mali, irrigated and deep-water floating riverine rice are the most important rice-cropping systems.

More recently, for its research programme in West Africa, the West Africa Rice Development Association distinguished four main types of rice cultivation (WARDA 1991, Becker 1990). This subdivision is based mainly on ecological/environmental differences, as follows:
- Irrigated Sahel;
- Coastal mangrove swamp;
- Deep-water floodplains of inland rivers and lakes;
- Upland/inland swamp continuum.

The upland/inland swamp continuum represents the diversity of ecosystems from – at the lower end – the valley bottoms, which are often seasonally submerged, to – at the higher end of the continuum – the uplands, comprising the rain-fed zones. The upland/inland swamp continuum is the characteristic toposequence of the inland valleys (see Section 2.3). As the inland valleys are the main subject of the present inventory, the rice cropping systems of the upland/inland swamp continuum will be described here in more detail.

The basic differences between the various rice-cropping systems of the upland/inland swamp continuum are the hydrological conditions in the rice fields. On the uplands (crests, upper and middle slopes), the only source of water for agriculture is precipitation. This is the pluvial zone, described in Section 2.4. In general, the soils drain freely and there is no saturation of the soil, even during the rainy season. The lowest parts of the slopes are characterized by a temporary saturation of the soils

due to subsurface groundwater inflow and runoff from the uplands (the phreatic zone) while the valley bottom soils are annually flooded for a certain period (the fluxial zone).

On the uplands, the rice-cropping system is defined as upland (or pluvial), on the temporarily-saturated footslopes as hydromorphic (or phreatic), and in the flooded valley bottoms as wetland (or fluxial) rice cultivation.

5.3.1 Upland (Pluvial) Rice-Cropping Systems

Traditionally, upland rice cultivation in West Africa is mainly found in the Equatorial Forest Zone and, because of the lower rainfall and the limited water retention, to a lesser extent in the humid parts of the Guinea Savanna Zone (see Table 5.1). In the Sudan Savanna Zone, rice cultivation is hardly found on the uplands because of the small amount of precipitation and its irregularity (Andriesse and Fresco 1991).

In the Equatorial Forest Zone, it is practised mainly within the shifting cultivation farming system, and it is one of the components of the bush fallow farming system in the Guinea Savanna Zone. Rice is not cultivated in permanent farming systems on the uplands.

Upland rice is mostly cultivated as part of a mixed cropping system. Combinations with maize, millet, sorghum, cassava, yam, and various kinds of vegetables and spice plants are frequently found. In some regions, upland rice is intersown in the first two years after the establishment of perennial crops like coffee, cocoa, and banana. Mixed cropping systems are practised for various reasons: to ensure the farmers of some cash income from crops other than rice, to meet the family needs for vegetables, spices, etc., and to spread the risk of crop failure.

In the second year of the cultivation cycle, a second rice crop is sometimes grown, but it is more common to grow other food crops (groundnut, maize, yam, sweet potato). Cassava is very often planted as the final crop of the cultivation cycle.

In West Africa, 75 to 95% of the rice area is used to grow traditional varieties. According to the farmers, traditional varieties are tastier and more resistant to drought and to storage pests than the improved varieties. In general, the traditional varieties are preferred for home consumption while the improved varieties are grown for the market (WARDA 1984).

Nearly all farm operations, from land clearing to harvesting, are performed manually with the help of simple tools. The use of animal power is very rare, as the presence of the tsetse fly prohibits the keeping of cattle. Most of the work is done by family labour. Hired labour, if available, is usually employed seasonally at times of peak labour demand. Labour scarcity is often a bottleneck in improving yields.

Towards the end of the dry season, the farmer begins to clear the land. After the first rains, the rice is sown broadcast and hoed into the soil. Soil preparation work is practically non-existent in the Equatorial Forest Zone, and is very superficial in the Savanna Zones, where only a little hoeing is done (Courtois and Jacquot 1988). Crops that are grown with rice on the same plot are sown by mixing the seeds with the rice (millet, sorghum, maize, various vegetables) or by interplanting them in the rice field (cassava, yam, etc.). The proper time for sowing depends on the rainfall

and varies considerably. Sowing generally takes place between early April and mid-June. The harvest is usually between July and October. Where the rainfall pattern is bimodal, upland rice is cultivated during the major rainy period (WARDA 1984).

Weeding is a labour-intensive and time-consuming operation. It is one of the main bottlenecks in the cropping calendar and, together with pests, diseases, and damage caused by birds and rodents, results in very low yields.

Table 5.2 shows the labour requirements of the various operations in the different upland rice cropping systems under shifting cultivation.

Table 5.2 Labour requirements (man-days/ha) of various operations in shifting upland rice cultivation in West Africa (source: Courtois and Jacquot 1988)

	Central Ivory Coast	Western Ivory Coast	Liberia	Western Nigeria	Sierra Leone
Land management					
Clearing, cutting, and burning*	25	50	79	49	37
Fencing	20	8	20	26	27
Rice cultivation					
Planting	20	24	37	30	42
Weeding	15-30	49	32	53	31
Harvest and transport	30	36	47	82	84

* including soil preparation

The yield of traditional upland rice is generally very low. The average yield in West Africa is about 900 kg/ha, with a range of 100 to 3,400 kg/ha (Bindraban 1991). In Sierra Leone, average yields of 1,100 kg/ha, with a variation from 200 kg/ha to 2,660 kg/ha, were reported by Ay et al. (1985), whereas Richards (1986) mentioned 1,350 kg/ha. In the Tai Region (Ivory Coast), yields vary between 750 and 1,000 kg/ha (de Rouw 1991).

Yield-increasing inputs like mineral fertilizers and pesticides are rarely applied. If used, they are leached by the intensive rains (FAO 1982).

Technical innovations will not always result in higher net economic returns for the farmer. Studies on mechanization in Nigeria have revealed that mechanical weed control for upland rice is not as efficient as hand and hoe weeding. In Ivory Coast, too, the net farm income was found not to increase with the introduction of mechanized farming (FAO/WAU 1976).

An advanced upland rice cropping system is described by Olagoke (1989), in the Anambra State, Nigeria. The studied area is situated in the derived Savanna Zone. Here, land use is rather intensive, with relatively short fallow periods of one to two years only. Fertilizer, herbicides, and insecticides are applied and a part of the soil preparation and weeding is done with machinery. Rice yields during the 1987-88 survey were up to 1,710 kg/ha.

5.3.2 Hydromorphic (Phreatic) and Wetland (Fluxial) Rice-Cropping Systems

In many ways, hydromorphic and wetland rice-cropping systems in West Africa resemble those of the uplands: most of the work is done manually and there is a low input of technology and capital. The main differences between these systems and the upland rice-cropping system will be explained below.

In the wet parts of the inland valley/swamp continuum (i.e. the lower footslopes and the valley bottoms), precipitation is not the only source of water for the crops. The precipitation and the lateral groundwater flow from the adjacent uplands cause the lower footslopes and valley bottoms to be saturated or flooded for a certain period. Because, in the Equatorial Forest Zone and the Guinea Savanna Zone, the groundwater flow continues for some time after the rains have ceased, the potential cropping period is longer than the rainy season (see Section 2.4.7).

On the footslopes and the valley bottoms in the Equatorial Forest and Guinea Savanna Zones, rice is cultivated during the rainy season as a single crop because of the wet growing environment. In the first part of the dry season, different kinds of vegetables and root crops are cultivated. On the wettest parts of the valley bottoms, these crops are planted on heaps or ridges made by the farmers. On the valley bottoms, double cropping of rice can be practised, with or without additional water management.

In the relatively dry Sudan Savanna Zone, with its highly irregular precipitation, the growing season is hardly prolonged by lateral groundwater flow. During the rainy season, rice is often intersown with maize on the valley bottoms. In dry years, the maize will perform best, whereas in wet years the rice will grow best and will be harvested. This is an example of spreading the risk of crop failure (Vierich and Stoop 1990).

The farmers treat the footslopes and the valley bottoms similarly to the upland areas, allowing the land to revert to bush or grass fallow after one to two cycles of rice cropping.

Despite the higher natural fertility of the bottomlands, farmers prefer to cultivate the uplands. This is because of the difficulties in the initial clearance of the wetland vegetation, the preference for upland rice in the local diet, the possibility of mixed cropping on the uplands, and the unhealthy working conditions in the wetlands.

Clearing the vegetation is hard work, even with effective tools. It is estimated that land clearing may require as many as 100 working days per ha, depending on the character of the vegetation. Ideally, land clearing should be rapidly followed by land preparation, in order to minimize the regrowth of the vegetation. Labour, however, is a serious constraint.

Rice is sown broadcast or it is transplanted. In areas where farmers cultivate crops on both uplands and bottomlands, rice on the footslopes and valley bottoms is generally transplanted during the later part of the rainy season, or after the harvest of most of the upland crops. This is the consequence of the farmers' greater interest in upland crops and of the shortage of labour, especially in the rainy season. Because the farmers cannot follow the ideal cropping calendar for the wetland rice, weeds, pests, and diseases are serious problems.

Yields are generally low. In Sierra Leone (Equatorial Forest Zone), average yields

are about 625 kg/ha, with variations from 100 to 2,330 kg/ha (Ay et al. 1984). Gebremeskel and de Vries (1985) found yields up to 2,700 kg/ha for wetlands in Nigeria (Guinea Savanna Zone). In Burkina Faso (Sudan Savanna Zone), yields vary from 270 to 1,000 kg/ha (Vierich and Stoop 1990).

An advanced wetland rice-cropping system is described by Olagoke (1989) in the Anambra State, Nigeria. In the same study area as was mentioned earlier (Section 5.2.1), and with similar inputs, yields during the 1987-88 survey were up to 1960 hg/ha, about 250 kg/ha more than the yields of the upland rice-cropping system.

The use of tractors for land preparation, harvesting, and threshing will increase the yields and the net return of wetland rice. Okereke (1990) reports that, under conditions similar to those in the study by Olagoke, yields during the 1988-89 survey varied from 2,540 kg/ha on farms without the use of tractors to 3,430 kg/ha on farms where tractors were used.