Chapter 5

Ecological Anthropological Study on Daily Herding Activities of Pastoral Fulbe in Central Nigeria

1. Introduction

Pastoralism is one of the basic modes of human subsistence economy together with hunting-gathering and agriculture. It refers to the management of the herds of domestic animals, such as cattle, horses, goats, sheep, camels, reindeers and yaks, by humans, who depend mainly on animal products, such as milk, meat and blood.

Pastoral people engaged in livestock husbandry are widely distributed in the regions of the Old World (Fukui and Tani, 1987) from the tundra and taigas in the northern part of Eurasia to the arid zones running through the Afro-Eurasian continent from east to west, that is, Mongolia, Central Asia, south-western Asia, the Sahara and the savanna areas south of it. In Africa, camel and cattle pastoralists can be observed. In the desert and semi-desert areas from the Sahara to Somalia and northern Kenya, Arabs, Berbers, Tuaregs, Bejas, Afars, Gabras, Somalis and Rendilles are pastoralists mainly of dromedary camels, the species well adapted to the arid climate. In savannas south of the Sahara, cattle are mainly raised and representative pastoralists are the Maasai, Samburu, Pokot, Turkana, Toposa, Dodoth, Jie, Karimojong and Borana in East Africa, the Nuer, Dinka and Bodi in southern Sudan, and the Herero and Himba in South Africa. Fulbe (Fulani), the subject of this chapter, are among the cattle pastoralists of West Africa.

The Fulbe are extensively distributed along the savannas in West Africa from Sudan in the east to Senegal in the west. Thus it is natural that slight differences have arisen in their culture according to area. However, they share identity as a single ethnic group speaking the Fulbe language (Fulfulde) and believing in Islam.

"Fulbe (singular form : Pullo)" is the word which Fulbe people call themselves, while they are mostly called "Peul," a Wolof name in Senegal, a French-speaking area, and "Fulani," a Hausa word, in English-speaking districts. In this chapter,"Fulbe," is used.

There are a relatively large number of anthropological studies of pastoral Fulbe. They include studies of Fulbe society in Niger by Dupire (1962, 1975), wide-range research on the society and ecology of Fulbe in Senegal by Ogawa (1980, 1987), studies of folk stories and oral epics of Fulbe living in northern Cameroon by Eguchi (1978, 1980, 1982, 1984), and the study of the Fulbe Emirate in Cameroon by Shimada (1995). In Nigeria, Hopen (1958) investigated the social, ecological and historical settings of the pastoral Fulbe family in Sokoto in the north ; Stenning (1959) conducted a socio-anthropological study of the Wodaabe mainly in western Bornu of north-east ; Awogbade (1983) studied their society and ecology in the Jos Plateau in the east ; and Ikeya (1993) conducted a preliminary study of Fulbe on their transhumance and economy on the same plateau. However, no study has been made about Fulbe on central Nigeria where the author did his research.

In this chapter, emphasis is put on Fulbe herding activities. Apparently, how to keep animal herds is the most important factor of a pastoral subsistence economy. The keeping method used by most pastoral people is putting animals on day-trip herding. The Fulbe are no exception ; they organize grazing herds, allot each herd to herders and allow the animals to eat grass and drink water everyday. Thus, without grasping daily herding activities, our understanding of pastoralism is incomplete. Although its necessity is widely recognized, as far as the author could ascertain, almost no detailed investigation has been made about everyday herding activities of pastoralists, for the following reasons.

It is necessary to record daily, for example, what time to leave, who herds, where and what to graze, what time to return and so on for at least one year. However, these data are highly difficult to collect, for it is almost impossible for a researcher to follow herding everyday and is also very hard to get an able and reliable herder to cooperate with him. These data are only know by herders and are usually forgotten as time goes by if not recorded.

In this chapter, further emphasis is put on the relationship between the two peoples : agricultural Nupe and pastoral Fulbe, who live and coexist together in the area where the author made his research. It will be good for both Fulbe and Nupe to improve their mutual relationship. These studies should not be limited only to the scope of the central Nigerian area but should also address a truly present-day problem – coexistence of more than one ethnic group engaged in different kinds of subsistence activities. To achieve this, it is necessary not only to study the relations between the two peoples but also to understand the details of Fulbe daily herding activities.

To accomplish this purpose, this chapter consists of four main parts :

1. An outline of Fulbe society (section 3), in order to understand the social background of the family studied and its herding activities.
2. Description of Fulbe settlements (section 4), in order to know what a Fulbe family (*baade*) is.
3. Relationship between Fulbe and their cattle (section 5), in order to know what is cattle for Fulbe.
4. An attempt to observe and examine details of Fulbe daily herding activities (section 6), one of the highlights of this chapter.

Many of the collected data have not been analyzed yet and the author has tried to make these data available to researchers as much as possible so that this chapter may provide them with a collection of reference materials.

2. Study area and method

2-1. Study area

The area in which the author conducted studies is the southern part of Bida, a town in Niger State in central Nigeria (Fig. 5-1). It is located about 150 km upstream of the confluence of the Niger and Benue rivers. Bida is surrounded by rivers the Kaduna to the west, the Gbako to the east and the Niger to the south.

The vegetation of the study site belongs to the Guinea savanna (humid savanna) zone and its yearly precipitation is about 1,100 mm. This area has two main seasons : the rainy season from April to October and the dry season from November to March. The study area can be divided into uplands and lowlands roughly by the contour line of 250 feet (approx. 75-80 m) (Fig. 5-1). While the uplands are not flooded even in the rainy season, the lowlands turn into flood-plains during this season.

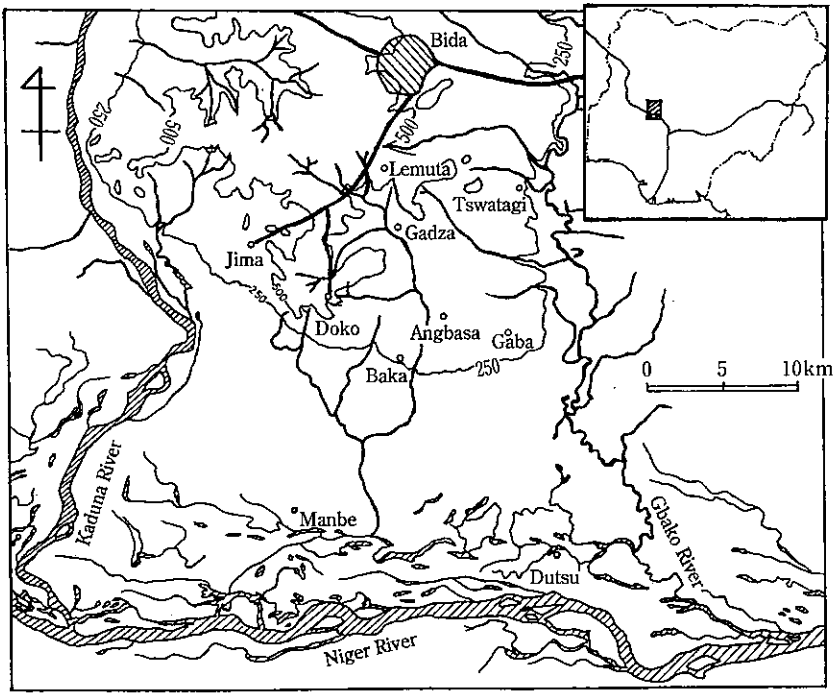


Fig. 5-1 Bida and its environs (contour lines shown in feet)

The details of the southern part of Bida are shown in Fig. 5-2. Nupe communities (marked with ■) are distributed roughly uniformly but in the rainy season of 1993, only seven Fulbe's settlements (marked with ○) existed around Lemuta, Madodo and some other Nupe's villages. The population of Fulbe in that season was about 200-210 (26 families (*baade*)) in total in the seven settlements, and the average size of households was nine members (± 3.75 members). The population of Nupe in this area is estimated to be at least over 2,000.

Of these seven settlements, the author chose that in Lemuta for his studies but carried out supplementary investigations of the Fulbe settlement in Madodo, too. The settlements in Lemuta did herding around Lemuta, Kudigi, Ndarubu and other nearby villages during the rainy season in 1993, but moved to Tswatagi in January 1994 and began herding around the village.

The Fulbe who live in the Bida area and make a living by livestock raising, the subject of the author's study, are tentatively called "Bida Fulbe."

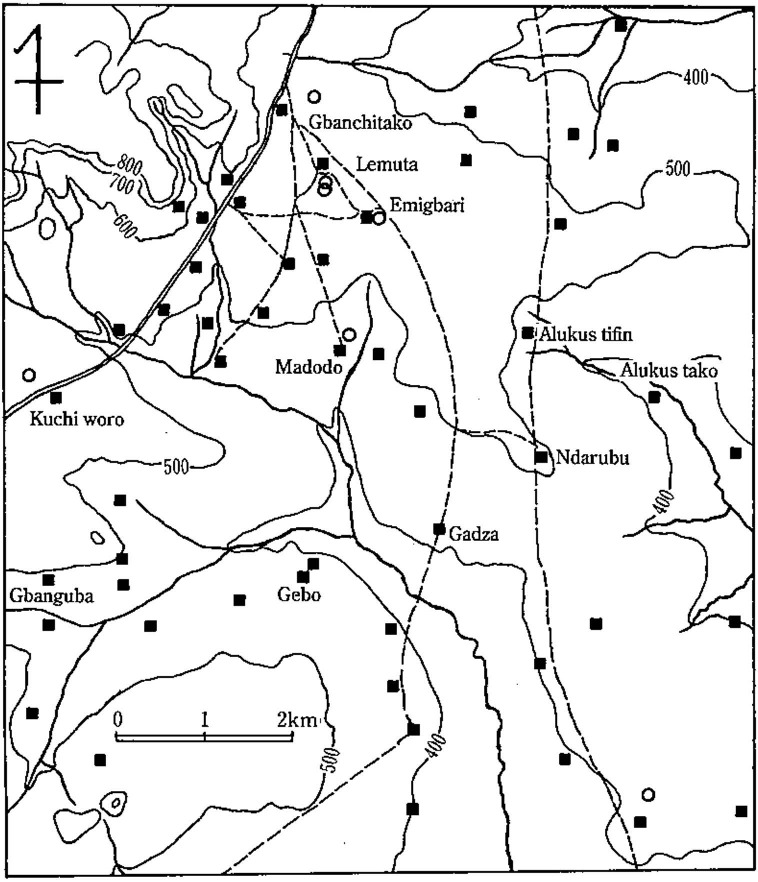


Fig. 5-2 Distribution of Fulbe settlements and Nupe villages in the southern part of Bida (as of October 1993)

○ Fulbe settlement ■ Nupe village contour lines shown in feet

2-2. Study period and method

The studies on which this chapter is based were conducted from August 1993 to February 1994 and from January to March 1996.

The chief of Bida Fulbe introduced Mohammad Abdullahi, a young member of the Fulbe settlement in Lemuta, to the author. He was only one in this area who spoke English and the author was able to gain his cooperation as an informant. The author did direct observation of the Fulbe with Mohammad and also conducted hearings in English with him. In addition, to make up for the short study period, the author asked Mohammad to record data of herding work at his settlement during the time when he was away from the study area. When the author visited the site again, he carried out hearings using the Mohammad's records.

3. Social background of Bida Fulbe

3-1. Bida Fulbe's political system

Bida Fulbe as a whole are regarded as an occupational organization of the Bida Emirate. The chief of Bida Fulbe is called *Dikko*, who is subordinate to Bida's emir known as *Etsu Nupe*. The *Dikko* is at the head of pastoral Fulbe around Bida and performs such functions as settling disputes, attending the transfer of ownership to cattle and collection of cattle tax (*jangali*) and its collective payment to the local government.

The *Dikko* had a settlement in Akote in 1993 and in Eyagi in January 1996. Every day, he left his settlement and went to his office in Bida town, where he met visitors and attended to political affairs. At the office, the *Dikko* is waited on by *faadanko'em*, who are his relatives and senior vassals. He is also assisted by other chief retainers, who are called by such titles as *Yerima* (number two after *Dikko*), *Waziri* (number three), *Chiroma* (number four), *Wakili* (number five) and *Ruga* (number six).

3-2. Bida Fulbe patrilineal kin groups

(1) Bida Fulbe clans and lineages

Bida Fulbe recognize that the Fulbe living around the Bida area are divided into two major groups : *Bororo'em* (sing. : *Bororoojo*) and *Ledi'em* (sing. : *Ledi*) (The singular forms are used to refer to one person and the plural ones, the name of group ; hereinafter the same). *Bororo'em* is also called "Fulbe be *tumbude bodeje* (lit. Fulbe of red calabash)" and is subdivided into such sub-groups as *Dindima'em* (sing. : *Dindimaajo*), *Fittooji'em* or *Fittooji* (sing. : *Fittoojijo*) and *Boodi* (sing. : *Boodo* or *Boodoo*). The people around Bida belong to the *Bororo'em* understand Nupe language and establish their settlement in Nupe land even in the rainy season.

Ledi'em is also called "Fulbe be *tumbude daneje* (lit. Fulbe of white calabash)." This group is subdivided into such sub-groups as *Ba'em* (sing. : *Baajiijo*), *Bogoyanchi* (sing.: *Bogoyankeejo*), *Dage'em* (sing.: *Dageejo*), *Daneeji* (sing.: *Danejijo*), *Gimsanko'em* (sing.: *Gimsankeejo*), *Jallanko'em* (sing.: *Jalankeejo*), *Keeranko'em* (sing.: *Keerankeejo*), *Raahaaji* (sing.: *Rahajijo*), *Yaube* (sing.: *Yaurankeejo*) and *Hausaaji* (sing.: *Hausajo*).

Fulbe basically call their patrilineal kin group "*lennyol*" and Bida Fulbe distinguish at least three levels of these groups: from the lowest level,"*iyaalu*," "*lennyol*" and "*lennyol go'o*."

The author was unable to obtain any definite explanation about how the levels of groups, such as *Bororo'em* and *Ledi'em*, are called but heard that *Dindima'em*, *Fittooji* and *Boodi*, the sub-groups of *Bororo'em*, are "*lennyol go'o* (plural form: *lennyi go'o*)." The sub-groups of *Ledi'em*, *Ba'em*, *Bogoyanchi*, *Daneeji* and *Raahaaji*, are *lennyol go'o*, too. But *lennyol go'o* is also called "*Lennyol Dindima'em*," etc. The sub-groups of *Dindima'em*, such as *Juuliranko'em* and *Sattanko'em*, belong to "*lennyol* (pl.: *lennyi*)" and are also called, for example,"*Lennyol Sattanko'em*." As far as we hear these names, we cannot see the difference between *lennyol go'o* and ordinary *lennyol*.

Hopen (1958: p.43, p.1) reported that the Fulbe word for a clan is *lenyol* and that the term *Bororo'en* does not refer to a specific 'clan' or 'tribe.' And the biggest *lennyol* which Bida Fulbe recognize is not *Bororo'em* but *Dindima'em* and so on. Considering these facts, it is appropriate to call an agnatic kin group equivalent to *Dindima'em* as a clan in this chapter.

The *Dindima'em* clan live mainly in the Bida area and are led by a *Dikko*. The people referred to as Bida Fulbe in this chapter mainly belong to the *Dindima'em* clan. The *Dindima'em* clan is further divided into such sub-clans as *Juuliranko'em* (sing.: *Juulirankeejo*), *Sattanko'em* (sing.: *Sattankeejo*), *Baasamanko'em* (sing.: *Baasamankeejo*) and *Rundanko'em* (sing.: *Rundankeejo*) (Note: It is said that *Rundanko'em* originated from *Macchube* (slaves)).

The *Boodi* clan live mainly around Agaie and are headed by their own chief (*Dikko*). The *Fittooji* clan live mainly around Kutigi but have no chief and are led by the Bida Fulbe's *Dikko*.

Of these clans belong to *Ledi'em*, *Daneeji*, *Bogoyanchi* and *Raahaaji* are led by a chief, but it is said that both *Hausaaji* and *Ba'em* have many chiefs within and tend to be split.

The *Jallanko'em* clan live around Wushishi and Kotangora, about 160 km north of Bida, during the rainy season and migrate to the Bida area in the dry season. But they say that these people establish no stable settlement and frequently move from area to area in the dry season. They hardly understand

Nupe language.

The *Hausaaji* clan are distributed mainly in the areas around Sokoto and speak Hausa language. It is said that this clan is a direct descendant of Usuman Dan Fodio who led the jihads in the early 19th century. But it was impossible to get any clear explanation of the classification of *Hausaaji*. This clan is classified under *Ledi'em* in the above but some Fulbe say that it belongs to *Bororo'em*.

Finally, a kin group whose patrilineal descent can be traced back is named "*iyaalu* (pl.: *iyaaluuji*)." This *iyaalu* is a group equivalent to "lineage," a term used by social anthropologists. Fulbe consider that children belong to the *iyaalu* of their father and wives, also belong, to the *iyaalu* of their father, and apparently recognize *iyaalu* as a patrilineal kin group. Kin groups equivalent to *iyaalu* are called with the prefix of their founder's names, such as "*Iyaalu Dikko* Usuman." (Note: "*Iyaalu Dikko* Usuman" can also be called "*Lennyol Dikko* Usuman; " here again, the difference between *iyaalu* and *lennyol* is not clear from these names.)

(2) The family studied

The family the author mainly studied was that of Alhaji Abdullahi, the father of Mohammad. Alhaji Abdullahi's family belonged to the *Juuliranko'em*, a sub-group of *Dindima'em*. It has belonged to the family of the *Dikko* of Bida Fulbe for generations and Alhaji Abdullahi is one of *faadanko'em*. The present *Dikko* is called *Dikko* Isah. *Dikko* Isah's predecessor was Musa *Dikko*, his half-brother. Alhaji Abdullahi is the first son of Musa *Dikko's* second wife.

The family of Alhaji Isa in Madodo, where the supplementary study was carried out, belonged to another sub-group of *Dindima'em*, that is, *Sattanko'em*.

3-3. Bida Fulbe's kinship terminology

The kinship terms of reference for consanguineal relatives used by Bida Fulbe are as follows:

The term for "father (F)" is *baaba* or *nyaako*, and that for "mother (M)," *inna* or *maduujo*. These words have no plural forms.

"Paternal uncle (FB)" is called *bappaajo* (pl.: *bappa'em*) and "paternal aunt (FZ)," *goggoojo* (pl.: *goggo'em*).

"Grandfather (FF)" is *maamirawo* (pl.: *maamira'em*) and "grandmother (FM)," *maama* (pl.: *maama'em*). "Great-grandfather (FFF)" is *maamiraabe* (pl.:

maamira'em) and "great-grandmother (FFM)," *maamaaji* (pl. : *maama'em*).

"Elder sibling (Sb(e))" is *mounyirawo* (pl. : *mounyira'em*) or *yaaya* (pl. : *yaaya'em*). "Younger sibling (Sb(y))" is *minyirawo* (pl. : *minyiraabe*).

"Child or brother's child (C, BC)" is called *biddo* (pl. : *bibbe*) but "sister's child (ZC)" is named "*baadirawo* (pl. : *baadira'em*). "Grandchild (CC)" is *taanirawo* (pl. : *taanira'em*) and "great-grandchild (CCC)," *selitanofel* (pl. : *selitanofel'em*).

Anthropologists call "father's brother's child (FBC)" paternal parallel cousin. Bida Fulbe call both this paternal parallel cousin and "father's father's brother's son's child (FFBSC)" *ibaaba* or *ibaabaajo* (pl. : *ibaaba'em*).

Bida Fulbe's name for "mother's younger brother's child (anthropologists' term : maternal cross-cousin) (MB(y)C)," "mother's sister's child (maternal parallel cousin) (MZC)" and "mother's father's brother's daughter's child (MFBDC)" is *biyaaye* (pl. : *biyaaye'em*).

The term for "father's sister's child (paternal cross-cousin) (FZC)" and "mother's elder brother's child (maternal cross-cousin) (MB(e)C)" is *dendirawo* (pl. : *dendiraabe*).

The author heard that while marriage with his *dendirawo* or *ibaaba* is possible, one with his *biyaaya* is difficult.

The kinship terms of reference for affinal relatives used by Bida Fulbe are as follows :

The term for "husband (H)" is *gorirawo* (pl. : *goriraabe*) and that for "wife (W)," yeirijo (pl. : yeiri'em). "Father-in-law or mother-in-law (wife's or husband's parent) (WP, HP)" and "wife's uncle or aunt (both paternal and maternal) (WFSb, WMSb)" are both called *esirawo* (pl. : *esirabe*). "Maternal uncle (MB)" is *kawujo* (pl. : *kawu'em*) and "maternal aunt (MZ)," *innaajo* (pl. : *inna'em*).

"Wife's elder sibling (WSb(e))" is named *yaaya* (pl. : ibid.) and "wife's younger sibling (WSb(y))," minyirawo (pl. : ibid.). "Wife's sibling's child (WSbC)" is *biddo* (pl. : *bibbe*) (This word means "child (children)").

"Co-wife (W(c))" is called *noulirawo* (pl. : *noulira'em*). "Mother's co-wife (MW(c))" is goggo (pl. : goggo'em),"mother's co-wife's child (MW(c)C)," *sakiike* (pl. : *sakeraba*), and "husband's brother's wife (HBW)," *pecchal* (pl. : *pecchiraabe*).

The kinship terms of address used by Bida Fulbe is as follows :

The kinship term used when speaking to "father," is a special word "*bappa*" instead of *baaba* mentioned above. But in all other cases, the same above-listed kinship terms of reference are used to speak to respective relatives.

3-4. Bida Fulbe's age-sex classes

A child under about 4 years of age is called *sukayel* (pl. : *sukahoi*) regardless of sex. But after this age, man (*gorko* ; pl. : *worbe*) and woman (*debbo* ; pl. : *reube*) have the following age-sex classes :

(1) Age classes of men

Boys about 5 to 9 years begin to take care of animals though not every day. A boy belonging to this age class is named *kayeyel* (pl. : *kayehoi*).

When boys reach 10 to 14 years, they start to herd and tend animals every day. In the past, boys of this age class began to join the folk dance of young men called *soro*. A boy in this age class is named *sukaajo* (pl. : *suka'em, sukaabe)*.

Formerly, young men about 15 to 20 years stopped to taking part in *soro*. Men in this age class have a special hairstyle : they bind their hair into many thin strings and attach wool pieces of such colors as red, yellow and green at the ends (Photo 5-1). A man at this age class is called *kayeejo* (pl. : *kaye'em*) and can marry.

Men from about 20 to 40 get married, are given their share of cattle from their father and set up their household. They can become independent but some of them choose to belong to their father's *baade* (discussed later). A man belonging to this age class is called *paanyo* (pl. : *faibe*) but wears neither a mustache nor a beard.

When men reach about 40 years or more, they begin to wear a mustache or a beard and establish their own *baade*. A man of 40 years and over is called *dottiijo* (pl. : *dottii'em*). An old man with a white beard is called *dottiiya* (pl. :

Photo5-1 Young Bida Fulbe men (*kaye'em* ; sing : *kayeejo*)

dottiiho).

In addition to the above, men are sometimes classified into single (*gourojo* ; pl. : *gouro'em*) and married (*moudo* ; pl. : *moube*) men.

(2) Age classes of women

A girl about 5 to 9 years is called *surbayel* (pl. : *surbahoi*).

A girl about 10 to 13 years is *surbaajo* (pl. : *surba'em*) and many get engaged (*howuki*). A young woman about 14 ready for marriage (*biikaaki*) is called *kaddiijo* (pl. : *kadii'em*).

Until a woman becomes pregnant after her wedding she is called *biikaado* (pl. : *biikaabe*). Pregnant women go back to their parents' home to give birth . For several years after that, they live in their father's settlement, apart from their husband. A woman in this period is called *boofiido* (pl. : *boofiide*) ; she has to be quietly dressed and cannot even join young women in folk dance parties.

After staying at her father's, woman returns to her husband's house with her child ; she is called *bantaado* (pl. : *bantaabe*). She gives birth to the second and subsequent children in her husband's home and the woman who has two or more children is called *nniraajo* (pl. : *nniraa'em*). A *bantaado* is called *nniraajo*, too, in some cases.

A barren woman is called *nayeejo* (pl. : *naye'em*). A widow is called *zaurankeejo* (pl. : *zauranko'em*) but since women in the Fulbe society are obliged to remarry after their husband dies, widows are rare and there was only one widow in the subjects of the author's study.

4. Bida Fulbe settlements

Fulbe people form small communities composed of several families and live in cooperation with one another. These communities are those expressed by an English word settlement and they call these communities *wuro* (pl. : *wuroji*).

4-1. *Baade* and *onde* : components of Fulbe settlements

Each settlement is composed of several *baade* (pl. : *baadeji*). *Baade* is usually the term referring to a family (nuclear family) headed by a married man who has an independent herd of cattle. But it sometimes means a patrilineal extended family that consists of one *dottiijo* (elder) and his sons' nuclear families, also. In short, *baade* is the word that generally means a "patrilineal family."

When a son who is not independent gets married, he sets up a sub-unit within his father's *baade*. Though this sub-unit supports itself, the cattle herd owned by its head (the son) are herded together with that of the head of the *baade* (the father), and the son follows his father's instructions about many other matters too. The sub-unit within a *baade* like this is named *onde* (pl. : *ondeji*). But while *baade* is a nuclear family composed of a male owner of an independent herd of cattle and his wife and children, this family may also be called *onde*. From the above discussion, *onde* can be considered the term that signifies a "household" which makes a somewhat independent living.

In this chapter, to avoid confusion,"*baade*" is used to refer to a family of a married man (including *onde* before becoming independent) and "(patrilineal) extended family," to mean a group of the families of a married man and his independent sons (that is, a group of *baade*).

Each settlement is led by a *dottiijo*. The head of a settlement like this is called *moudo wuro* (pl. : *moube wuro*), while the head of *baade* (head of a family) is named *dottiijo baade* (pl. : *dotti'em baade*).

4-2. Spatial structure of Fulbe settlements

In general, Fulbe's settlements have long and narrow rectangular forms extending from south to north (Photo 5-2). As noted later, this is related to the fact that Nupe people use the site of these settlements as their fields after Fulbe have moved to other areas.

Each *baade* settlement consists of the residential section of Fulbe people and the enclosure for their cattle herd. The rule is that while the cattle enclosure

Photo5-2 View of a Bida Fulbe settlement in the rainy season

Photo5-3 Cattle enclosure (*hoggo*) in the dry season, with calves' rope (*dangol*) in the foreground

is placed on the west of the north-south center line of the settlement, the living section is established on the east side.

Fulbe call their cattle enclosure *hoggo* (pl. : *koule*). In the settlements established on uplands in the rainy season, *hoggo* is enclosed with logs, but in those built in lowlands during the dry season, no logs are used to enclose cattle in most cases (Photo 5-3). In the residential section, houses stand in two rows from south to north, those of males (herders) known as *hurgooru* (pl. : *kurgooji*) on the western side (closer to the *hoggo*) and those of females (married women) called *suudu* (pl. : *suudi*) on the eastern side.

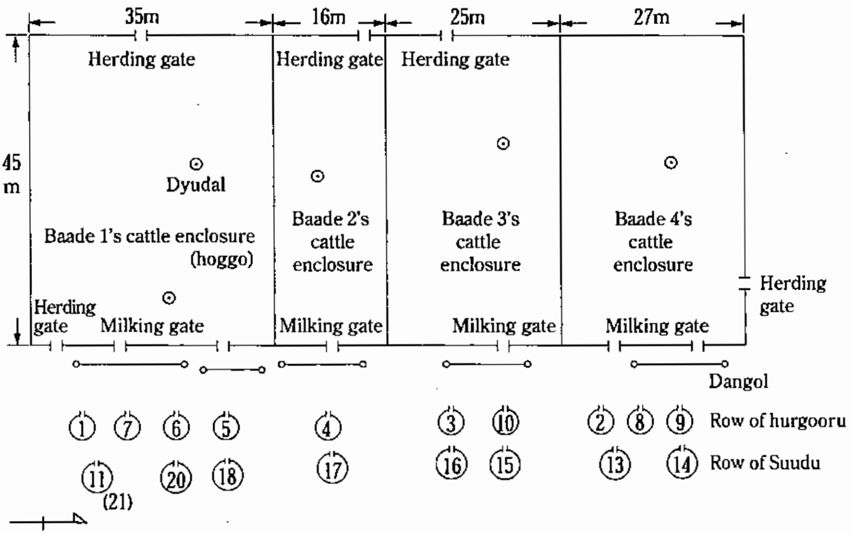


Fig. 5-3 Spatial layout of the Fulbe settlement studied (rainy season in 1993)

Note : The figures given for each house correspond to the members of the families shown in Fig. 5-4.

Bida Fulbe recognize the area nearer the *hoggo* as the front and that of *suudu*, as the back. Thus they call the area between the *hoggo* and the *hurgooru* (closer to the *hoggo*) "*yeeso hurgooru*" (pl.: *yeeso kurgooji*)("*yeeso*" means "front"), the space between the *hurgooru* and *suudu* "*hakude*" (pl.: *hakkudere*, the word meaning "space") and the area behind the *suudu* "*gada suudu*" (pl.: *gada suudi*) or "*gada wuro*" ("*gada*" means "back").

As described above, the several houses of *baade* standing in straight lines from south to north form a settlement. Fig. 5-3 shows the spatial structure of the settlement studied.

(1) Fulbe's houses (hurgooru and suudu)

Hurgooru and *suudu* have basically the same structure with each other (Photo 5-4). A cylindrical wall 4-5 m across (*yaasin*; pl.: *yaasinji*; or *baarol*; pl.: *baarolji*) is covered with a conical roof (*yanta*; pl.: *yantaaji*). The projection at the center of the roof is called *yoomoode* (pl.: *joomoode*), and the height of the base of the *yoomoode* is about 2 m from the ground. A doorway (named *damuki*) is made on the wall. The roof is bound and fixed with ropes known as *kabbilgol* (pl.: *kabbilli*).

Hurgooru is the house of a herder. The doorway of both a man's and woman's houses faces the *hoggo*, and is built in such a way convenient for the herder to watch the state of cattle in the *hoggo*. Inside the house are a bed called *jengowo* (pl.: *jengeeji*), which is made using four props about 50 cm long and a wooden plank about 2 m long, and a shelf for storing various belongings.

Suudu is the house of a married woman. It is equipped with a bed known as *leeso* (pl.: *leesheeji*) constructed by putting a mattress made of grass on the

Photo5-4 Row of Bida Fulbe herder's house (hurgooru)

Photo5-5 Inside of a married woman's house (*suudu*)

props, a shelf for spices, etc. (*dangajel shondi* ; pl. : *dangajoi shondi*), a shelf for firewood (*dangajel ledde* ; pl. : *dangajoi ledde*) and a shelf for other things (*danki* ; pl. : *dankiiji*). In addition, there are a water jar (*loonde* ; pl. : *loode*), a furnace (*kaatane* ; pl. : *kaataneji*) and stands with three twigs set in the ground (*tatiyel* ; pl. : *tatihoi*) for putting pots and gourds with a round bottom (Photo 5-5). Outside the *suudu*, another water jar is placed, and a shelf for drying tableware, etc. (*dangajel*) and a furnace are provided.

(2) Cattle enclosure (hoggo)

The fence of *hoggo* is called *hoggo lekki* (pl. : *hoggo ledde*) and is made using the branches of such trees as mango (*mungorohi*), locust bean (*narehi*), *karehi*, *konkotorohi* and thorny *giehi*. The stakes for supporting the fence are named *dangari* (pl. : *dangare*) and are made of *kohi*, *karehi*, locust bean (*nerehi*), mango (*mungorohi*) and other trees (thorny *giehi* are not used for this purpose).

The inside area of *hoggo* is given a generic name *der hoggo* and is roughly divided into the middle area (*chaka hoggo* ; *chaka* means "middle") and the surrounding area (*daade hoggo* ; *daade* means "surrounding area").

The gate of *hoggo* is generically named *damuki* (pl. : *damude*) and has two types : *damuki naatirki* (pl. : *damude naatirde*) or *damuki biruki* (*naata* and *bira* both mean "milking"), the gate where calves are taken out for milking, and *damuki laggirki* (pl. : *damude laggille*), the gate through which cattle are brought out for grazing. While *damuki laggirki* is shut immediately after the herd of cattle returns from grazing, *damuki naatirki* is closed at eight to nine o'clock in the evening. By these hours, calves 2 years or under are taken out from *hoggo* and gathered to the *dangol* (see below).

In the evening when cattle herds come back from the herding range, men who remained in the settlement collect cattle dung and build a bonfire around the center of each enclosure to produce smoke for insect control. They call this bonfire *dyudal* (pl. : *dyude*).

Salt is named *landan* (pl. : *landanji*). For feeding salt to cattle, enameled ware called *wouru landan* (pl. : *bobi langanji*) is usually used. But sometimes a device made by putting a hollow in the top of a broken termite-mound is used ; this device is known as *jiraare* (pl. : *jiraaje*).

The ropes for tying calves at night are stretched in the space between the *hoggo* and *hurgooru*, the houses of herders, and are named *dangol* (pl. : *dandi*) (cf. Photo 5-3).

(3) Other facilities

In the area between *hurgooru* and the *hoggo*, a place for offering prayers (*juuluki*) called *nangardam* (pl. : *nangardanji*) is provided. *Nangardam* is made by burying three sticks in the ground horizontally. When saying a prayer, people squat down and wash their body in advance and kneel down at the west side of the *nangardam*, causing the forehead to touch it. Of the three sticks, the one at the west side is the longest and that on the east side, the shortest. These sticks are named *mangardam* or *shurmorgel* (pl. : *shurmorkoi*). Few women make *nangardam* ; instead, they generally offer prayers in their *suudu*.

The pen of calves is called *hurgooru biikoi* (pl. : *kurgohoi biikoi*), and the basket used for carrying chickens, *shuurel grooki* (pl. : *shuuroi groode*).

4-3. Social structure of Fulbe settlements

(1) Case study of Alhaji Abdullahi's settlement

Alhaji Abdullahi's settlement, the main case studied, is composed of two family groups. One of them is Alhaji Abdullahi's extended family, and the other is the *baade* of Alhaji Nuhu, Alhaji Abdullahi's younger brother.

In Alhaji Abdullahi's extended family, his first son Sheshi and second son Saadu, both born of his first wife, have already become independent. Thus his family has three *baade* in all. In addition, as of March 1996, Alhaji Abdullahi's *baade* included two *onde* : those of his third son Shefu and fourth son Mohammad who were born of his first wife.

In March 1996, Alhaji Nuhu's family was a single *baade* because none of his sons were independent yet. But it did include the *onde* of Kaajibo, the first son

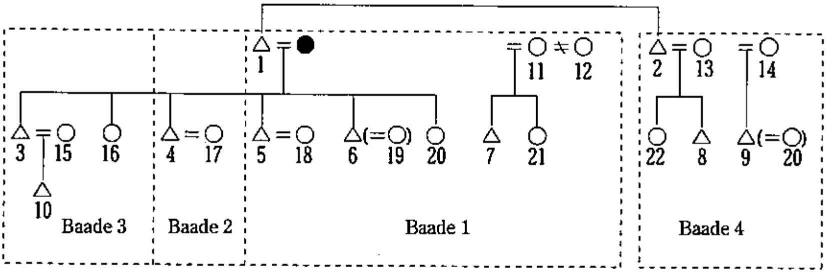


Fig. 5-4 Outline of the social structure of the Fulbe settlement studied (as of January 1994)
△ : male ○ : female ( ) : boofiido

Table5-1 Composition of the members of the settlement studied by age-sex class (as of January 1994)

Age-sex class	Alh.Abdullahi's baade	Sheshi's baade	Saadu's baade	Alh.Nuhu's baade
Dottiijo	1	0	0	1
Paanyo	2	1	1	0
Kayeejo	1	1	0	2
Sukaajo	1	1	1	1
Kayeyel	1	2	0	0
Sukayel (male)	1	1	0	0
Nniraajo	2	2	1	2
Bantaado	0	0	0	0
Boofiido	3	0	0	1
Biikaado	0	0	0	0
Kaddiijo	2	2	0	3
Surbaajo	0	1	0	1
Surbayel	0	0	1	0
Sukayel (female)	2	2	2	0
Total	16	13	6	11

of his second wife.

The social structure of Alhaji Abdullahi's settlement studied is shown in Fig. 5-4 and Table 5-1.

(2) Structural principle of a settlement

A patrilineal extended family is a large constituent unit in each Fulbe settlement and several extended families stand in a row from south to north and form a settlement. The position of each extended family in a settlement is determined basically according to the age of its head. In other words, a settlement is built so that the extended family with an older head can have its positon at a more southern side.

The inner structure of a patrilineal extended family before the family head's sons become independent is as follows : The *hurgooru* of the family head is built at the position where one can see the bonfire made at the center of the *hoggo* (*dyudal*) right in front if facing west with the south on his left side (that is, at the direct right of the *dyudal*). The houses of his sons are built on the northern side of the family head's *hurgooru*. When the first son reaches the age of *sukaajo*, his own *hurgooru* is constructed to the north of his father's *hurgooru*. Then when the second son reaches the age of *sukaajo*, his *hurgooru* is built between his father's and the first son's (his elder brother's) ones. Similarly, the third son's *hurgooru* is constructed between his father's and the second son's ones, and the fourth son's one, between his father's and the third son's ones. In other words, the *hurgooru* of a younger son is built between his father's and his immediate elder brother's ones ; if the family head has four sons, their *hurgooru* will be constructed in order of the head's, his fourth son's, his third son's, his second son's and his first son's ones from south to north. And the family head's *hurgooru* always stands at the southernmost location of the settlement.

The sons will become independent someday and establish their own *baade*, and in this case, the same order of *hurgooru* will be adopted.

The *suudu* of a married woman is built "behind" her husband's *hurgooru*. If the husband has two or more wives, the *suudu* of his first wife is located on the left side of her husband's house, and those of his second wife, his third wife, fourth wife and so on are built to the right of the first wife's in this order. All houses are constructed jointly by the male members of the settlement (Notes : The author heard that in the case of *Ledi'em*, women build houses).

5. Relationship between Bida Fulbe and cattle

5-1. Animals kept by Bida Fulbe

Bida Fulbe keep two kinds of animal and one type of fowl : cattle, sheep and chickens.

The Nupe breed goats but Bida Fulbe do not. According to Bida Fulbe, they do not breed goats because goats fear water and won't cross a river, because they do not follow cattle unlike sheep, and because they enter someone else's field and eat crops.

Bida Fulbe do not raise donkeys or camels, either, and little use wild animals.

5-2. Bida Fulbe's cognitive system of cattle

Bida Fulbe regard cattle as the most important of the animals they keep. They call cattle "*nagge*" in general and use "*ne'i*," the plural form of "*nagge*," to call a herd of cattle (including both males and females).

(1) Age and sex classes of cattle

Fulbe classify male cattle into seven classes according to their growth condition (i.e. body size) and whether they are castrated or non-castrated.

1. A male calf up to about two years is called *gaggel* (pl. : *gaggoi*). At this stage, calves are usually given milk by their mothers. This age class is hereinafter referred to as "male calf."
2. A male about two to four years is named *gaari* (pl. : *ga'i*). This class is hereinafter referred to as "young male."
3. A non-castrated male about four to six years is called *burtiri* (pl. : *burti*). This class is referred to as "small bull."
4. A "Large bull" is named *kaladdi* (pl. : *kalali*).

The males that will not be used as seed bulls in the future are castrated (*tappuki* ; the word meaning "beating") at the age of four or so.

5. A castrated male about four to six years is called *tappaandi* (pl. : *bujaadi*). This class is hereinafter referred to as "small ox."
6. A middle-sized castrated male about six to eight years is named *daandi* (pl. : *daali*). This class is hereinafter referred to as "middle-sized ox."
7. A larger castrated male about eight years or over is called *bujiri* (pl. : *buji*). This class is hereinafter referred to as "large ox."

Fulbe classify female cattle into five classes according to growth and delivery conditions :

1. A female calves up to about two years that are still given mother's milk are called *biggel* (pl. : *biikoi*). This age class is hereinafter referred to as "female calf." The plural form "*biikoi*" is also used to mean calves in general regardless of sex.
2. A female about two to three years is named *nyanlohol* (pl. : *nyallibi*). This class is hereinafter referred to as "nulliparous cow (not yet pregnant)."

Table5-2 Fulbe terms describing the body color of cattle and the shape of their horns

No.	Singular form(female)	Singular form(male)	Plural form	Explanation
	⟨Color of cattle⟩			
1	amare	amardi	amari	
2	baleye	baleri	baleji	Black
3	boba	bobiri	bobi	Brown
4	bodeye	boderi	bodeji	Red
5	bunaye	bunari	bunaji	
6	dageye	dageri	dageji	
7	dake	dakeri	daki	
8	dake ge fellere	dauri	dauriji	Red spots on the face
9	daunduye	daunduri	daunduji	
10	elaye	elari	elaji	
11	finange	finandi	pinadi	
12	fure	purdi	puri	
13	galaye	galari	galaji	Ears neither red nor black
14	gedaddare	didaddare	didaddaje	
15	hobaye	kobari	kobaji	Black spots on the face
16	hurunbaye	hurunbari	kurunbaji	
17	kiriboliye	kiriboliri	kiriboliji	
18	kodeye	koderi	kodeji	
19	malleye	malleri	malleji	Small red dots only on the belly
20	nore	nordiri	nori	Black dots on the belly
21	nyawe	nyauri	nyawi	Black dots
22	saige	chaigiri	chaigi	Small red dots on the whole body
23	sodaye	sodari	sodaji	Black and white,roan
24	sulkeye	shulkeri	sulkeji	
25	sunkodeye	sunkoderi	sunkodeji	
26	tattabaraye	tattabarari	tattabaraji	
27	torlankeye	torlankeri	torlankeji	Red, large ears, large white horns, fast-growing
28	wage	bagiri	bagi	
29	wagummeye	wagummeri	wagummeji	White,red spots on the ears and face
30	wanduye	wanduri	wanduji	Brown
31	wudale	gudaldi	gudali	
32	wudale ge tukkure	gudaldi di tukkure	gudali di tukkuje	No horns,white
33	wule	buldi	buli	White face, black body
34	yakanaye	yakanari	yakanaji	
35	yellaye	yellari	yellaji	Brown
	⟨Shape of horns⟩			
1	beboye	bebori	beboji	
2	bokolo	bokolori	bokoloji	Short and small horns,which are shakable
3	donkole	donkoldi	donkoli	Short downward horns
4	elaye	elari	elaji	Sidewise horns,small body
5	gafi	gauri	gafe	
6	jungoye	jungori	jungoji	
7	kippa	kippiri	kippi	Horns leaning foward
8	kurgaye	kurgari	kurgaji	Downward horns
9	loshiya	loshiri	loshiji	
10	morgaye	morgari	morgaji	
11	wudale	gudaldi	gudali	Horns are shakable
12	yadde	jaddiri	jaddi	White,short horns

3. Females begin to have the capacity to become pregnant at the age of about three. The cow that has become pregnant but has not yet delivered a calf is called *wigge* (pl. : *bijji*). This class is hereinafter referred to as "nulliparous cow (pregnant)."
4. The cow that has given birth to a calf for the first time is named *haange* (pl. : *kaabi*). This class is hereinafter referred to as "monoparous cow." Some Fulbe call even the cow that have delivered a second calf *haange,* too.
5. The cow that have given birth to two or more calves is called *nagge* (pl. : *ne'i*). This class is hereinafter referred to as "multiparous cow."

In some cases, the parous cow that has delivered five to six calves or more is named *nagge nniraye* and that too old to give birth to a calf, *nagge nayeye* (pl. : *ne'i nayeji*).

(2) Terms for the body color of cattle and shape of their horns (future subject)

The author collected the 35 Fulbe terms that describe the body color of cattle and the 12 terms that mean the shape of their horns (Table 5-2). He would like to discuss these terms in more detail in a separate paper.

5-3. A cattle herd owned by a family

(1) Structure of the cattle herd

The settlement of Alhaji Abdullahi has four *baade* : Alhaji Abdullahi's, his first son Sheshi's and his second son Saadu's and his young brother Alhaji Nuhu's. Each of these *baade* has its own cattle herd. Here we will call the Alhaji Abdullahi's cattle herd Herd A, Sheshi's Herd B, Saadu's Herd C and Alhaji Nuhu's Herd N.

The author took photos of all the cattle belonging to the four herds and identified each individual. Then he conducted hearings about the features of each of the cattle, including the name, age and sex class, owner, mother-infant relationship and body color. As noted later, each of the cattle is given a name according to the cattle family group it belongs to. The author decided to describe each head of cattle by a combination of the alphabet showing the herd (A, B, C or N), one or more alphabets showing its name and the number showing the mother-infant relationship within the cattle family group. These data for Herd A are attached at the end of this chapter as an appendix.

This section will describe mainly Alhaji Abdullahi's cattle herd (Herd A) in detail.

1) Size of cattle herds

During the rainy season of 1993, the author investigated Fulbe settlements distributed in the southern part of Bida. The result of the study is summarized

Table5-3 Fulbe settlements and *baade* in the Bida area (as of October 1993)

Baade	Settlement	Patrilineal kin group	No. of members (persons)	Cattle herd (head)	No.of hoggo
1 Alh.Abdullahi	AA	D.J.	16	136	1
2 Saadu	〃	D.J.	6	47	1
3 Sheshi	〃	D.J.	13	43	1
4 Alh.Nuhu	〃	D.J.	11	45	1
5 Alh.Adamu Juma	AAJ	D.J.	8	51	1
6 Mohd.Bedu	〃	D.J.	6	37	1
7 Alh.Isah	AI	D.S.	11	130-140	2
8 Chakule	〃	D.S.	7	40-45	1
9 Alh.Abdullahi	〃	D.S.	6	50-60	1
10 Adako	〃	D.S.	5	40-50	1
11 Baaba	〃	D.S.	14	50-55-60	1
12 Mahmudu	〃	D.S.	10	60-70	1
13 Alh.Usuman	〃	D.S.	7	50-60	1
14 Alh. Jiburin Alkali	AJA	D. J.	8	30-35	1
15 Mal. Isah	〃	D. J.	12	80-90	1
16 Macha	〃	D. J.	1?	25-30	1
17 Bawa	〃	D. J.	6	15-20	1
18 Alh. Kawu Bargujo	AKG	D.B.	6	15-20	1
19 Kaunadida	〃	D.B.	8	50-60-70	1
20 Shaabiri	〃	D.B.	6	40-45	1
21 Dabbel	〃	D.B.	9	40-45	1
22 Soowa	〃	D.B.	3	25-30	1
23 Benu	〃	D.B.	9	40-50	1
24 Nyankpa Adari	NA	D.B.	8	30-40	1
25 Alh. Sule	AS	D.B.	6	110	1
26 Alh. Haruna	〃	D.B.	8	160	2
27 Alh. Shaba	〃	D.B.	6	1000 or more	2
28 Agogo	〃	D.B.	5	120-130	1
29 Alh. Giwa	Giwa	D. J.	20	220	2
30 Zugu	〃	D. J.	?	60-80	1
31 Alh. Magaji	Magaji	D. J.	14	180-190	2
32 Dafada	Da	?	20	160-170	2
33 Chiroma	Ch	?	7	80-90	1
34 Gora	Gora	L.R	7	40	1

Note: D.J.: Dindima'em, Juuliranko'em; D.S.: Dindima'em, Sattanko'em;
D.B.: Dindima'em, Baasamanko'em; L.R.: Ledi'em, Raahaaji.

Table5-4 Size and composition by age-sex class of the four cattle herds studied (as of January 1996)

Age-sex class			Herd A (%)	Herd B (%)	Herd C (%)	Herd N (%)
Male: Bull	Large bull	kaladdi	3	0	1	0
	Small bull	burtiri	1(2.5)	0(0.0)	1(4.3)	1(2.6)
Ox	Large ox	bujiri	1	0	1	0
	Middle-sized ox	daandi	3	0	0	1
	Small ox	tappaandi	1(3.1)	0(0.0)	0(2.1)	0(2.6)
Young male		gaari	19(11.7)	8(17.4)	6(12.8)	2(5.3)
	Sub-total		28(17.3)	8(17.4)	9(19.1)	4(10.5)
Female Parous cow	Multiparous cow	nagge	16	5	4	1
	Monoparous cow	haange	35(31.5)	12(37.0)	14(38.3)	13(36.8)
Nulliparous cow	(pregnant)	wigge	33	7	5	6
	(not yet pregnant)	nyanlohol	10(26.5)	2(19.6)	3(17.0)	4(26.3)
	Sub-total		94(58.0)	26(56.5)	26(55.3)	24(63.2)
Calf: Male calf		gaggel	22	7	8	4
Female calf		biggel	18	5	4	6
	Sub-total		40(24.7)	12(26.1)	12(25.5)	10(26.3)
Grand total			162	46	47	38

in Table 5-3. The number of cattle per *baade* was 59.8 (±34.3) heads on average for the six *baades* whose cattle could be checked precisely and 61 (±40.4) heads for the 29 *baades* including those *baades* of which cattle could be known only roughly (The settlement including a *baade* having by far the greatest number of cattle, 1,000 head or more, was excluded from this calculation).

Table 5-4 shows the size and age and sex composition of Herds A, B, C and N as of January 1996. According to the table, Herd A was the largest with 162 head of cattle, followed by Herd B with 46 heads, Herd C with 48 heads and Herd N with 39 heads. If these figures are divided by the number of these *baade's* members (13, 13, 6 and 11, respectively; newly-born infants excluded), the number of cattle per person was 12.5 head for Herd A, 3.5 for Herd B, 8.0 for Herd C and 3.5 for Herd N.

There were two more *baades* whose cattle could precisely be counted. One of them had eight members and kept 51 heads (6.4 heads per person), while the other had six members and raised 37 heads (6.2 heads per person). From the data of these six families, it can be known that Bida Fulbe make a living by keeping 6.7 heads of cattle per person on average.

2) Age and sex composition of cattle herds

Bida Fulbe's cattle classification by age and sex is not always according to actual age and greatly differs from cattle to cattle.

In the case of males, classification by age class is made according to body size rather than age. For example, Male ATa5 was about two years in January 1994 and about four years in January 1996 but was classified into the class of *kaladdi* (large bull). This bull had grown quickly already when a calf and had been allowed to drink mother's milk longer than other calves to use it as a seed bull in the future. As a result, it grew to a size equivalent to *kaladdi* at the age of only four.

Females are classified only according to pregnancy and delivery. For example, AWe3 was estimated at eight years but is still called *wigge* because it had become pregnant several times but had not given birth to any calf. Similarly, the cow ten to eleven years remains *haange* if it has delivered only one calf and that eight years is *nagge* if it has given birth to two calves.

The following facts can be pointed out about the age and sex composition of the cattle herds studied (see Table 5-4) :

1. In all the cattle herds, about 25.4% were calves on average.
2. In all the cattle herds, females account for as much as 58.1% on average but males make up only 16.6%. In addition, while there are many cows older than ten years, no males are over ten.
3. In Herd B, *kaladdi* and *burtiri* died in succession during the past two years and there are no uncastrated bulls. But the three other groups have 3.1% of uncastrated bulls on average.
4. The ratio of castrated males to the cattle herd is very low : 2.6% in all the herds on average.

(2) Ownership of cattle

Here one cow and its descendants are referred to as a cattle family group. Fulbe know well the matrilineal kin relations of the cattle belonging to their settlement and give a name to each of the cattle family groups. Table 5-5 shows the 44 names given to the family groups of the cattle herd studied. According to the table, the most (21) of the names are given after the body colors of cattle, followed by those given after the features of horns (12 names), body size (5), tail (2) and milk production capacity (2). In addition, there are the names given because the cow is "strong as a buffalo" or because "it returned when called *Ijje*."

Table5-5 Names given to cattle and their reasons

#	Name	Reason	#	Name	Reason
1	Amardi	Body color	23	Hobaye	Body color
2	Amare	Body color	24	Hurunbaye	Body color
3	Amare nyawe	Body color	25	Ijje	Returned when called "Ijje ai"
4	Bale	Body color (black)	26	Kippa	Horns (leaning forward)
5	Bodeya	Body color (red)	27	Loshiya	Horns
6	Bokolo	Horns (short, small, shakable)	28	Malleye	Body color
7	Bokoloyel	Horns (small), smaller than Bokolo	29	Moriye	Horns (morgaye)
8	Dakalei	Milk (little to no milk production)	30	Mowayel	Horns (morgaye)
9	Damudo	Size (short)	31	Muute	Horns (short horns)
10	Dandaye	Body color	32	Namali	Horns (very short & strong)
11	Eda	Buffalo, the mother was strong	33	Nyawe	Body color (nyawe)
12	Ela	Horns (sidewise), small body	34	Saaje	Body color (hobaye)
13	Felle	Body color (wule)	35	Saige	Body color
14	Fonduye	Tail (short)	36	Saye	Body color (red but not true red)
15	Fure	Body color	37	Seunge	Size (lean)
16	Gafe	Horns	38	Sodari	Body color
17	Gajere	Size (very short)	39	Tounga	Size (grow very tall)
18	Gajereyel	Size (very very short)	40	Wage	Body color
19	Galako	Horns (thick horns)	41	Wagummye	Body color
20	Galaye	Body color	42	Wudale	Horns (shakable)
21	Gidooma	Milk (much milk production)	43	Wule	Body color
22	Gowagi	Body color(galaye)	44	Yadde	Tail (short tail)

Basically, each cattle family group is the unit of cattle ownership. The cattle belonging to a family group are all owned by one single owner A and the family group's descendants will come into A's possession.

A cattle herd includes not merely the cattle owned by the head of each *baade* but also those possessed by the *baade's* other members. The number of cattle of each *baade* by owner is shown in Table 5-6. This table suggests that while almost all cattle belong to the head of *baade* and his sons, the wife of the head of *baade* owns a few head of cattle.

(3) Emigraton of cattle from a herd

Cattle emigrate from their herd for various reasons, such as death, donation and exchange. During the two years from January 1994 to January 1996, 52 head of cattle were taken from Herd A. The details are shown in Table 5-7. The reasons for emigration are given in the left column of the table.

There were a total of 28 cases of sale. Of these, 26 were the cases of sales to butchers and the other two were sales to villagers living near the settlement. As these figures suggest, the butchers' organization plays an important role.

Table5-6 Size and the number of cattle family groups of the cattle herds studied (as of January 1996)

Cattle herd	Owner	Relationship	No. of cattle	No. of cattle family groups
A	Alh.Abdullahi	Head	72	22
A	Shefu	Son	29	9
A	Mohammad	Son	33	15
A	Mammam	Son	25	7
A	Azumi	Daughter	2	1
A	Nbabo (butcher)	-	1	1
	Sub-total		162	55
B	Sheshi	Head	30	11
B	Kiirowa	Son	11	2
B	Shanono	Son	2	1
B	Gogo	Wife	1	1
B	Wowo	Wife	2	2
	Sub-total		46	17
C	Saadu	Head	45	13
C	Ibrahim	Son	2	1
	Sub-total		47	14
N	Alh.Nuhu	Head	18	9
N	Kaajibo	Son	6	2
N	Yuguda	Son	13	5
N	Goggo	Wife	1	1
	Sub-total		38	17
	Total		293	103

Table5-7 Emigration of cattle from Herd A during the period from January 1994 to January 1996

Type of emigration	Cause	Male	Female	Total
Sale	Disease	4	10	14
〃	Old age	-	3	3
〃	None	10	1	11
Giving (to Nupe villagers)	Disease	5	2	7
Disposal	Death	5	1	6
〃	Accident	2	1	3
Unknown	Disease	1	2	3
Donation	None	1	-	1
Exchange	None	2	-	2
Slaughter	None	2	-	2
Total				52

Both Fulbe and Nupe are mostly Muslims and are not allowed to eat any meat other than the one that has gone through a special ritual. The butchers' organization undertakes all of this and supplies meat to these people. Fulbe play their own part in the area's livestock raising sector by supplying cattle to the organization.

Of the 26 cases where Alhaji Abdullahi sold cattle to butchers, he earned money in just 13 cases (when Fulbe sell cattle suffering from a disease, such as trypanosomiasis transmitted by tsetse flies, they mostly use the money earned to buy medicines for other cattle), while he bought additional cattle with the money in other 13 cases. He got young males (*gaari*) in 6 of the 13 cases and pregnant young cows (*wigge*) in the remaining 7 cases. Fulbe do not prefer cows in particular but tend to choose young cattle.

In 14 of the 28 cases of cattle sale, diseases was the reason for selling. When the disease of the cattle worsens and they conclude it will never recover, Fulbe sell it to a butcher before it dies. Cattle are also sold for other reasons. For example, Alhaji Abdullahi sold three cows to a butcher because of old ages. He also sold 10 males though they were healthy. Fulbe sell their males not only when they have to sell because of a disease, etc. but also when they need a large amount of money (e.g. payment of wages to employed herders). In some cases, they sell large males and buy younger and smaller (less expensive) cattle, and use the margins for some other purposes. These are the main reasons for the imbalanced sex ratios and age compositions of their cattle herds.

Too small calves and too thin cattle due to the worsening of a disease to be sold are given to villagers around the settlement before the animals die. Of the 7 head of presented cattle shown in the table, 6 were calves and one was *haange* (parous cow (only one calf)).

There were 6 cases where animals died just after delivery because of a stillbirth or premature delivery, and all of the animals were disposed of. Those animals which died after falling into a hole or well during grazing or which fell on their back in the mud and died were also disposed of.

The one case of donation shown in the table was the present from the groom to the father of the bride. A young male is used for this purpose and is called *kabbi*. The two head of cattle exchanged were both *kaladdi*. The two cases of slaughtering were for the naming ceremonies, one for Mohammad's first son and the other for Shefu's third son.

(4) Donation of cattle and formation of a family's herd

Table 5-8 summarizes how the 13 cattle owners, excluding two *dottiijo*, obtained their cattle (founder of the cattle family group). From this table, it can be pointed out that donation from the father is the most important thing to sons in building up their own cattle herds and that donation from the mother is also important. Saadu was given cattle from his *kawujo* (maternal uncle) but there were no other cases of donation from relatives or friends.

When a non independent son marries, he establishes a household (*onde*) within the *baade*. If the *baade's* head permits him to become independent, the son can establish his own *baade* and set out on his own.

When the son set up his *baade*, he has to put his own cattle herd out to pasture independently of his father's herd. While his sons are young, he cannot use them as herders and is so faced with the problem of how to secure herders until his sons grow up. Fulbe cope with this problem by hiring herders from other families. One example is the case of Saadu whose first son reached ten in 1996. Hired herders are usually given a young male after six months' work.

(5) Terms for other animals

Fulbe generally use the word *baalu* (pl. : *baali*) for sheep. Chickens are named *grooki* (pl. : *groode*).

A goat is called *be'a* (pl. : *be'i*), a donkey, *jakiya* (pl. : *jakiji*) (*jaki* in Hausa)

Table5-8 Methods of obtaining cattle by owner

Herd	Owner	Donation from father	Donation from mother	Donation from others	Purchase /exchange
A	Shefu	6	1	0	2
A	Mohammad	7	1	0	7
A	Mammam	5	1	0	1
A	Azumi	1	0	0	0
B	Sheshi	5	1	0	4
B	Kiirowa	1	0	0	1
B	Shanono	1	0	0	0
B	Gogo	0	0	1	0
B	Wowo	0	0	1	1
C	Saadu	8	2	0	2
C	Ibrahim	1	0	0	0
N	Kaajibo	2	0	0	0
N	Yuguda	1	1	0	3
N	Goggo	1	0	0	1
	Total	39	7	2	22

and a camel, *geloba* (pl. : *gelodi*). The word for a dog is *lahooru* (pl. : *lahoji*) and that for a cat is *muusuuru* (pl. : *muusuuji*).

5-4. Animal products and their use

(1) Milk and its use

1) Milking procedures

1. *Yoofuki* : The dairyman (usually the herder) releases a calf from the *dangol* and calls the name of its mother cow. The mother cow comes to the calf.
2. *Jogaaki* : If the cow is unwilling to give milk to the calf or be milked, another man holds her horns to prevent her movement (the word meaning "to release the horns" is *jontuki*).
3. *Tottuki* (inducing milk secretion) : The calf is allowed to suckle milk from the mother for one to two minutes. Without this process, the cow won't secrete any milk.
4. *Radaaki* : The calf is bound to the mother cow's left forefoot by the neck.
5. *Tongaaki* : If the cow walks or kicks during milking, its hind legs are bound, too.
6. *Moituki wissho yeire* : Before milking, the cow's nipples are wiped with the hair of the end of its own tail.
7. *Naatuki* : Before milking, the worker applies the butter (*nebbam*) smeared on the edge of calabash (half-cut gourd container) in advance to the cow's nipples to make them damp and soft. In the dry season, the nipples are dry and hardened and so may be cut and injured unless they are softened with butter. In such an event, cow's nipples hurt and they cannot keep still. If milk has blood

Photo5-6 Bida Fulbe's herder is milking a cow

in it, it is not good for making cheese (Note : Butter is used in the rainy season, too, but not so much as in the dry season).

8. *Biruki* (milking) : The worker milks the cow from its right side. In a half-sitting posture, he holds a milking calabash (*naarde* ; pl. : *bidude*) between his legs and milks the cow with both of his hands (Photo 5-6).

9. *Tongitaaki* : If the cow's hind legs are bound, the worker unbinds the legs.

10. *Raditaaki* : The calf is released by unbinding its neck.

11. *Laulaaki* : After milking, the worker puts the milk in the milking calabash into a large calabash for milk storage (*tumbude jo inirude*), which is placed in front of the *hurgooru*.

2) Allocation of dairy cows

Basically, the milk produced by the cows owned by the members of a *baade* is used by these members. Fulbe cannot lend or borrow dairy cows to or from any other *baade*. The allocation of dairy cows as of January 1994 is outlined below :

The *baade* of Alhaji Abdullahi, the owner of Herd A, was divided into three households (*onde*) : (1) household composed of six members, that is, Alhaji Abdullahi and his wife Goggo and their children ; (2) household composed of five members, Mohammad and his two younger sisters (both *boofiido*) and their children ; and (3) household composed of three members, Shefu and his wife and their child.

The first *onde* was allotted a total of nine cows : Gowagi (AGo2), two Saige (ASa, Asa2) and Dakalei (ADka2) owned by Alhaji Abdullahi and Moriye (AMr1), Dandaye (ADn), Mowayel (AMw) and two Felle (AFe, AFe2) owned by Mammam, first son of Alhaji Abdullahi's second wife. These cows were milked by Mammam.

The second *onde* had five cows : Fonduye (AFo2), Gajere (AGja1) and Gafe (AGfa1) owned by Mahammad and Fure (Afua) and Tounga (ATa) owned by Alhaji Abdullahi. Mohammad took charge of milking these cows.

The third *onde* was allotted four cows : Saige (ASb1), Wagummeye (AWu) and Hurunbaye (AHu) owned by Shefu and Galaye (AGla) owned by Alhaji Abdullahi. These cows were milked by Shefu.

The *baade* of Sheshi, the owner of Herd B, was divided into the household of seven members consisting of Sheshi, his second wife and their children and that of six members consisting of Sheshi's first wife and her children, including her first son Kiirowa. The eight cows of the *baade* were equally allotted to the two *onde* : Sheshi's Gajere, Kippa, Fure and Bokolo to the second wife's *onde*, and Kiirowa's Nyawe and Fure and Sheshi's two Hobaye to the first wife's *onde*. The milking work of the second wife's *onde* was performed by Sheshi, while that of the first wife's *onde*, by Kiirowa.

The *baade* of Saadu, the owner of Herd C, had four members (Saadu, his wife and their two children) and as of January 1994, possessed eight cows (Saaje, Saye, Hobaye, Dakalei, two Bale, Bokolo, Nyawe) and used their milk. Saadu owned all of these cows and milked them.

The *baade* of Alhaji Nuhu, the owner of Herd N, was divided into two *onde* : the household of six members, that is, Alhaji Nuhu, his second wife and their children, and that of five members, Alhaji Nuhu's first wife and her children. The *baade's* four cows were equally allotted to the two *onde* (Ela owned by the first son Kaajibo and Bodeya owned by Alhaji Nuhu to the second wife's *onde*, and Eda owned by the first son Yuguda and Dakalei owned by Alhaji Nuhu to the first wife's *onde*). Since Yuguda was too young, all of these cows were milked by Kaajibo (Note: When Kaajibo was not at home, Mahammad took charge of the milking task).

3) Milk processing

1. Yogurt and butter

The milk just produced in the morning is called *biraadam* (fresh milk). *Biraadam* is put into a large half-cut calabash (*tumbude*) and by the evening begins to turn into *kosam* (sour milk, yogurt). *Kosam* can be stored for a maximum of three days.

By the following morning, *biraadam* has turned into *daaniidam* in the calabash. *Daaniidam* is divided into two layers; the upper layer is called *kettungol* and the lower one, *wuluire*.

Kettungol is put into a narrow-mouthed gourd (*fandu* ; pl.: *paali*) and shaken (*yonkuki*) for 15-20 minutes. Then the contents of the *fandu* are moved to a half-cut calabash and are stirred (*janpuyuki*) for 5-10 minutes with a stirring stick (*buruuki* ; pl.: *buruude*). Butter is separated onto the top. The butter is entirely scooped up with a small half-cut calabash (*tunmugel* ; pl.: *tunmukoi*) and is rolled and hardened on a gourd dish about 10 cm across (*maarahi* ; pl.: *maaraaji*), turned into a spindle shape. This is *nebbam keccham* ; it is solid but its milk constituents and moisture have not totally been separated.

By putting this *nebbam keccham* into a pan and heating it together with fine pieces of onion and salt, Fulbe make a yellow liquid *nebbam bolinaadam*. They put this on rice, etc. and eat it.

Photo5-7 Fresh milk is processed into cheese (*wankashi*)

What remains after scooping up *nebbam* is called *lamudan*. The mixture of *wuluire* and *lamudan* is called *kosam*, too. This *kosam* is consumed at home and sold in the market.

2. Cheese

Cheese is called *wankashi* (pl.: *wankashiiji*) (Hausa word for cheese is *awara*).

Taking care not to allow flies into it, Fulbe put fresh milk (*biraadam*) into a large pan. They put the leaves of a tree known as *bonbomu* (pl.: *bonbomuuji*) into a mortar (*wouru* ; pl.: *bobi*) and pound them with a long mallet (*unurki* ; pl.: *unulle*). When a small quantity of fresh milk is added to this, the *bombomu* solidifies and the liquid turns into green. The solid *bonbomu* is taken out and placed separately. The green liquid is mixed into the fresh milk in the pan.

The solidified *bonbomu* is put into about half a glass of water. Five to ten seconds after, the *bonbomu* is taken out and thrown away. The water is poured into the fresh milk in the pan. After the fresh milk is cooked for about 30 minutes, it coagulates. The white and soft lumps in the pan are put into 15 to 20 small conic baskets sewn with bark (*shekorgel* (pl.: *shekolloi*)), which are placed in a large basket (In some cases, a small circular plate named *horde* (pl.: *kore*) is used to press the lumps in *shekorgel* from above and to give them a good shape). After cooling them a little, the lumps are taken out of *shekorgel* and floated on water. Fulbe make *wankashi* in this way (Photo 5-7). *Wankashi* is almost all made for sale in the market.

4) Use of milk

The author asked Mohammad to measure and record the milk production

Photo5-8 Fulbe women going to the Bida market to sell their dairy products

of his cows for two years. The analysis of these data is a future task.

Married women (helped by their daughters in some cases) walk to the market of a nearby town, such as Bida, with a calabash filled with *kosam*, *wankashi* and other dairy products, on the head to sell them (Photo 5-8). They are allowed to spend the money earned by selling milk products as they like.

During the rainy season, milk production per cow is large and so if a household has four milking cows, they can secure a sufficient quantity of milk both for their own consumption and sale. But in the dry season, the milk produced by four cows is not enough because production per cow is smaller. They Fulbe take milk for their own use first and ,if they have surplus milk, they sell it in the market. When milk production reduces with the advance of the dry season, they store excess milk for three days and then go to the market to sell it.

(2) Use of other livestock products

Fulbe people do not eat the meat of their animals (*teewu*) very much except during their ceremonies. To slaughter an animal is called *hirsuki*. Fulbe slaughter cattle only at the three ceremonies : naming ceremony, ceremony after the fast period (*leiya*) and wedding ceremony. Sheep is slaughtered for the same three ceremonies, though rarely for a wedding ceremony. Sheep are also slaughtered for the charity ceremony called *sadaka*.

Cattle blood is never used for food.

6. Bida Fulbe's herding activities

6-1. Outline of Bida Fulbe's herding

(1) Baade and settlement as the units for herding

Baade is the minimum unit of Bida Fulbe herding activities. The cattle owned by the members of a *baade* are all placed into the *baade's* cattle enclosure (*hoggo*), and during the day, are put out to pasture as a group by one of several herders (*moduroi* ; pl. : *beduroi*). But there are some cases where the cattle group of a *baade* is herded in two or more separate groups. Thus we will hereinafter call the cattle group herded as a unit group "pastoral herd."

Basically speaking, as noted, a settlement has the same number of pastoral herds as that of its *baade*, and these herds are herded separately. But actually, a settlement's pastoral herds are herded in close contact with each other, though each of them maintains their unity. For example, the pastoral herds of the same settlement leave for the same herding range at the same time and return to the settlement in formation at the same time. In this sense, a settlement serves as a larger unit for the herding activities of its pastoral herds.

(2) Outline of day-trip herding

Pastoral herds start from the settlement in the morning, while each of them are led by one to several herders. Cattle continue grazing during the day, moving slowly in the herding range, and return to the settlement in the evening. This type of grazing is known as day-trip herding. Fulbe day-trip herding activities during the rainy season are outlined below :

Milking work is started about seven in the morning. This work is carried out only once a day ; in each pastoral herd, a herder (male) spends about one hour for milking. Fulbe milk cows only and do not milk sheep.

After milking, herders gather in the shade of a specific tree near their settlement with a meal and a mat and exchange information with each other and determine the day's herding range and herding route while having the meal. Fulbe call this meeting *howaare* (pl. : *kowaaje*) (Photo 5-9).

While an outline of the day's herding activities is decided at *howaare*, the final decision about a settlement's entire herding activities is the task of the settlement's head. For example, the head determines : "Because the herd that went to the southern area yesterday included the cattle suffering from foot-and-mouth disease, we should not take our cattle to that area for some time."

Photo5-9 Meeting before herding (*howaare*)

Fulbe call the starting hour of herding "*laggol wadi*". After ten a.m. (this hour differs from day to day ; it is earlier on a rainy day), just after cattle get up and begin mooing, herders outfit themselves and open the gate of the *hoggo*. Which of the gates should be opened is determined according to the day's herding route. Each pastoral herd of cattle leaves the settlement in several columns.

Several pastoral herds belonging to a settlement all head for one herding range, while each pastoral herd stay as a unit. The roads to the major herding ranges are roughly fixed and those frequently used have been trodden hard by cattle hooves, turned into *buruti* (pl. : *burutol*) (cattle track).

When arriving at the herding range, each pastoral herds disperses within this range and continues grazing. There is a watering site called *reggorde* (pl. :

Photo5-10 Smoke from *dyudal* meets cattle herds coming back from day-trip herding

deggolle) within (or around) the herding range. *Reggorde* is also a river-crossing point, and so is established at a particular site. When the herd comes near to a *reggorde*, the herder take cattle there to drink water.

After 4 p.m., the dispersed pastoral herds are gathered again and start to move to the settlement. They reach the settlement about 6 : 30 p.m. Just before that, dried cattle dung is collected to a specific place in the *hoggo* and burnt there to repel insects, producing white smoke. Fulbe name this fire *dyudal* (Photo 5-10).

(3) Fulbe words related to herding

As already mentioned, the study area can be divided into uplands not submerged even in the rainy season and lowlands turning into floodplains in this season by a contour line of about 250 ft (75-80 m). Fulbe call the uplands "*yolde* (pl. : *yoli*)" and the lowlands "*mayo* (pl. : *mayoji*)." They build their settlements for the rainy season in the uplands and those for the dry season in the lowlands.

According to vegetation and the cultivation conditions by Nupe, Fulbe classify the type of herding range into field (*gesa* ; pl. : *geseeji*), paddy field (*yaire* ; pl. : *jeeje*), fallow land (*shaabeho* ; pl. : *shaabeeje*) and forest (secondary forest)(*yola* ; pl. : *yolo*). The floodplain of the Gbako River and other relatively large rivers are called *lugge*. *Lugge* is the best pastureland for the Fulbe because in *lugge*, grasses grow thickly in the rainy season, for the water level is not too high, and grasses remain even in the later months of the dry season. They sometimes use "*fadama*," a Hausa word, to call paddy field and floodplain collectively.

The watering sites for cattle are established at rivers of various sizes and are named *reggorde* (pl. : *deggolle*), as stated above. Fulbe call a large river like the Niger River *gurunga* (pl. : *guruko*) and name the Niger Gurunga Naija. Rivers like the Gbako and the Kaduna are *wurungo* (pl. : *gurule*), and those which are smaller but do not dry up even in the dry season are *changol* (pl. : *chandi*). Rivers so small as to go dry in the dry season are called *chaltel* (pl. : *chaltoi*) and streams are *pogowa* (pl. : *pogoji*).

Lakes and ponds are also used as watering sites for cattle. Natural lakes that do not run dry in the dry season are named *bela* (pl. : *belo*), and small ones that dry up in that season, *beelel* (pl. : *beeloi*). The artificial ponds made at sites where Nupe dug holes in the ground to build their houses and the ponds created after rivers go dry are *jonga* (pl. : *jonko*). The puddles made after rain are *bulam* (pl. : *buludi*). These ponds are almost all used only by cattle to drink water but there are some artificial ponds used by Fulbe, which are called *bula* (pl. : *bulo*).

(4) Bida Fulbe's classification of seasons

Bida Fulbe roughly divide a year into four seasons: *setto*, *dungu*, *yande* and *sheedu*.

"*Setto*" is the period in the first half of the rainy season from April to June. Normally in April, it begins to rain. After confirming that the year's rain has started to fall in earnest, Nupe begin to plant early millets, egusi melon, maize and other crops in their upland fields in.

According to the informant, there is a short period from June to mid-July when rain stops falling temporarily, which they call "*setto luggini*." *Luggini* is the Fulbe word meaning "between" and *setto luggini* is the period between *setto* and *dungu*.

Rain begins falling on a full scale in mid-July and Nupe start to plant sweet potato. The period from this time to October is the height of the rainy season and is named "*dungu*." In August and September, Nupe harvest crops in their upland fields, such as cowpea, egusi melon and early millets and begin to plant rice in lowland paddy fields simultaneously. In September, when an arthropod such as a scorpion known as *babba du laasol* (pl. : *babba di laashi*) starts appearing in *gooba* (mixture of cattle dung and soil), *dungu* reaches its middle stage and people know that the rainy season will end in a month. This period is sometimes called *dungu luggini*.

In October, rainfall decreases and the sunlight becomes stronger and in late October or early November, rain no longer falls even when clouds form in the sky. This is the beginning of *yande* or the dry season and sorghum in the fields begins to put forth white ears around this time. Then in November, Nupe harvest sorghum and late millets. The hot and dry harmattan starts blowing from the Sahara in December and everything in the distance is visible only dimly because of fine sand dust. The sand dust blocks the sunlight out, so the temperature does not rise very much. In January, Nupe reap rice.

The period from early March when the harmattan ceases to blow to April when rain starts falling is called *sheedu*. By March, the hottest and driest season begins. This is the most difficult season for the Fulbe.

6-2. Details of herding activities at the settlement studied: cycle of six herding patterns

This section describes the details of the herding activities of the settlement studied in the period from June 1994 to June 1995.

With changing seasons and the progress of Nupe's farming activities, the environment of the Fulbe changes. According to such environmental changes, Fulbe choose the best type of herding range available each time. This means that a year can be divided into several herding periods by the main object of herding activities (i.e. where and on what to graze). In the settlement studied, the herding patterns clearly change in accordance with such events as movement to uplands or lowlands, or end of morning herding and the division or integration of pastoral herds. These events can also be used as the indicators for classifying herding patterns.

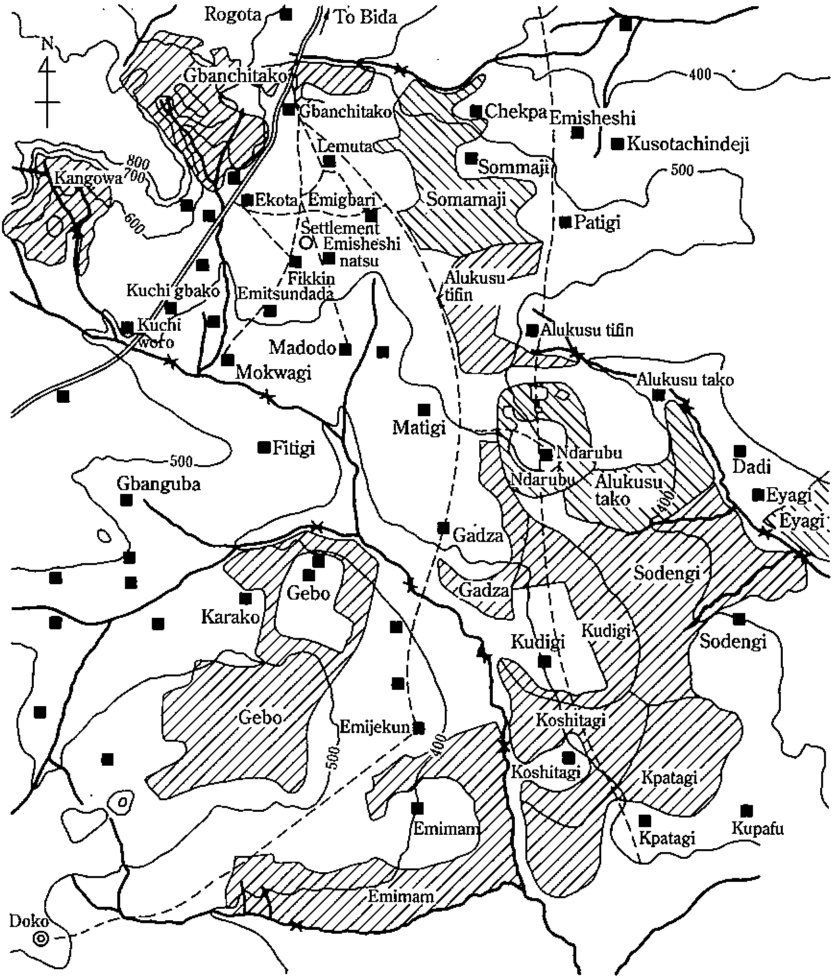
Based on these indicators, the author was able to distinguish six major patterns of Fulbe herding activities: *setto luggini*, *dungu*, early and late *yande*, *sheedu* and *setto*. These herding patterns are described in detail below:

(1) Herding pattern in *setto luggini*

This herding pattern was observed just after the rainy season began and the settlement studied moved to the uplands. It was continued for 41 days from June 4, 1994, the day after the settlement moved from Tswatagi, a village in a lowland, to Emisheshi natsu, one in an upland, through July 15. Because this period is *setto luggini* according to the Fulbe classification of seasons, this herding pattern is referred to as "herding pattern in *setto luggini*." From this period to about early November when *dungu* ends, the settlement studied continued grazing in the uplands as a whole.

In the season just after the Fulbe move to the uplands, Nupe are still planting crop and Fulbe pastoral herds use grass newly grown in Nupe fields before cultivation.

The distribution of the herding ranges in the uplands used by the settlement studied is shown in Fig. 5-5. In the first week after moving to the uplands (June 5 to 11), they did herding twice a day in the morning and afternoon. In morning herding, they left the settlement at 8 : 14 (the week's average; the leaving time ranged from 8 : 00 to 8 : 31) and returned at 10 : 43 (the week's average; the returning time ranged from 10 : 15 to 11 : 27), spending an average of 2 hours and 29 minutes for herding. The herding ranges used were the fields before cultivation of the villages near the settlement including Emigbari, Ekota, Lemuta and Fikkin. After morning herding, the pastoral herd left the settlement again at 11 : 35 (the week's average; the leaving time ranged from 11 : 00 to 12 : 10) and returned at 18 : 36 (the week's average: the returning time ranged from 18 : 20



(The scale is the same as that of Fig. 5-2.)

○ Fulbe Settlement studied (rainy season in 1994)

■ Nupe communities

◎ Town

▨ Herding range

× Reggorde

Fig. 5-5 Distribution of herding ranges in uplands

to 18 : 50), the average pasturing time being 7 hours and 1 minute. Afternoon herding was carried out in Kangowa for the first time in 1994 and also in the fields before cultivation of Kuchi gbako, Fitigi and other nearby villages (see Table 5-9).

On June 12 and after, only daytime herding was carried out. An average of

Table5-9 Herding pattern in *setto luggini* (1)

Herding range		Type	No. of days	
			Morning	Afternoon
1	Emigbari	F	3	-
2	Ekota	F	2	-
3	Fikkin	F	1	-
4	Lemuta	F	1	-
5	Kangowa	S	-	4
6	Alukusu tifin	F	-	1
7	Fitigi	F	-	1
8	Kuchi gbako	F	-	1
Total			7	7

Note: F=Farm; S=Secondary Forest.

Table5-10 Herding pattern in *setto luggini* (2)

Herding range		Type	No. of days	Remarks
1	Alukusu tifin	F/UL	8	
2	Kudigi	F/UL	7	
3	Ndarubu	F/UL	5	
4	Gebo	F	5	Used only in this period
5	Emimam	F	2	Used only in this period
6	Fitigi	F	2	
7	Gadza	F	2	Used only in this period
8	Gbanchitako	F	2	
9	Kangowa	S	1	
Total			34	

Note: F=Farm; UL=Uncultivated Land; S=Secondary Forest.

8 hours and 57 minutes was spent from 10 : 36 (the-34 day average; the leaving time ranged from 10 : 10 to 11 : 50) to 18 : 57 (the-34 day average; the returning time ranged from 18 : 36 to 19 : 30). The herding ranges used were the fields, the fallow lands and the forests of Alukusu tifin, Kudigi and Ndarubu, and the fields of Gebo, Emimam, Gadza, Fitigi, Gbanchitako (Table 5-10). The lands of Gebo, Emimam and Gadza were used only in this period. These village lands become hard to approach as the fields already planted are close together but are accessible in this period because Nupe planting is still under way.

Though the date dividing this period from the next is not clear, the last day when the pastoral herd went to Gebo, July 15, is the date used in this chapter.

(2) Herding pattern in *dungu*

This herding pattern was observed for 121 days after the period mentioned above from July 16 to November 13, 1994. On November 12, a half of the settlement moved to Nasarafu, a village in a lowland, and morning herding started on November 14. November 13 just before morning herding started is regarded as the last day of this herding pattern. Because this period precisely corresponds to the one Fulbe call *dungu*, this herding pattern is referred to as "herding pattern in *dungu*."

By this time, the Nupe have finished the first stage of planting work and the distribution of cultivated fields is almost determined. So Fulbe pastoral herds are put out to other ranges than cultivated fields, that is, fallow lands and secondary forests (Photo 5-11).

In this period, the Fulbe do daytime herding. They leave their settlement at 10 : 33 (the 121-day average ; the leaving time ranged from 9 : 40 to 11.40) and returned at 18 : 59 (the 121-day average : the returning time ranged from 18 : 07 to 19 : 44). The average pasturing time was 8 hours and 25 minutes.

The herding ranges used in this period can be divided into three types (see Fig. 5-5 and Table 5-11).

First of all, there are the major herding ranges established in five Nupe villages: Gbanchitako, Alukusu tifin, Ndarubu, Kudigi and Alukusu tako. These ranges were used for a total of 108 days (89.3%). The settlement studied used these five ranges in day-to-day rotation.

The second type of herding range is those developed in three Nupe villages, Koshitagi, Eyagi and Sodengi, which are used only in rainy days. When it rains before leaving for pasture, cattle prefer to start earlier because their body

Photo5-11 Herding in an upland fallow (*shaabeho*)

Table5-11 Herding pattern in *dungu*

Herding range	Type	No. of days	Remarks
1 Gbanchitako	UL	29	Major herding range
2 Alukusu tifin	UL	24	〃
3 Ndarubu	UL	24	〃
4 Kudigi	UL	17	〃
5 Alukusu tako	UL	14	〃
6 Koshitagi	UL	7	Only on rainy days
7 Eyagi	UL	1	〃
8 Sodengi	UL	1	〃
9 Sommaji	UL	4	Only in October
Total		121	

Note: UL=Uncultivated Land.

temperature lowers more quickly. This makes it possible to start earlier and use more distant ranges.

Finally, the third type is the herding range in Sommaji. This range is near the settlement but was used as often as four times in October 1994 when *dungu* entered its final phase. This herding range is probably the one reserved for an emergency though this requires confirmation by the informant.

Case of the settlement in Madodo (For reference): The settlement in Madodo, on which a supplementary study was conducted, established and used five major herding ranges: Gbangba, Gebo (two areas), Gadza and Kangowa. Of these, the ranges in Gbangba, Gebo and Gadza were named after the names of Nupe villages near them, while Kangowa had its origin in a Fulbe word meaning "wide and large valley." The Madodo settlement used these five ranges in day-to-day rotation.

Besides these five major herding ranges, the settlement used other ranges carefully according to the situation.

〈Example 1〉 On a rainy day, cattle leave for grazing earlier than usual and go to a more distant range for grazing. The settlement in Madodo establishes a herding range for rainy days in Emimam.

〈Example 2〉 In some cases, the Madodo settlement put its cattle out to pasture near it instead of going to one of the major herding ranges in an attempt to make up for pasturing among these five ranges. In such a case, each pastoral herds of this settlement in widely dispersed.

(3) Herding pattern in early yande

As already noted, a half of the settlement studied moved about 10 km west to

Nasarafu, a village in a lowland, on November 12, 1994. Then on January 7, 1995, the other half that had stayed in the uplands also migrated to Nasarafu. In the period between the two movements of the settlement, that is, the 54-day period between November 14, 1994 (when the half of the settlement in the upland started morning herding) and January 6, 1995, a special herding pattern was observed. According to the Fulbe, this period corresponds to the first half of *yande* and so this herding pattern is here named "herding pattern in early *yande*." One feature in this period is that the settlement was divided into upland and lowland areas.

Around November, grass for cattle begins to disappear in secondary forests and fallow land in the uplands. Moreover, cattle prefer remnants (dried leaves and stems) of harvested sorghum and late millets to live grass. Thus in this period, Fulbe pastoral herds are put out to these fields and feed on remnants there. Fulbe call letting cattle eat post-harvest remnants in fields "*nyaile*" and in this type of herding, pastoral herds stay in one field longer.

In the upland settlement, both morning and afternoon herding was carried out during this period. In morning herding, the pastoral herds left at 8 : 06 (the 54-day average : the leaving time ranged from 7 : 30 to 8 : 27) and returned at 11 : 15 (the 54-day average : the returning time ranging from 10 : 24 to 13 : 09), with an average of 3 hours and 10 minutes spent for herding. Morning herding was carried out in the post-harvest sorghum fields mainly in Emigbari, Emisheshi natsu and Lemuta. These herding ranges were used in 48 days (88.9%) of the 54

Table5-12 Herding pattern in early *yande*

Herding range	Type	No. of days	
		Morning	Afternoon
1 Emigbari	F	17	
2 Emisheshi natsu	F	16	4
3 Lemuta	F	15	3
4 Gbanchitako	F/UL	2	2
5 Mokwagi	F	1	5
6 Madodo	F	2	7
7 Alukusu tifin	F/UL	1	11
8 Ekota	F		10
9 Fikkin	F		5
10 Sommaji	UL		4
11 Emitsundada	F		3
Total		54	54

Note : F=Farm ; UL=Uncultivated Land.

days (see Table 5-12).

Afternoon herding was carried out from 12 : 07 (the 54-day average : starting time ranged from 11 : 20 to 13 : 25) to 18 : 34 (the 54-day average ; returning time ranged from 18 : 02 to 19 : 00), spending an average of 6 hours and 26 minutes. The herding ranges mainly used were Alukusu tifin, Ekota, Fikkin and Mokwagi, which were more distant than those for morning herding (Table 5-12). At first, the secondary forests in Alukusu tifin and Sommaji were used. But on November 26 and after, upland villages completed the harvest of sorghum and the ears of this crop were all cut down. Thus the pastoral herds began to graze on these fields even in afternoon herding.

No data were obtained about the pastoral herds that moved to the lowland village, but it is supposed that the herds did *nyaile* in the sorghum (and late millet) fields in nearby villages just like those in the upland, while they used secondary forests and fallow lands.

(4) Herding pattern in late yande

By early January 1995, the half of the settlement that had remained in the upland area moved to the lowland one and joined the other half that had migrated in November 1994. This herding pattern was carried out for 52 days from January 8, 1995, one day after the day when all of the settlement got together again in Nasarafu, to February 28, one day before the day when the settlement ended morning herding. In other words, this period was the one when the entire settlement started pasturing in the lowland. Since it corresponds to the second half of *yande*, this herding pattern is referred to as "herding pattern in late *yande*."

From January to February, Fulbe cattle herds graze mainly in *fadama* (paddy fields and floodplains) in the lowlands. Fulbe call grazing in lowland *fadama* like these "*dabbol*." The distribution of the herding ranges used by the settlement studied is shown in Fig. 5-6.

Throughout this period, the settlement did both morning and afternoon herding just like in the early *yande* (see Table 5-13).

Morning herding was carried out for an average of 2 hours and 47 minutes from 8 : 10 (the 52-day average : the leaving time ranged from 8 : 00 to 8 : 26) to 10 : 57 (the 52-day average : the returning time ranged from 10 : 16 to 11 : 49). The herding ranges mainly used were sorghum fields after harvest in Emidogo (31 days, 59.6%) and in Nasarafu (17 days, 32.7%). In morning herding, the pastoral herds used sorghum fields near the settlement in most cases. But the

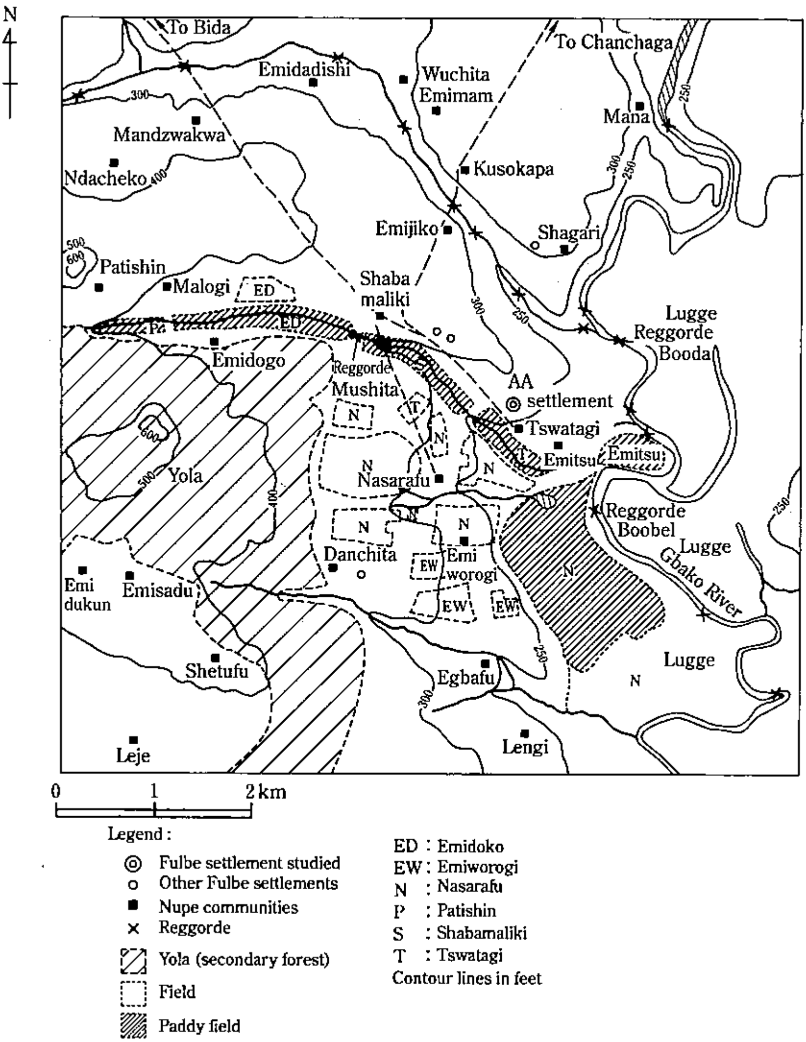


Fig. 5-6 Distribution of herding ranges in lowlands

Fulbe said that because cattle prefer grazing in forests when there is a strong wind, they sometimes graze in secondary forests on a windy day.

Afternoon herding was done for 7 hours and 1 minute on average from 11 : 28 (the 52-day average ; the leaving time ranged from 10 : 30 to 12 : 15) to 18 : 30 (the 52-day average ; the returning time ranged from 18 : 07 to 18 : 47). This grazing used mostly the *fadama* in Nasarafu : for 49 days accounting for 94.2% (Table 5-13).

Table5-13 Herding pattern in late *yande*

Herding range	Type	No. of days	
		Morning	Afternoon
1 Emidogo	F	31	
2 Nasarafu	F	17	1
3 Nasarafu	FD	2	49
4 Emiworogi	F	2	
5 Tswatagi	F		1
6 Tswatagi	FD		1
Total		52	52

Note: F=Farm; FD=Fadama.

Photo5-12 Grazing in lowland floodplains (*lugge*)

In afternoon herding, cattle feed on grass mainly in lowland paddy fields and floodplains (Photo 5-12). They mainly eat the grass that newly grows in paddy fields after rice has been reaped (*kudal* ; sing. : *kudel*), the new sprouts that grow from the stubs of rice after harvest (*biluttuuri* ; pl. : *biluttuuje*) and the grass in floodplains (*hudo lugge*).

(5) Herding pattern in *sheedu*

This herding pattern was observed for 53 days from March 1 to April 22, 1995 (on April 23, there was rain in the area of the settlement). This herding pattern is referred to as "herding pattern in *sheedu*" because this period corresponds to *sheedu*, the driest season.

In this period, the distinction between morning and afternoon herding disappeared and daytime herding was carried out instead in relatively distant ranges. The pastoral herds left the settlement at 9 : 21 (the 53-day average ; the leaving time ranged from 8 : 40 to 9 : 55) and returned at 18 : 43 (the 53-day average ; the returning time ranged from 18 : 19 to 19 : 40), spending an average of 9 hours and 23 minutes for pasturing. The herding range used in this period was only the *fadama* in Nasarafu (for 53 days, 100%). When grazing was carried out in Nasarafu, the watering site on the Gbako River called Reggorde Boobel was used. The pastoral herds were given water twice a day, at 11-12 o'clock and 15-16 o'clock.

In this period, cattle feed on rice straw in *fadama*. Nupe farmers pile up harvested rice into hollow cylinders about 5 m across, with the ears inside, to dry it. After threshing and winnowing the rice, they leave rice straw in the fields. All day long, cattle feed on rice straw moving from hill to hill (Photo 5-13). The grazing in this period is characterized by feeding for a long time at the same location (a rice straw hill). (In this respect, this herding pattern contrasts markedly with that in the rainy season where cattle continue moving from pasture to pasture for about eight hours).

But the supply of rice straw is limited and is eaten up sooner or later. In 1994, the stock of rice straw remained till early April but in 1995 it ran out by the end of February.

Secondary forests are often burned in this period. After burning, grass grows to about 10 cm but soon withers and dies because of dry weather. But even this grass is an important feed for cattle.

After rice straw and this grass have been eaten up, cattle manage to endure the remaining days up to the rainy season by feeding on rice stubs (*tuggo maalooni* ; pl. : *tuggo maalooje*. *tugge roobaare* ; pl. : *tugge doobaaje*).

Photo5-13 Herding in lowland paddy fields (*yaire*), feeding on rice straw after harvest

(6) Herding pattern in setto

This herding pattern was observed for 42 days from April 23 (when the first rain fell in the area of the settlement) to June 3 (the settlement moved to Lemuta in upland on the following day), 1995. It is referred to as "herding pattern in *setto*" since this period corresponds to *setto* (first half of the rainy season) according to Fulbe classification of seasons.

In this period, the settlement continued daytime herding as in the season of *sheedu*. The pastoral herds left the settlement at 9 : 19 (the 42-day average ; the leaving time ranged from 8 : 33 to 10 : 00) and returned at 18 : 44 (the 42-day average : the returning time ranged from 18 : 15 to 19 : 42), feeding for 9 hours and 25 minutes on average. The range used for pasturing in this period was the *fadama* in Nasarafu (for 27 days, 64.3%), and the sorghum fields and fallow land in Emidogo were often used, too (15 days, 35.7%). When grazing was carried out in Nasarafu, Reggorde Boodel on the Gbako River was used, and when it was done in Emidogo, Reggorde Mushita was used, twice a day (in the morning and the afternoon).

In early April when rain begins falling, such grass as *hargaare* (pl. : *kargaaje*) and *naanaare* (pl. : *naanaaje*) grow in *fadama* and cattle like these kinds of grass. These grass species provide cattle with feed in this period.

Even when one or two full-scale rainfalls signal the end of the dry season and *setto* starts, Fulbe do not move to upland areas immediately because rivers there have not risen well yet and water is still in short supply. But if cattle continue eating grass in *fadama* until June or July, they have diarrhea. This is why Fulbe begin to migrate from the lowlands to the uplands in *setto luggini* in early June.

7. Discussion and conclusion

7-1. The first conclusion and a proposition of the problem for this section

The subject of Bida Fulbe dietary habits is not taken up here but their food is very diverse for a pastoral people. Not only cattle, sheep and chickens but also rice, sorghum, millets, maize, yam, cowpea, onion and other farm products and such fresh-water products as raw and dried fish are important food materials for the Fulbe.

Fulbe buy these farm and fresh-water products at markets in Bida and in Nupe's villages in the neighborhood. In addition to food, they purchase many other products, such as clothes, beads, medicines for animals, gourd products and baskets, from other communities. To prepare for an important ceremony, they sometimes buy butter, yogurt (*kosam*), etc. from other Fulbe. In short, Bida Fulbe's life is exposed to a money economy to a great extent.

However, though they are so deeply immersed in a money economy, their life is still supported by cattle husbandry. As far as the author could ascertain, they are not engaged in farming at all. The only mode of subsistence for Bida Fulbe is to raise and propagate cattle, to use milk and its products and to sell cattle and their products. In this sense, it can be said that Bida Fulbe are pure pastoralists dependent heavily on cattle.

In addition, the following points are drawn from the sections 4 and 5 ; the Bida Fulbe family (*baade*) is the basic unit not only of a settlement but for cattle owning, for consumption of cattle and their products and for cattle herding. From the data of six families whose cattle could be checked precisely, it is concluded that Bida Fulbe make a living by keeping 59.8 (±34.3) head per *baade* and 6.7 (ranging from 3.5 to 12.5) head of cattle per person on average. The latter figure is quite a lot in comparison with that of the East African pastoralists (Sato, 1984); this means that Bida Fulbe's pastoral life is quite comfortable.

Furthermore, from the observations of the settlement studied described in section 6, we can calculate and obtain the following figures ; the one way distance for their seasonal migration is only about 10 km ; the area of total herding ranges for the uplands is about 100 km^2 ; and the area of total herding ranges for the lowlands is about 40 km^2. These figures seem to be fairly small in comparison with that of other authors', for example ; Awogbade (1983 : p.53) showed that the one way distance for seasonal migration of the homestead which he studied in Jos Plateau was 20 km ; Hopen (1958 : p.32) estimated that the average one way distance for transhumance was about 100 km (ranging from 10 km to 303 km) in Sokoto ; and from the map Stenning (1959 : p.93, pp214-219) showed, we can know that the general movement of Fulbe groups in western Borno covered more than 260 km annually, changing their camping site frequently.

Considering these figures, we can conclude that Bida Fulbe families studied can continue their pastoral activities in the very limited district of the Bida area where Nupe farmers conduct their agricultural life. It is the aim of this section to tackle the problem of how Bida Fulbe can achieve such things.

7-2. Background of coexistence : relationship between pastoral Fulbe and agricultural Nupe

(1) Nupe's deep-rooted antipathy against Fulbe

In the early 19th century, when Usuman Dan Fodio, a Fulbe,"criticized the corruption and deterioration of Islam in the Hausa Emirate in those days and declared a jihad, many people immediately responded to it in many districts and the holy war spread all over central Sudan. As a result, (...) a giant emirate of Sokoto was built (Shimada, 1995 ; pp.7-8)." "The rule of this great nation was left to the emirs of many districts (ibid., p.8)" and those districts under the emirs' reign were called emirates. The Bida Emirate was one of them and Fulbe conquered the Nupe at that time. Since then there have been complex emotions between Nupes and Fulbes.

In the vast lowlands in the south of Doko, there are some villages of landed Nupe farmers. But in the most villages around Bida, Fulbe are the absentee landowners (descendants of high-ranking worriers during the jihad ; Tsoeda, Natsu, etc.) and Nupe are tenants. Since they are tenants, Nupe cannot use the land freely.

The Fulbe engaged in cattle raising are the same ethnic group as Fulbe absentee landlords. But pastoral Fulbe led by *Dikko* are regarded as only one of the Bida Emirate's occupational organizations just like, for example, the organization of butchers headed by "*sarkin pawa* (Hausa word meaning the chief of butchers)." Fulbe nobles, including absentee landowners, and pastoral Fulbe are different groups and therefore, should be viewed and studied separately.

Despite this, the author realized that many of Nupe were antagonistic toward pastoral Fulbe while he was talking with them. For example, the author often heard from Nupe that Fulbe's cattle damaged their fields, that Fulbes broke irrigation canals and that Nupe women were raped by Fulbe men. He also heard that some Nupes hurled such words of abuse as "Fulbe are farmers' enemies!" at Fulbe while they were grazing their herds and that others burnt remnants in the fields just after harvesting in an attempt to prevent the Fulbe from using them.

Pastoral Fulbe do not try so hard to maintain harmonious relations with Nupe, either ; for example, they never form marital relations with Nupe. Fulbe herders and Nupe farmers seem to coexist without mixing together just like oil and water and preserve their cultures of different nature.

(2) Cooperative relations between Fulbe and Nupe

There are those Nupe (and their villages) who are antagonistic towards the pastoral Fulbe some are not.

As already stated, the Fulbe settlement studied moves every year from the uplands to the lowlands in November to January and returns to the uplands in early June. In other words, they have their settlement in a Nupe's upland village in the rainy half of the year and in a Nupe's lowland village in the dry half of the year. The Nupe villages where the Fulbe built their settlement are shown in Table 5-14. While there are some cases where the locations of their settlement are not the same as those in the previous year both in the cases of the rainy and dry seasons, they are mostly the same Nupe villages or nearby ones. This means that the Fulbe in the study site repeat "transhumance-like" movements each year.

Since the site of Fulbe settlements can be turned into very fertile fields, Nupe do behind-the-scenes activities in an effort to invite Fulbes to build their settlement in their village. The chiefs of Tswatagi and Nasarafu as well as those of nearby villages visit Fulbe settlement with money and other presents more than one year before. If they succeed in attracting Fulbe to their community, the Nupe prepare the land for Fulbe settlements and offer a variety of services, such as the supply of grass for building houses and logs for the cattle enclosures.

The areas where Fulbe establish their settlements are almost fixed year by year, as described above. Because of this, very friendly and cooperative relations have been created between a particular Fulbe group and the Nupe community where the Fulbe group builds its settlement regularly.

Though small scale, Fulbe women make dairy products (yogurt (*kosam*)), cheese (*wankashi*), butter (*nebbam*), etc.) and sell these at the market in a nearby town. Pastoral Fulbe also keep a close relationship with butchers' organizations and sell sick cattle, healthy bulls, etc. to butchers (who are usually Nupe).

Table5-14 Sites of the Fulbe settlement studied

Year	Lowland (January-May)	Upland (June-December)
1981	Nasarafu	Rogota
1982	Shabamaliki	Rogota
1983	Shabamaliki	Ndacheko
1984	Shabamaliki	Ndacheko
1985	Shabamaliki	Mandzwakwa
1986	Nasarafu	Emisheshi natsu
1987	Nasarafu	Emisheshi natsu
1988	Nasarafu	Emisheshi natsu
1989	Nasarafu	Lemuta
1990	Nasarafu	Lemuta
1991	Nasarafu	Lemuta
1992	Nasarafu	Emigbari
1993	Nasarafu	Lemuta
1994	Tswatagi	Emisheshi natsu
1995	Nasarafu	Emisheshi natsu
1996	Tswatagi	

Through these activities, Fulbe pastoralists try to live together with butchers' organizations in mutual prosperity and support the area's cattle husbandry sector. From a broader viewpoint, these can also be regarded as collaborative relations between Nupe and Fulbe.

7-3. Bida Fulbe herding methods (see Table 5-15)

(1) Bida Fulbe herding plan : change in main types of herding range

The observation of Bida Fulbe herding activities for at least over one year has led to the discovery of six herding patterns. These herding patterns are characterized by the main types of herding range which differs from period to period as described below :

1) In *setto luggini* in June when the rainy season approaches its height and just after Fulbe have moved upland, Nupe farmers are in the middle of planting work. In this period, Fulbe put cattle out to pre-cultivation fields to let them feed on new grass that begins to grow in the rainy season.

2) In *dungu* when Nupe finish planting, new grass in fallow fields and secondary forests in the uplands is the main feed for cattle. This is the longest herding period, continuing for about four months from mid-July to mid-November.

3) Around November when *yande* begins, Nupe harvest sorghum and late millets. In this period, a half of the settlement moves to the lowlands while the other half remains in the uplands. Fulbe pastoral herds feed mainly on remnants left on the fields after the reaping of these crops.

4) About January, the second half of *yande*, the entire settlement goes to the

Table5-15 Biba Fulbe's six herding patterns (summary)

Herding patterns	Period (1994-'95)	Position of settlement	Main types of herding range	Herding time (hours : minutes)		Splitting of pastoral herd	No. of herders
Setto luggini	6/05～6/11	Upland	Fields before cultivation	Morning+afternoon	9:30	no	2.64
〃	6/12～7/15	〃	Fields before cultivation	Daytime	8:21	no	2.03
Dungu	7/16～11/13	Upland	Secondary forests and falow lands	Daytime	8:25	no	1.70
Early yande	11/14～1/06	Upland /Lowland	Fields after harvest	Morning+afternoon	9:36	yes	?
Late yande	1/08～2/28	Lowland	Fadama	Morning+afternoon	9:57	yes	2.52
Sheedu	3/01～4/22	Lowland	Paddy fields after harvest	Daytime	9:22	yes	2.08
Setto	4/23～6/03	Lowland	Fadama	Daytime	9:25	yes	2.00

lowlands and carries out grazing mainly in lowland *fadama* (paddy fields and floodplains) using grass there.

5) About March, the driest part of *sheedu*, Nupe finish harvesting rice in paddy fields. In this period, Fulbe's pastoral herds feed on rice straw left after rice has been reaped.

6) Finally, the rainy season (*setto*) begins in April. In this season, Fulbe pastoral herds continue to feed, until about late May, on the new grass growing in lowland *fadamas*.

As noted, Bida Fulbe can continue their pastoral activities in the limited district of the Bida area by changing main types of herding range one after the other. They developed and shaped the plan of changing the six types of herding range according to the season through trial and error for many generations who have carried out cattle raising in this area. Only if all of the six kinds of herding range are available, they can continue raising cattle ; if they cannot get any one of them, they could not succeed in cattle breeding in the Bida area. Their herding plan is so perfectly designed. In addition, it is supported by Fulbe's very broad and deep knowledge not merely about the kinds of feed eaten and liked by cattle but also about Nupe farming activities and distribution of cultivated and uncultivated lands. In this sense, their herding plan may be called a compilation of all of Bida Fulbe's pastoral culture.

The plan described above is the one shared by Fulbe people but only gives an idea on how to raise cattle in the Bida area. To put this idea into practice, several realistic procedures and techniques are needed. These procedures and techniques are outlined and discussed below :

(2) Seasonal migration of the settlement

The main type of herding range mentioned above are those where feeding resources are not only available in each period but also the most reliable. As already stated, the study area can be divided, by the altitude of about 250 feet (75-80 m), into uplands (*yolde*) not submerged even in the rainy season and lowlands (*mayo*) that turn into floodplains in the rainy season and remain humid relatively far into the dry season. In the rainy season, reliable feeding resources exist in the uplands in quantities enough to feed pastoral herds but in the dry season, as the weather grows increasingly drier, such resources come to be found only in lowland *fadamas*. Therefore, to make the most of these reliable resources while conducting day-trip herding, Bida Fulbe should devise and follow the procedure for establishing their settlements in the uplands in the rainy season and in lowlands in the dry season. Needless to say, this is inseparable from their seasonal movement from the lowlands to the uplands in the early rainy season and vice versa in the early dry season. In other words, for Fulbe, seasonal migration is the most basic procedure for making the periodic and greatly changing environments available for their use.

In addition, in the settlement studied, Sheshi's and Saadu's *baade* and Shefu's *onde*, which are equivalent to half of the settlement, moved from the uplands to the lowlands in early November, and Alhaji Abdullahi's other *baade* and Alhaji Nuhu's *baade* migrated to the lowlands in early January. In short, the entire settlement did not move to the lowlands at the same time; instead, half of it migrated first and then two months later, the other half moved.

The major feeding resources in early *yande* are remnants in the fields of sorghum and other crops, and by dividing the settlement temporarily, Fulbe can use both upland and lowland fields at the same time. This is possible largely because their upland and lowland settlements are not very far from Bida and is the only herding technique Bida Fulbe are capable of adopting.

(3) Bida Fulbe's other herding techniques

In addition to the foregoing procedures and techniques for making important feeding resources available, Bida Fulbe adopt several techniques for more efficient and effective use of their herding ranges.

1) Carrying out morning herding

Fulbes build their settlement in a relatively open area close to a Nupe community. This is because tsetse flies do not like open fields. This type of area is surrounded by Nupe fields but since Fulbe have to observe the rule,"You must not enter any fields before harvest," their pastoral herds cannot use these fields during the period from planting to harvesting of crops. But this also means that Fulbe can graze their cattle as far as they do not break this rule, that is, in any other places than paddy and upland fields before reaping. It can safely be said that what interests Fulbes most is how to carry out herding activities without invading pre-harvest fields, i.e., how to make the most of pre-cultivation and post-harvest fields. This is clearly reflected in their herding plan and the herding ranges that they actually choose.

If they want to use pre-cultivation and post-harvest fields, Fulbes carry out morning herding.

In *setto luggini*, just after Fulbes move to the uplands, Nupe farmers are in the middle of planting and there still remains unplowed and grazable fields both near and far from the Fulbe settlements. So their pastoral herds use nearby pre-cultivation fields in morning herding and go to more distant fields in afternoon herding. In this way, they can use all pre-cultivation fields around the settlement effectively.

The following effects are also taken account of :

1. Morning herding is mostly carried out very close to the settlement and in one single field for a long time. Because of this, even boys under ten years can be used as herders, which saves the use of herders and is helpful in training boys in cattle herding.

2. In addition, morning herding in a nearby field makes it possible to extend the day's herding time easily. It is noteworthy that the total grazing hours in the season when morning herding is done is more than that in the period when daytime herding is carried out.

Before and after their migration to the lowlands in November 1994, Fulbe also did morning herding from about 8 to 10 : 30 a.m. A half of the settlement studied moved to a lowland area on November 12, 1994, and the other half that stayed in an upland area began to do morning herding on November 14. Morning herding was continued after the other half joined the settlement in the lowland village, until early March 1995.

In early and late *yande*, Fulbes use the remnants in sorghum fields near their settlement in morning herding and the informant explained the reason as follows : In the dry season (*yande*), temperatures rapidly rise at 10 : 00 and after. Because of this, sorghum leaves crumble easily and cattle have difficulty eating them. But before ten the sun is still low in the sky and temperatures are not so high and so the leaves are firmer and easier to eat. But since cattle feel thirsty when they eat sorghum leaves, it is impossible to continue pasturing in sorghum fields for a long time. In this period, water should be given to cattle on their way back to the settlement.

As described above, morning herding is the technique for using more effectively grazable fields near the settlement.

If no usable fields are available around the settlement, Fulbes carry out daytime herding – they go to a distant range in the morning and return in the evening.

Daytime herding in the dry season (*sheedu*) is longer than that in the rainy season (*setto luggini* and *dungu*) by about one hour on average. This shows how hard pasturing in *sheedu* is. The author would like to make the reasons that the herding hours in *setto*, the early rainy season, are as long as nine hours and 25 minutes on average the subject of his future studies, but this fact may suggest that the period is an unexpectedly difficult one.

2) Establishment of major herding ranges

Every day Fulbes must choose the range where they put their pastoral herds out to pasture. In this case, they always determine the day's pasturing site and herding route at the meeting before herding (*howaare*). In *dungu* (the rainy season), however, they add the characteristic method, that is, they establish several major herding ranges in advance and choose the day's grazing site from among these. As described in the former section, both settlements studied in Lemuta and Madodo established five major herding ranges and used these ranges in day-to-day rotation. (And besides these five major ranges, these settlements established herding ranges for rainy days.)

In these cases, Fulbes establish their major herding range according to the already available units, that is, Nupe villages. For example, the herding range of Ndarubu, that of Gebo and so on. The reasons why Fulbes establish their herding ranges in Nupe villages were unable to be found in the present study. But it is certain that they know from experience that the feeding resources available in one village are enough to meet the demand of their pastoral herds during the day.

Besides the range for grazing, the watering site and access to the herding range are taken into account in establishing a herding range.

First of all, whether a watering site can be secured near the major herding range or not is so important that it affects even the range's utility as pasture-land. For example, in the uplands, Fulbe have established a watering site near their four major herding ranges in Gbanchitako, Alukusu tifin, Alukusu tako and Kudigi, and use the one in Alukusu tifin when going to the major herding range in Ndarubu. The quality of watering sites is considered in determining major herding ranges, too. The settlement studied used a range in Kangowa in June 1994 for the first time but stopped after using it five times. According to the informant, this was because the watering site in Kangowa was too small and had insufficient water.

In some cases, whether access to the range can be secured or not is also an important factor in establishing a major herding range. For example, Fulbes have access to herding range in Gebo and Emimam just after they move there because the Nupe have not planted all fields but their route is blocked by Nupe fields after crops have been planted.

Dungu is the longest period which continues from mid July to mid November for about four months. In this period, Fulbe pastoral herds graze in uncultivated areas of the uplands, that is, fallow land and secondary forests. By mid July, Nupes have finished the first stage of planting work in upland fields and so the distribution of the cultivated and uncultivated lands is almost fixed. The method of establishing major herding ranges in each Nupe villages is apparently possible in this period when the distribution of grazable lands is stable for a long time.

(Note: Because the size of both Nupe lowland villages and the grazable lands in these villages, i.e., paddy and floodplain, are large, Fulbes do not establish herding ranges in each lowland village.)

The method of selecting the day's grazing site from among several predetermined major herding ranges has a number of advantages. First of all, the alternate use of several major herding ranges will allow them to use the limited land around their settlement for a long time and in a sustainable way. In addition, if they continue using the same major herding ranges for many years, they can store data on their conditions and changes, which will make their herding activities easier. This is certainly Fulbe herding technique for effective land use.

3) Herding techniques related to the size of pastoral herds

Bida Fulbe adopt the following techniques as to the size of their pastoral herds. While the cattle owned by a *baade* are put out to pasture basically as one pastoral herd, one pastoral herd is sometimes divided into two if it has over 100 head.

In *dungu* (the rainy season), there is an abundant supply of grass for cattle and thus it is easy to secure in one location the quantity of grass enough to feed 150 head or so. This can be proved by the fact that the average herding time in *dungu* is relatively short (eight hours and 25 minutes). Therefore, Herd A studied is not divided but herded together as one pastoral herd by one or two herders. This technique can save labor (i.e. reduce the number of herders needed for herding) and herders off duty can take a rest longer.

But in *yande* and *sheedu* (the dry season), the supply of food decreases and food patches are more scattered. Sorghum remnants in each field are small in quantity and the size of each field is small. The hills of rice straw in paddy fields are not very large and are dispersed widely in large areas.

To cope with this situation, Fulbe divide a large pastoral herd into smaller ones for pasturing purposes.

In the first half of *yande*, as a result of the migration of a half of the settlement to a lowland area, Herd A composed of over 160 head was divided into two pastoral herds, each with about 70-80 head. In other words, the settlement's seasonal movement is also the opportunity to split its pastoral herd.

According to the informant, the reasons why the pastoral herd is divided at this period are as follows: Nupe spend long hours in cutting sorghum by the roots and then reaping it by cutting off its ears. The Fulbe pastoral herd can feed on the sorghum after the Nupe have cut off the ears but at the early stage of harvesting, feed is liable to be in short supply. Thus by dividing the herd into two and reducing the number of cattle in each herd, Fulbe manage to feed their cattle with the little grass remaining in secondary forests and fallow land as well as with small quantities of sorghum remnants left after harvesting.

In late *yande*, the other half that has stayed in the uplands moves to the lowlands and joins the group already migrated there. After that, the cattle of Herd A are put into one enclosure (*hoggo*) but the former two herds continue to maintain their unity, led by different herders during pasturing. This situation lasts until early June when the entire settlement moves to upland again. In short, it is only during *setto luggini* and *dungu* that Herd A with over 150 head of cattle is grazed as one pastoral herd; in the other periods, the herd is split into two pastoral herds, and herded independently.

As evident from the foregoing, dividing a large cattle herd into smaller ones is the technique for using a few small food patches as efficiently as possible. Fulbes empirically know that in difficult situations in the dry season, the best grazing size is 50-80 head (at least under 100 head).

4) Herding techniques related to the number of herders

The number of herders has already been discussed in the sections of morning herding and the size of pastoral herds. This section summarizes this subject again.

Even a large herd of more than 150 head of cattle can be led and grazed by one herder. In *dungu*, Herd A was put out to pasture as one pastoral herd and the average number of herders was 1.70. This is because in 34 of the 119 days (28.6%) before Herd A was split into two, all the cattle were taken care of by one herder (in the remaining 85 days, two herders led the cattle).

If a pastoral herd is divided into smaller ones, each small herd needs at least one herder and so the total number of herders needed for herding work increases. For example, the settlement had an average of 1.70 herders in the *dungu* of 1994 but the figure grew to an average of 2.52 in the late *yande* of 1995 and to an average of 2.08 in the *sheedu* of that year. This means harder labor for herders but this is unavoidable if they are to keep their cattle with smaller food patches in these periods.

There is another reason that herders must be increased. This is in the case where herding activities are done in a range having many pre-harvest fields. In this case, the pastoral herd would have to pass through narrow roads between fields, which requires two to three herders to lead the cattle. For example, during the first week of *setto luggini*, the settlement used 2.64 herders on average, the largest number in the year, though the cattle were grazed as one pastoral herd. This was because they used pre-cultivation fields while carefully avoiding the farms just plowed.

7-4. The second conclusion : careful cattle herding in farming areas

As described in the foregoing sections, the author was able to find Bida Fulbe's main cattle herding procedures and techniques in their six herding patterns.

The environment where Fulbes perform herding activities has both natural and artificial diversities ; the former includes seasonal changes, differences between uplands and lowlands and a wide variety of vegetation according to area, and the latter is the outcome of Nupe farming activities, such as paddy and upland fields and fallow fields. Bida Fulbe have continued their herding in this seasonally changing and diverse environment and have produced the herding plan of changing main types of herding range and feeding resource depending on the changing seasons. The herding activities for the Bida area have been drafted according to this herding plan.

According to this herding plan, they move their settlement and choose herding ranges. In addition, they perform morning herding and control the size of pastoral herd and the number of herders. All of these are the herding procedures and techniques worked out by Fulbes, after many years of efforts, to make land more useful and to utilize it more effectively and safely. In other words, all of these shape Bida Fulbe's unique herding system. While conducting day-trip herding making full use of these procedures and techniques, they maintain peaceful coexistence with the Nupe and continue their pastoral activities in the limited district of the Bida area.

Appendix. Data of Cattle of Herd A studied

Name	Cattle symbol	Body color	Owner	Age/sex		Sex	Age		Milk		Alive/dead	
				1994	1996		1994	1996	1994	1996	1994	1996
1 Saaje	AAd	nyawe	M	haange		F	9				d	d
2 Amardi	AAdl	amardi	M	bujiri		M	8				1	d
3 Amare Nyawe	AAn	nyawe	Shefu	nagge		F	12				d	d
4 Amare Nyawe	AAn1	baleri	Shefu	bujiri	bujiri	M	8	10			1	c
5 Amare Nyawe	AAn2	sodari	Shefu	daandi	daandi	M	6	8			1	d
6 Amare Nyawe	AAn3	baleri	Shefu	gaari	gaari	M	2	4			1	1
7 Amare	AAr	yaka.	A	nagge	nagge	F	9	11			1	1
8 Amare	AArl	yaka.	A	daandi		M	7				d	d
9 Amare	AAr2	yaka.	A	nyan.	haange	F	3	6			1	1
10 Amare	AAr21	wagummeye	A		biggel	F		1		y	-	1
11 Amare	AAr3	nyawe	A		nyan.	F		1.5		y	-	1
12 Bokolo	ABa	wagummeye	A	nagge		F	12				d	d
13 Bokolo	ABa1	baleye bova	A	haange	nagge	F	7	9			1	1
14 Bokolo	ABa11	galaye	A	biggel		F	0.3		y		d	d
15 Bokolo	ABa12	baleye	A		nyan.	F		1			-	1
16 Bokolo	ABa13	yaka.	A		gaggel	M		0.3		y	-	1
17 Bokolo	ABa2	baleye bagguye	A	nyan.	wigge	F	3	5			1	1
18 Bokolo	ABa3	galaye	A	biggel	wigge	F	1	3	Mother died		1	1
19 Bokolo	ABb	bokolo	M	wigge	haange	F	3	5			1	1
20 Bokolo	ABb1	boderi	M		gaggel	M		1		y	-	1
21 Bigel	ABi	nyawe	Shefu	wigge	haange	F	3	5			1	d
22 Bigel	ABi1	yaka.	Shefu		gaggel	M					-	d
23 Bokolo	ABokolo	nyawe	A	kaladdi		M	10				d	d
24 Dabba	ADab	yaka.	Shefu	gaari	kaladdi	M	3	6			-	d
25 Dakalei	ADka	galaye	A	nagge		F	15				d	d
26 Dakalei	ADka1	yaka.	Shefu	nagge		F	9				d	d
27 Dakalei	ADka11	nyawe	Shefu	nagge		F	8				d	d
28 Dakalei	ADka111	nyawe	Shefu	wigge	wigge	F	4	6			1	d
29 Dakalei	ADka112	baleri	Shefu	gaggel	gaari	M	2	4			1	1
30 Dakalei	ADka113	nyawe	Shefu	biggel	wigge	F	1	3	Mother died ?		1	1
31 Dakalei	ADka12	yaka.	Shefu	haange		F	7				d	d
32 Dakalei	ADka121	baleye	Shefu	haange		F	6				1	d
33 Dakalei	ADka1211	yaka.	Shefu	daandi		M	4				1	d
34 Dakalei	ADka13	yaka.	Shefu	haange		F	6				d	d
35 Dakalei	ADka131	hurunbaye	Shefu	wigge	haange	F	7	9			1	1
36 Dakalei	ADka1311	yaka.	Shefu	gaggel		M					d	d
37 Dakalei	ADka1312	yaka.	Shefu		gaggel	M				y	-	1
38 Dakalei	ADka2	yaka.	A	wigge		F	6				d	d
39 Dakalei	ADka3	yaka.	A	gaari		M	3				d	d
40 Dakalei	ADkb	yaka.	A	nagge		F	12	15			1	1
41 Dakalei	ADkb1	hurunbari	A	gaari		M	3				d	d
42 Dakalei	ADkb2	hurunbaye	A	haange	haange	F	7	9			1	1
43 Dakalei	ADkb21	hurunbaye	A	biggel	wigge	F	1	3	y		1	1
44 Dakalei	ADkb22	yaka.	A		biggel	F				y	-	1
45 Dakalei	ADkb3	yaka.	A	haange	haange	F	5	6			1	1
46 Dakalei	ADkb31	yaka.	A	biggel	nyan.	F	0.7	2	y		1	1
47 Dakalei	ADkb4	yaka.	A	gaari		M	1				d	d
48 Dakalei	ADkb5	yaka. kobari	A	gaari	garri	M	1.5	4			1	d
49 Dakalei	ADkb6	yaka.	A		gaari	M		2			-	1
50 Dakalei	ADkc	yaka.	A		gaari	M		2			-	1
51 Dakalei	ADkd	yaka.	A		gaari	M		2			-	d
52 Damudo	ADma	hurunbaye	Mam	wigge	haange	F	5	8			1	d
53 Damudo	ADma1	yaka.	Mam		gaggel	M					-	d
54 Damudo	ADma2	nyawe	Mam		biggel	F				Mother died	-	1

Name	Cattle symbol	Body color	Owner	Age/sex		Sex	Age		Milk		Alive/dead	
				1994	1996		1994	1996	1994	1996	1994	1996
55 Damudo (Sodaye)	ADmb	nyawe	Mam		wigge	F		2			-	1
56 Dandaye	ADn	yaka.	Mam	nagge		F	9				d	d
57 Dandaye	ADn1	yaka.	Mam	nagge	nagge	F	11	14			1	1
58 Dandaye	ADn11	yaka.	Mam	daandi	bujiri	M	7	9			1	1
59 Dandaye	ADn12	bunari	Mam	gaari	daandi	M	5	7			1	1
60 Dandaye	ADn13	yaka.	Mam	gaari		M	2				d	d
61 Dandaye	ADn14	yaka.	Mam	gaggel	gaari	M	0.6	4	y		1	1
62 Dandaye	ADn15	yaka.	Mam		gaggel	M		0.3			-	d
63 Dandaye	ADn16	yaka.	Mam		biggel	F				y	-	1
64 Dandaye	ADn2	yaka.	Mam	haange		F	7				d	d
65 Dandaye	ADn21	sodaye	Mam	nyan.	wigge	F	2	4			1	1
66 Duleye	ADu	duleye	Shefu		wigge	F		4			-	1
67 Eda	AEd	yaka.	M		wigge	F		3			-	1
68 Ela	AEla	yaka.	M	haange		F	7				d	d
69 Ela	AEla1	baleri	M	daandi	bujiri	M	8	9			1	d
70 Ela	AElb	yaka.	M		wigge	F		5			-	1
71 Felle	AFe	yaka.	Mam	nagge	nagge	F	14	16			1	1
72 Felle	AFe1	yaka.	Mam	haange	haange	F	9	11			1	1
73 Felle	AFe11	yaka.	Mam	nyan		F	2				1	d
74 Felle	AFe12	yaka.	Mam		biggel	F				y	-	1
75 Felle	AFe2	nyawe	Mam	haange	haange	F	7	9			1	1
76 Felle	AFe21	wagummeye	Mam	biggel	wigge	F	1	3	y		1	1
77 Felle	AFe22	yaka.	Mam		biggel	F				y	-	1
78 Felle	AFe3	yaka.	Mam	nyan.	haange	F	4	5			1	1
79 Felle	AFe31	yaka.	Mam		gaggel	M				y	-	1
80 Felle	AFe4	nyawe	Mam	gaggel	gaari	M	2	3	y		1	d
81 Felle	AFe5	wagummeri	Mam		gaggel	M				y	-	1
82 Fonduye	AFo	hurunbaye	M	nagge		F	14				d	d
83 Fonduye	AFo1	yaka.	M	nagge	nagge	F	13	14			1	d
84 Fonduye	AFo11	yaka.	M	burtiri	burtiri	M	6	7			1	d
85 Fonduye	AFo12	yaka.	M	burtiri	kaladdi	M	5	7			1	1
86 Fonduye	AFo13	yaka.	M	wigge		F	4				d	d
87 Fonduye	AFo14	nyawe	M	nyan.	wigge	F	2	4			1	1
88 Fonduye	AFo15	nyauri	M		gaari	M		2			-	1
89 Fonduye	AFo2	yaka.	M	haange	haange	F	8	10			1	1
90 Fonduye	AFo21	gaalaye	M	wigge	wigge	F	3	5			1	1
91 Fonduye	AFo22	gaalaye	M	biggel	nyan.	F	0.6	2	y		1	1
92 Fure	AFua	fure	A	nagge	nagge	F	13	15			1	1
93 Fure	AFua1	fure yaka.	A	haange	haange	F	7	8			1	d
94 Fure	AFua11	bagiri buldi	A	gaggel	gaari	M	2	4	y		1	1
95 Fure	AFua12	bagel	A		nyan.	F		1		Mother died	-	1
96 Fure	AFua2	nyawe	A	wigge	haange	F	6	7			1	1
97 Fure	AFua21	yaka.	A		biggel	F		1		y	-	1
98 Fure	AFua3	yaka.	A	gaari		M	4				d	d
99 Fure	AFua4	sodaye	A	biggel	nyan.	F	1	3	y		1	1
100 Fure	AFua5	fure yaka.	A	nyan.	wigge	F	2	4			1	1
101 Fure	AFua6	yaka.	A		biggel	F		2		y	-	1
102 Fure	AFub	sodaye	M	wigge	hannge	F	3.5	6			1	d
103 Fure	AFub1	sodaye	M	biggel	wigge	F	0.5	3	y		1	1
104 Fure	AFuc	hurunbaye	Nbabo		wigge	F		4			-	1
105 Fure	AFure	yaka.	A	gaari		M	3				d	d
106 Galako	AGalako	yaka.	A	kaladdi		M	13				d	d
107 Gafe	AGfa	nyawe	M	nagge	nagge	F	10	11			1	d
108 Gafe	AGfa1	nyawe	M	haange	haange	F	5	7			1	1

Name	Cattle symbol	Body color	Owner	Age/sex		Sex	Age		Milk		Alive/dead	
				1994	1996		1994	1996	1994	1996	1994	1996
109 Gafe	AGfa11	yaka.	M	gaggel	gaari	M	0.6	3	y		1	1
110 Gafe	AGfa12	kobari	M		gaggel	M					-	d
111 Gafe	AGfa13	kobari nyawe	M		gaggel	M		0		y	-	1
112 Gafe	AGfa2	yaka.	M	wigge	haange	F	3	5			1	1
113 Gafe	AGfa21	yaka.	M		gaggel	M				y	-	1
114 Gafe	AGfa3	yaka.	M	gaggel		M	1				d	d
115 Gafe	AGfa4	yaka.	M	gaggel	gaari	M	0.2	2.5	y		1	1
116 Gafe	AGfb	yaka.	M←Saadu	wigge	haange	F	3	5			1	1
117 Gafe	AGfb1	yaka.	M		biggel	F		1		y	-	1
118 Gidoma	AGi	yaka.	Shefu	nagge	nagge	F	10	11			1	1
119 Gidoma	AGi1	yaka.	Shefu	haange	haange	F	6	7			1	1
120 Gidoma	AGi11	yaka.	Shefu	gaari	gaari	M	2	3.5			1	d
121 Gidoma	AGi12	yaka.	Shefu		wigge	F					-	1
122 Gidoma	AGi2	yaka.	Shefu	gaari	gaari	M	2	4			1	1
123 Gidoma	AGi3	yaka.	Shefu	nyan.	wigge	F	2	4			1	1
124 Gidoma	AGi4	yaka.	Shefu	gaggel	gaari	M	1	3			1	1
125 Gajere	AGja	hobaye	A	haange		F	10				d	d
126 Gajere	AGja1	yaka.	M	haange	nagge	F	7	10			1	1
127 Gajere	AGja11	yaka.	M	nyan.	wigge	F	2	3			1	1
128 Gajere	AGja12	yaka.	M	biggel		F	1		y		1	d
129 Gajere	AGja13	yaka.	M		gaggel	M		2		y	-	1
130 Gajere	AGja2	yaka.	A	gaari	daandi	M	4	6			1	1
131 Gajere	AGjb	hurunbaye	Azumi	wigge	haange	F	5	7			1	1
132 Gajere	AGjb1	yaka.	Azumi		nyan.	F		2			-	1
133 Galaye	AGla	yaka.	A	nagge	nagge	F	8	11			1	1
134 Galaye	AGla1	yaka.	A	nyan.	haange	F	3	6			1	1
135 Galaye	AGla11	nordiri di fellere	A		gaari	M		2			-	1
136 Galaye	AGla2	yaka.	A	gaggel	gaari	M	3	5			1	1
137 Galaye	AGla3	yaka.	A	nyan.	haange	F	2	4	y		1	1
138 Galaye	AGla31	yaka.	A		gaggel	M		0		y	-	1
139 Galaye	AGla4	yaka.	A		biggel	F					-	d
140 Galaye	AGla5	yaka.	A		gaggel	M		1		y	-	1
141 Galaye	AGlb	yaka.	A	nagge	nagge	F	8	10			1	1
142 Galaye	AGlb1	yaka.	A	wigge	haange	F	5	7			1	1
143 Galaye	AGlb11	yaka.	A		gaggel	M				y	-	1
144 Galaye	AGlb2	yaka.	A	gaggel	gaari	M	2	4			1	1
145 Galaye	AGlb3	yaka.	A		biggel	F					-	d
146 Galaye	AGlb4	yaka.	A		biggel	F		0.5		y	-	1
147 Gowagi	AGo	yaka.	A	nagge		F	14				d	d
148 Gowagi	AGo1	yaka.	A	kaladdi	kaladdi	M	9	11			1	c
149 Gowagi	AGo2	yaka.	A	haange		F	7				1	d
150 Gowagi	AGo21	yaka.	A	gaari		M	3				d	d
151 Gowagi	AGo22	yaka.	A	biggel	wigge	F	2	4	y		1	1
152 Gowagi	AGo3	sodaye	A	haange		F	5				d	d
153 Gowagi	AGo31	daunduuri	A	gaari	daandi	M	2	4			1	1
154 Gowagi	AGo4	yaka.	A	gaari	burtiri	M	3	6			1	1
155 Gowagi	AGo5	yaka.	A	wigge	haange	F	4	6			1	1
156 Gowagi	AGo51	yaka.	A		gaari	M		2			-	1
157 Hobaye	AHo	nyawe	M←Shefu		gaari	M		1			-	1
158 Hurunbaye	AHu	hurunbaye	Shefu	nagge	nagge	F	12	14			1	1
159 Hurunbaye	AHu1	yaka.	Shefu	daandi		M	7				d	d
160 Hurunbaye	AHu2	nore	M	wigge	wigge	F	4	6			1	1
161 Hurunbaye	AHu3	hurunbaye	A	nyan.	wigge	F	1.5	4			1	1
162 Hurunbaye	AHu4	yaka.	Shefu	gaggel	gaari	M	0.1	2	y		1	1

Name	Cattle symbol	Body color	Owner	Age/sex		Sex	Age		Milk		Alive/dead	
				1994	1996		1994	1996	1994	1996	1994	1996
163 Hurunbaye	AHu5	yaka.	Shefu		gaggel	M		0.5			-	d
164 Ijje	AI	yaka.	Shefu	wigge	wigge	F	4	6			1	d
165 Loshiya	ALa	yaka.	M←A	nagge	nagge	F	9	12			1	d
166 Loshiya	ALa1	yaka.	M←A	gaari	kaladdi	M	3	6			1	1
167 Loshiya	ALa2	yaka.	M←A	nyan.	wigge	F	2	4			1	1
168 Loshiya	ALa3	yaka.	M←A	gaari	gaari	M	1	3			1	d
169 Loshiya	ALa4	nyawe	M←A		nyan.	F		2			-	1
170 Loshiya	ALb	hurunbaye	M←A		wigge	F		3			-	1
171 Moriye	AMr	hurunbaye	Mam	nagge		F	15				d	d
172 Moriye	AMr1	hurunbaye	Mam	haange	haange	F	7	9			1	1
173 Moriye	AMr11	yaka.	Mam	biggel	wigge	F	2	4	y		1	1
174 Moriye	AMr12	yaka.	Mam		gaggel	M		0.9		y	-	1
175 Moriye	AMr2	yaka.	Mam	burtiri	burtiri	M	5	6			1	d
176 Muute (Tounga)	AMu	yaka.	A	wigge	haange	F	6	7			1	1
177 Muute (Tounga)	AMu1	yaka.	A		biggel	F		1.4			-	1
178 Mowayel	AMw	yaka.	Mam	nagge	nagge	F	9	11			1	1
179 Mowayel	AMw1	galari	Mam	gaari		M	4				d	d
180 Mowayel	AMw2	kobari yaka.	Mam	gaggel	gaari	M	1.5	3	y		1	1
181 Mowayel	AMw3	yaka.	Mam		biggel	F				y	-	1
182 Nyawe/Nore	ANa	nyawe	A	nagge	nagge	F	12	15			1	1
183 Nyawe/Nore	ANa1	hurunbari	A	gaari		M	6				d	d
184 Nyawe/Nore	ANa2	nyawe	A	wigge	haange	F	6	8			1	d
185 Nyawe/Nore	ANa3	hurunbari	A	burtiri	kaladdi	M	5	7			1	d
186 Nyawe/Nore	ANa4	yaka.	A	wigge	haange	F	4	6			1	1
187 Nyawe/Nore	ANa41	yaka.	A		gaggel	M		0.3		y	-	1
188 Nyawe/Nore	ANa5	yaka.	A	nyan.	wigge	F	3	5			1	1
189 Nyawe/Nore	ANa6	kobari yaka.	A	gaggel		M	2				d	d
190 Nyawe/Nore	ANa7	yaka.	A	biggel	nyan.	F	1	2.5	y		1	1
191 Nyawe/Nore	ANa8	nyawe	A		gaggel	M					-	d
192 Namali	ANamali	wagummeri	A	kaladdi		M	8				d	d
193 Gafe	ANb	yaka.	A	wigge	wigge	F	4	5			1	1
194 Nore	ANoa	nore	A		wigge	F		5			-	1
195 Nore	ANob	nore	Shefu←A		gaari	M		3			-	d
196 Saige	ASa	saige	A	nagge	nagge	F	10	12			1	d
197 Saige	ASa1	yaka.	A	biggel		F	0				d	d
198 Bijayel	ASa2	yaka.	M	haange	haange	F	8	10			1	1
199 Bijayel (Saige)	ASa21	wagummeri	A	gaagel	gaari	M	0.2	2	y		1	d
200 Bijayel	ASa22	yaka.	M		biggel	F		1.8		y	-	1
201 Saige	ASa3	yaka.	A	wigge	haange	F	6	8			1	1
202 Saige	ASa31	sodaye	A		biggel	F		0.2		y	-	1
203 Saige	ASa4	yaka.	A	biggel		F	1				d	d
204 Saige	ASa5	saige	Shefu←A	wigge	haange	F	4	5			1	d
205 Saige	ASa51	yaka.	A		biggel	F		1.8			-	1
206 Saige	ASa6	saige	A	biggel	wigge	F	1	3	y		1	1
207 Saige	ASb	hurunbaye	Shefu	nagge	nagge	F	14	16			1	d
208 Saige	ASb1	wagummeye	Shefu	haange	nagge	F	9	12			1	1
209 Saige	ASb11	kobari nyawe	Shefu	tappandi		M	4				1	d
210 Saige	ASb12	kobari sodari	Shefu	gaari	tappaandi	M	2	5			1	1
211 Saige	ASb13	yaka.	Shefu	biggel		F					d	d
212 Saige	ASb14	yaka.	Shefu		gaggel	M		1.3		y	-	1
213 Saige	ASb2	hurunbaye	Shefu	wigge	haange	F	6	8			1	1
214 Saige	ASb21	yaka.	Shefu		gaggel	M					-	d
215 Saige	ASb3	amaridi	Shefu	gaari		M	4				d	d
216 Saige	ASb4	saige/melleye	Shefu	nyan.	haange	F	2	5			1	1

Name	Cattle symbol	Body color	Owner	Age/sex		Sex	Age		Milk		Alive/dead	
				1994	1996		1994	1996	1994	1996	1994	1996
217 Saige	ASb41	yaka.	Shefu		gaggel	M				y	-	1
218 Saige	ASb5	hurunbari	Shefu	gaggel	gaari	M	1	3	y		1	d
219 Saige	ASb6	yaka.	Shefu	biggel	nyan.	F	1	2	y		1	1
220 Saige	ASb7	yaka.	Shefu		gaggel	M		1			-	1
221 Saige	ASc	saige	A		wigge	F		3			-	1
222 Saige Kurunbami	ASK	yaka.	Shefu	nagge		F		16			d	d
223 Saige Kurunbami	ASK1	yaka.	Shefu	wigge		F	7				d	d
224 Saige Kurunbami	ASK2	hurunbaye	Shefu	wigge	haange	F	5	7			1	1
225 Saige Kurunbami	ASK21	yaka.	Shefu	gaggel	gaari	M	1	3.5	y		1	d
226 Saige Kurunbami	ASK22	yaka.	Shefu		biggel	F					-	d
227 Saige Kurunbami	ASK23	yaka.	Shefu		gaggel	M		1		y	-	1
228 Saige Kurunbami	ASK3	yaka.	Shefu	wigge	haange	F	4	6			1	1
229 Saige Kurunbami	ASK31	yaka.	Shefu		gaggel	M		0.8		y	-	1
230 Saige Kurunbami	ASK4	yaka.	Shefu	gaari		M	3				1	d
231 Tounga	ATa	yaka.	A	nagge	nagge	F	11	14			1	d
232 Tounga	ATa1	yaka.	A	biggel		F	0				d	d
233 Tounga	ATa2	yaka.	A	haange		F	7				d	d
234 Tounga	ATa21	yaka.	A	nyan.	haange	F	2	5			1	1
235 Tounga	ATa211	yaka.	A		biggel	F				y	-	1
236 Tounga	ATa3	yaka.	A	haange	nagge	F	5	8			1	1
237 Tounga	ATa31	sodaye	A	biggel		F	1				d	d
238 Tounga	ATa32	yaka.	A	gaggel		M					-	d
239 Tounga	ATa33	yaka.	A		gaggel	M		0.3		y	-	1
240 Bebowa	ATa4	yaka.	Mam←A	wigge	haange	F	3	5			1	1
241 Bebowa	ATa41	yaka.	Mam←A		gaggel	M		1		y	-	1
242 Tounga	ATa5	yaka.	M←A	gaari	kaladdi	M	2	4	y		1	1
243 Tounga	ATa6	yaka.	A		gaggel	M		1			-	d
244 Tounga	ATb	yaka.	A	wigge	haange	F	4	6			1	1
245 Tounga	ATb1	yaka.	A		biggel	F				y	-	1
246 Tounga	ATc	yaka.	A	nyan.	haange	F	2	4			1	1
247 Tounga	ATc1	yaka.	A		biggel	F				y	-	1
248 Tounga (Donkola)	ATd	yaka.	A	nyan.	wigge	F	2	4			1	1
249 Wage	AWe	beleye	A	nagge		F	15				d	d
250 Wage	AWe1	yaka.	A	daandi		M	10				d	d
251 Wage	AWe2	sodaye	A	wigge	haange	F	8	10			1	1
252 Wage	AWe21	sodari	A		gaggel	M		1.7			-	d
253 Wage	AWe3	yaka.	A	nyan.	wigge	F	6	8			1	1
254 Wage	AWe4	kobari	A	gaari		M	3				d	d
255 Wagummeye	AWu	wagummeye	A	haange	nagge	F	8	10			1	1
256 Wagummeye	AWu1	nyawe	Shefu	wigge	haange	F	4	6			1	1
257 Wagummeye	AWu11	chaigiri	Shefu		gaari	M		2			-	1
258 Wagummeye	AWu2	nyawe	A	nyan.	wigge	F	2	4			1	1
259 Wagummeye	AWu3	yaka.	A		gaggel	M		1		y	-	1
260 Yadde	AYd	galaye	Shefu	haange		F	8				d	d
261 Yadde	AYd1	kobari buldi	Shefu	burtiri	burtiri	M	4	6			1	d
262 Yalleye/Malleye	AY1	bodeye	Shefu	nyan.	wigge	F	2	4			1	1
263 Gari Kabbi	AZKa1	yaka.	A	gaari		M	2.5				d	d
264 Gari Nyawe	AZKa2	nyawe	A	gaari		M	3				d	d
265 Gari Wule	AZKa3	nyawe	A	gaari		M	2				d	d
266 Ijje	NI2	yaka.	M←N	wigge	haange	F	4	6			1	1
267 Ijje	NI21	yaka.	M←N		gaggel	M					-	1

Note: Body color: yaka.=yakanaye or yakanari; Owner: A=Alh. Abdullahi, M=Mahammad, Mam=Mammam, N=Alh. Nuhu; Age/sex: nyan=nyanlohol; Sex: M=male, F=female; Milk: 'y' shows that the individual was suckled; Alive/dead: 1=alive, d=dead, c=exchanged, -=not yet born.

Let's consider the foregoing facts from another viewpoint: The Fulbe's relationship with the Nupe. Fulbes have very broad knowledge and experience of Nupe farming activities and land use and know when and where usahle grazing lands for day-trip herding are available. Regarding the selection of herding range, it is basically important that Fulbe herd on land other than the paddy and upland fields being cultivated by Nupe, i.e., that there are differences in space and time between Fulbe herding and Nupe farming activities. The good combination of differences in space (between the fields plowed by Nupes and Fulbe herding ranges) and in time (between Nupe pre-harvest and harvesting activities and Fulbe pre-cultivation and post-harvest herding) allows Fulbe cattle raising to exist. Figuratively speaking, Fulbe cattle farming and Nupe crop farming will be able to continue (coexist) without unification (intervention) forever like two well-meshing gears. Pastoral Fulbe and agricultural Nupe have realized "land segregation" in the same area.

7-5. Future of pastoral Fulbe coexistence with agricultural Nupe

The foregoing sections have discussed the relations between Fulbes and Nupe laying emphasis on Fulbe's cattle herding activities. They have pointed out, among others, that by doing herding activities carefully, pastoral Fulbe have realized coexistence with agricultural Nupe and that, while many Nupes have a strong antipathy towards Fulbes, some of them have built up friendly relations with Fulbes. Fulbes coexistence with Nupes is dependent on a very delicate balance.

But as their population is increasing, Nupes are enlarging their cultivated area. This means that coexistence with Nupes is becoming more difficult for Fulbe pastoralists. For example, Fulbes check the cultivation condition of Nupe fields before their seasonal migration, and if they consider it hard to secure the route for moving pastoral herds because of too many fields, they study the possibility of changing the settlement site. This is the most important reason why Fulbe make a great change in the location of their settlement.

Recently, Nupes have begun to use river water in the dry season to irrigate their upland fields. As a result, rivers sometimes dry up in their downstream sections in the dry season, a situation that never occurred in the past. This suggests that watering sites for Fulbe cattle herds decrease, making herding activities in this season even harder to perform. In 1993, because of this situation, the Fulbe in Madodo established their settlement for the dry season in a different area.

It was reported that in some areas in northern Nigeria, pastoral Fulbe let their herds feed on Hausa fields and receive money from Hausas in exchange (Hill, 1972 : p.287). There will be the need to devise some measures to improve the relations between Fulbes and Nupes, taking account of such phenomenon and other situations.

At present, Fulbe's pastoral herds are use remnants on paddy and upland fields after harvest (sorghum stems and leaves, rice straw, etc.) and grass in fallow land. Some Nupes who maintain close relations with Fulbes invite the latter to build a settlement in their community and use the site of the settlement as fields after Fulbes leave. However, in the Bida area, no further cooperation exists between the two peoples on the level of subsistence economy. Could a further step forward be taken and a new relation of coexistence – in which, for example, Nupe plant drought-resistant grass for Fulbe pastoral herds in fallow fields and post-harvest paddy fields and the Fulbe use the grass at a certain price during the dry season – be established ? If such a relationship can be formed, it may be possible to build up a friendly and permanent coexisting system of farming and cattle raising by the joint efforts of Fulbe herders and Nupe farmers.

Unless no action is taken, Fulbe relations with Nupes will be broken sooner or later. In such an event, Fulbes movement to another area will settle the matter. Will that be a really good thing to the Nupe ? Or is it possible to take some action to avoid such a situation ? These are grave questions for the future.

Acknowledgement

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Mr. Dikko Isah gave the author permission to conduct studies on Fulbes in

Bida and did everything he could to facilitate the investigations. Mr. Alhaji Abdullahi and his family in the settlement welcomed the author warmly and extended him their generous cooperation in the investigation. In particular, Mr. Mohammad Abdullahi helped the author as an informant and invited him to Fulbe world. Without him, the author could not have completed this report in such a short period of time. Finally, Misako, the author's wife, accompanied him on his tours in Nigeria and supported him in his research activities in a country she visited for the first time.

The author would like to express his sincere gratitude to all of these people for their cooperation and assistance. (Kazuhiro Shikano)

Chapter 6

On-farm Demonstration Studies for the Restoration of Ecological Environment and Rural Life

1. Topography, land use and hydrological characterization of benchmark inland valley watersheds

1-1. Topographical features of inland valleys

The diagrammatic profile of inland valleys and flood plains in West Africa is shown in Chapter 2, Fig. 2-13 (Savvides, 1981). The inland valley of the water source area in the figure is known as headwaters area and midstream is described as stream flow inland valley. The inland valley located between the flood plain and the stream flow inland valley is a river overflow inland valley. Figure 6-1 shows the sketches by Raunet (1985) of the upper-, middle- and lower-basin cross sections of inland valleys shown in Figure 2-13 (quoted by Windmeijer and Andriesse, 1993).

In a stream flow inland valley, the stream in the central part of the valley, if any, is shallow and not more than several meters wide. But as shown in Chapter 2, Fig. 2-31, the width and slope of inland valleys differ according to climatic zone and geological feature. In the basement rock area in the Guinea savanna zone, for example, the valley bottom is about 10 m wide in upper basins and about 100 m wide in lower basins. Topographic formation action in this zone is mainly colluvial. Though not clearly shown in Fig. 6-1, the length of the inland valleys where alluvial action is also observed reaches 25 km or more in

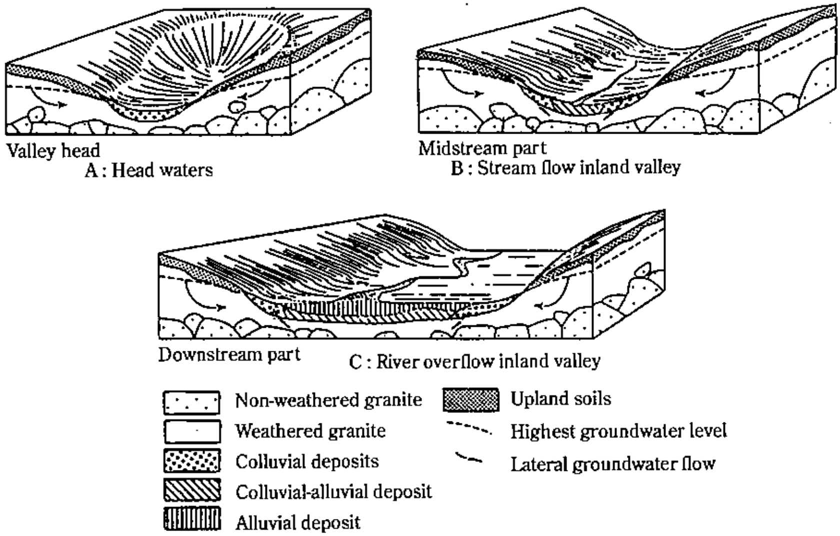


Fig. 6-1 Valley head, midstream part and downstream part of an inland valleys
(after : Raunet, 1985 ; adapted)
Note : See also Fig.2-13 for the diagrammatic location of A, B and C. Compare Fig 2-31 too.

some cases.

River overflow inland valleys appear in the downstream part of inland valleys. The watercourse is wider, larger and more distinct. Alluvial action can be seen more clearly than in stream inland valleys and flood plains begin to be found. In the Guinea savanna zone, the width of the valley bottom usually reaches tens to hundreds of meters.

Fig. 2-31 shows the width and slope of inland valleys in the basement rock area for each climatic zone around B in Fig. 6-1 of Raunet (1985), the area between the stream and river flow inland valleys (Wakatsuki 1994, Raunet 1985). The inland valleys with a very gradual slope and a great width, such as those shown at the top of Fig. 2-31, can be observed in the Sudan/Sahel zone having a mean annual precipitation of 500-1,000 mm or less. Surrounded by gentle slopes with a slope of 3% or less, the valley bottom is as long as hundreds of meters to 1 km and is flat and wide. The relative height between the valley bottom and the top of the slopes is 10 m or less. The total area of these valley bottoms, where sawah fields may be developed, is estimated at 1-3% of the entire Sudan savanna zone. Windmeijer and Andriesse (1993) estimated that the areas where rice fields could be established would be about 6-14% but these figures include the area of the lower parts of upland (fringes). Since sawah fields may be developed mainly in valley bottoms, we estimated such areas to be about one-fifth that of the total area of lowlands.

The inland valleys in the Guinea savanna zone, where the mean annual precipitation is 1,000-2,000 mm, generally have concave slopes with an inclination of 3-8%, and their valley bottoms are tens to hundreds of meters wide. Valley bottoms have an inclination of about 1-2% in the direction of cross section. The slope to the direction parallel to the river flow, however, may be 0.1 to 0.5%. The relative height between valley bottoms and the top of slopes is several tens of meters. The intervals between ridges range from several kilometers to 10 km. Based on the results of on-farm studies on the development of small-scale sawah fields in Sierra Leone, central Nigeria, and Ashanti region of Ghana, the potential area of valley bottoms where irrigated sawah fields can be developed was estimated at about 25% of the entire area of the lowlands. This means about 2-5% of the area of a watershed can be developed to sawah. Topographic character is not a limitation. The major limitation is an available supply of water for irrigation.

The inland valleys in the equatorial forest zone with a mean annual precipitation of 2,000 m or more are somewhat convex and have rather steep (3-25%) surrounding slopes. The width of valley bottoms ranges from several tens to several hundreds of meters. Valley bottoms have an inclination up to about 1-3%. The relative height sometimes reaches 50 m or more. The intervals between ridges are several hundreds of meters to 1 km. While the area of valley bottoms that may be used as sawah fields is 3-10%, the soil is mostly very poor in nutrition. This may become a factor restricting the development of sawah fields.

1-2 Land use and hydrological characteristics of the benchmark inland valleys in the tropical forest zone of Sierra Leone and Guinea Savanna zone of Central Nigeria

The situations of land use in typical inland valleys in the benchmark sites near Makeni in central Sierra Leone, which belongs to the equatorial forest, zone are shown in Fig. 6-2 and Fig. 6-3(1) and (2) (Smaling *et al.* 1985a, b). The similar land uses in the benchmark sites close to Bida in central Nigeria, which is in the Guinea savanna zone are, shown in Fig. 6-4, 5, 6, 7, 8, 9 and 10. Fig. 6-11 show the cropping calendar in bottom areas of inland valley watersheds near Makeni (Hekstra and Andriesse 1983, Gunneweg *et al.* 1986, Smaling *et al.* 1985a,

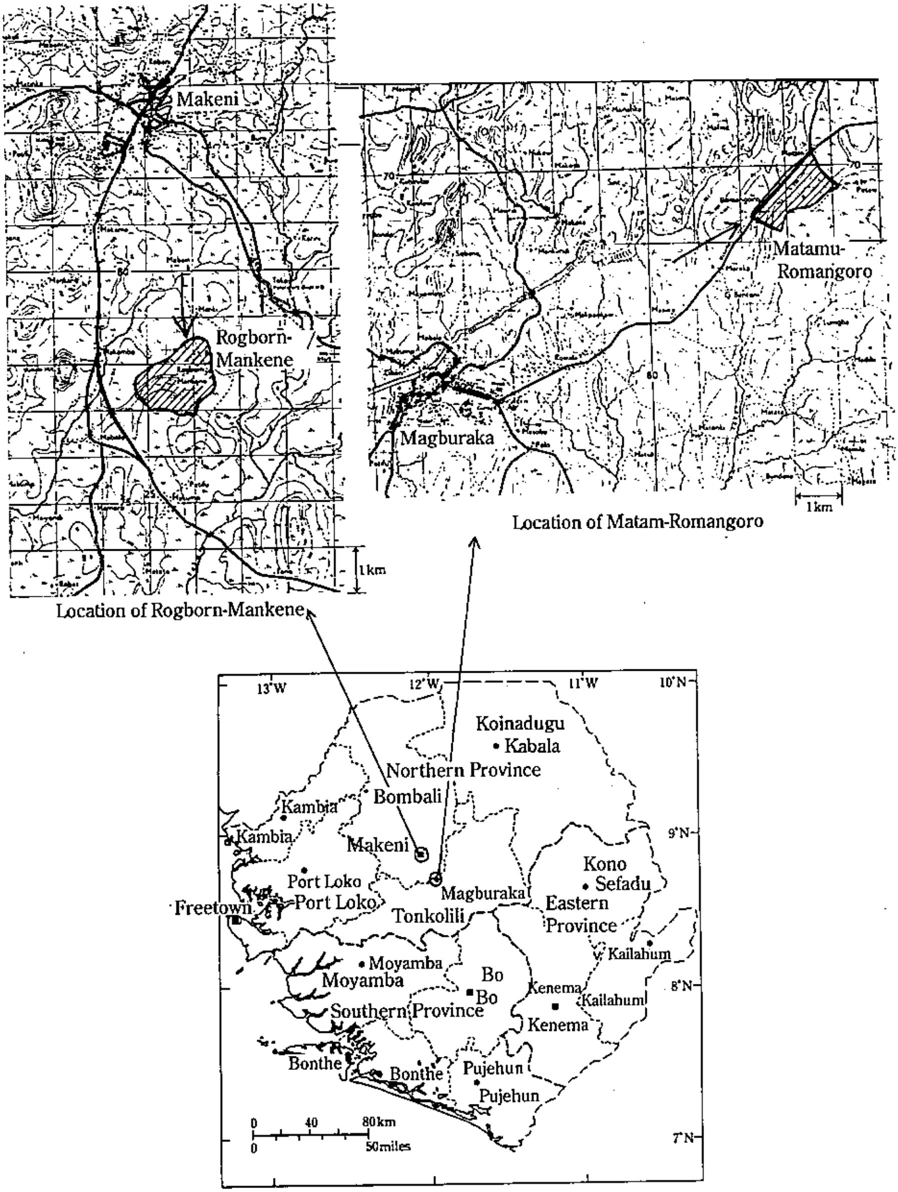


Fig. 6-2 Location of the benchmark sites in Sierra Leone (Smaling *et al.*, 1985a)

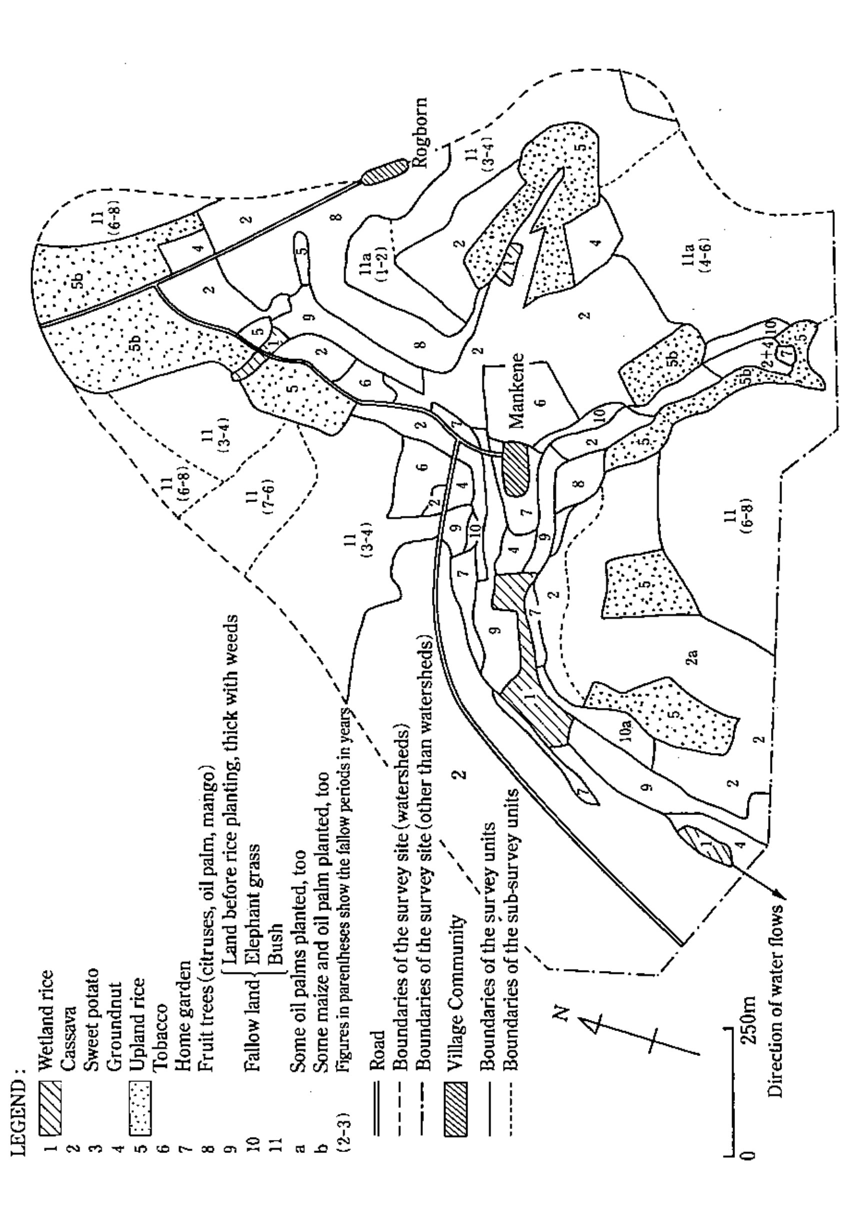


Fig. 6-3(1) Situation of land use in Rogbon and Mankene (Smaling *et al.*, 1985a)

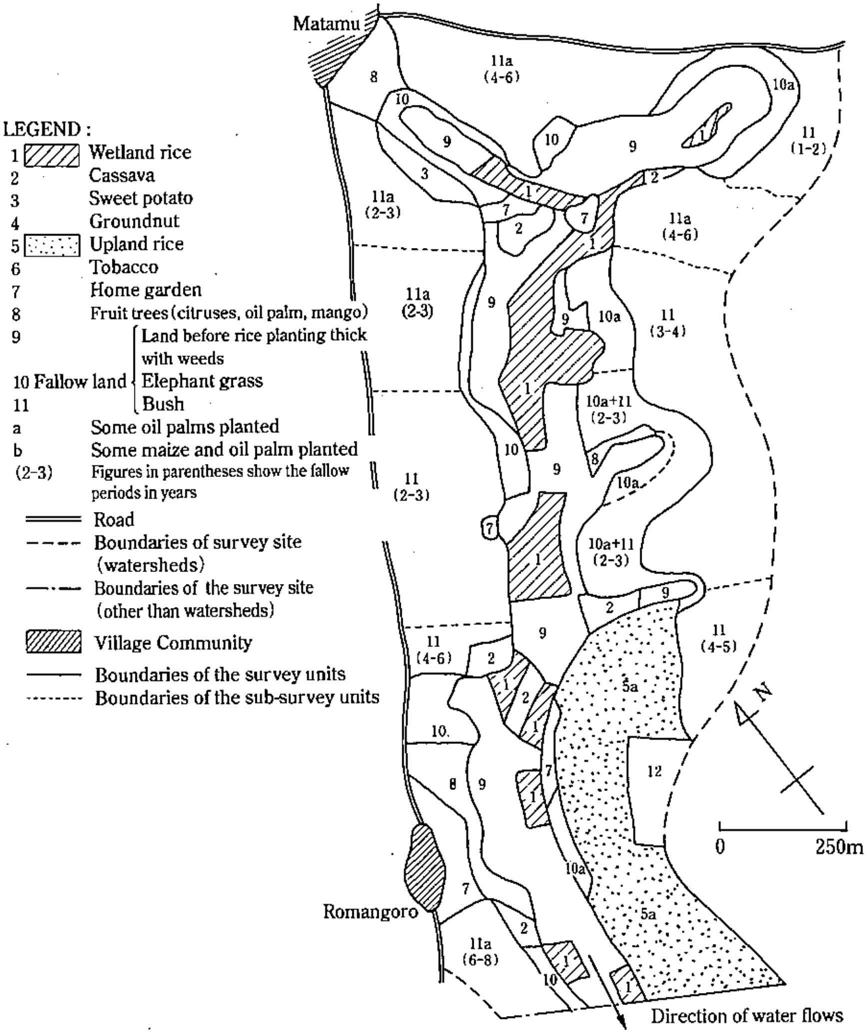


Fig. 6-3(2) Situation of land use in Matam and Romangoro (Smaling *et al.*, 1985a)

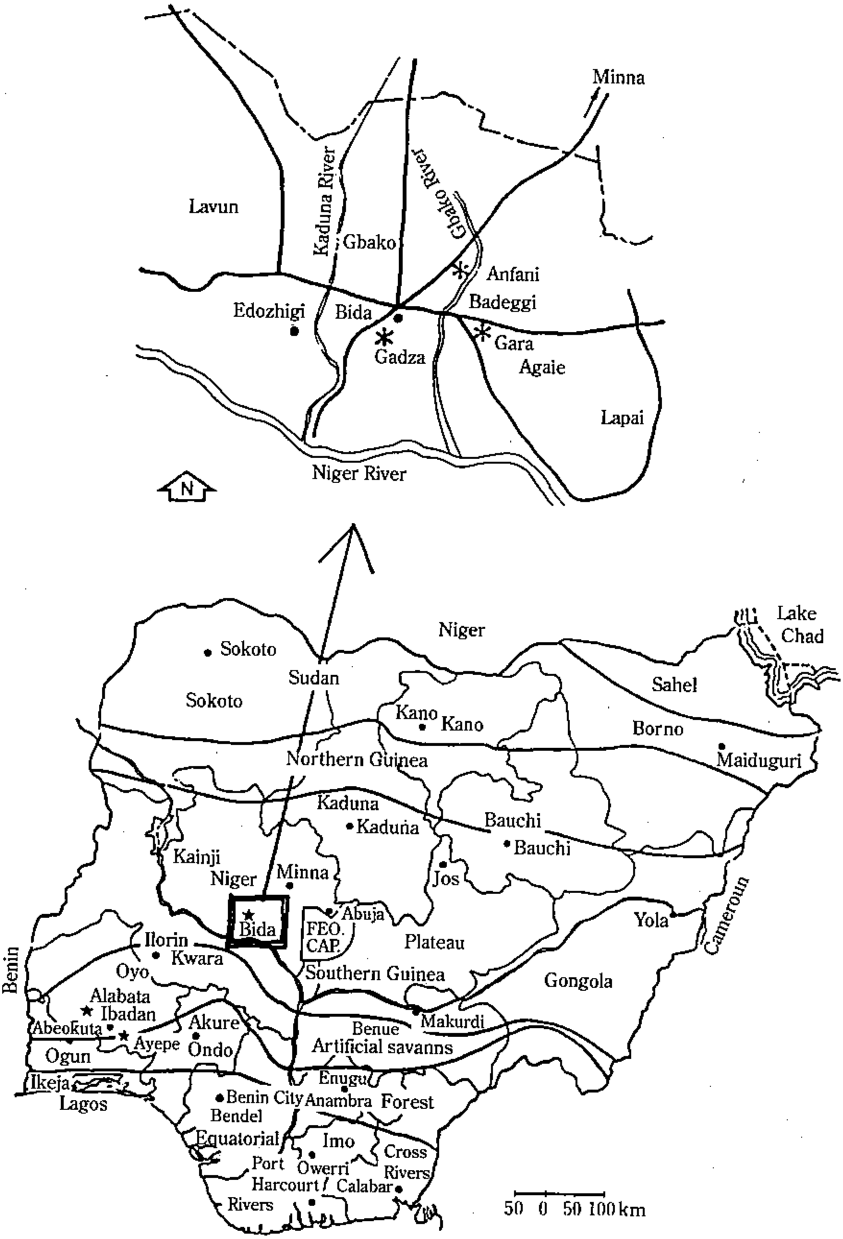


Fig. 6-4 Location of the on-farm studies in Nigeria

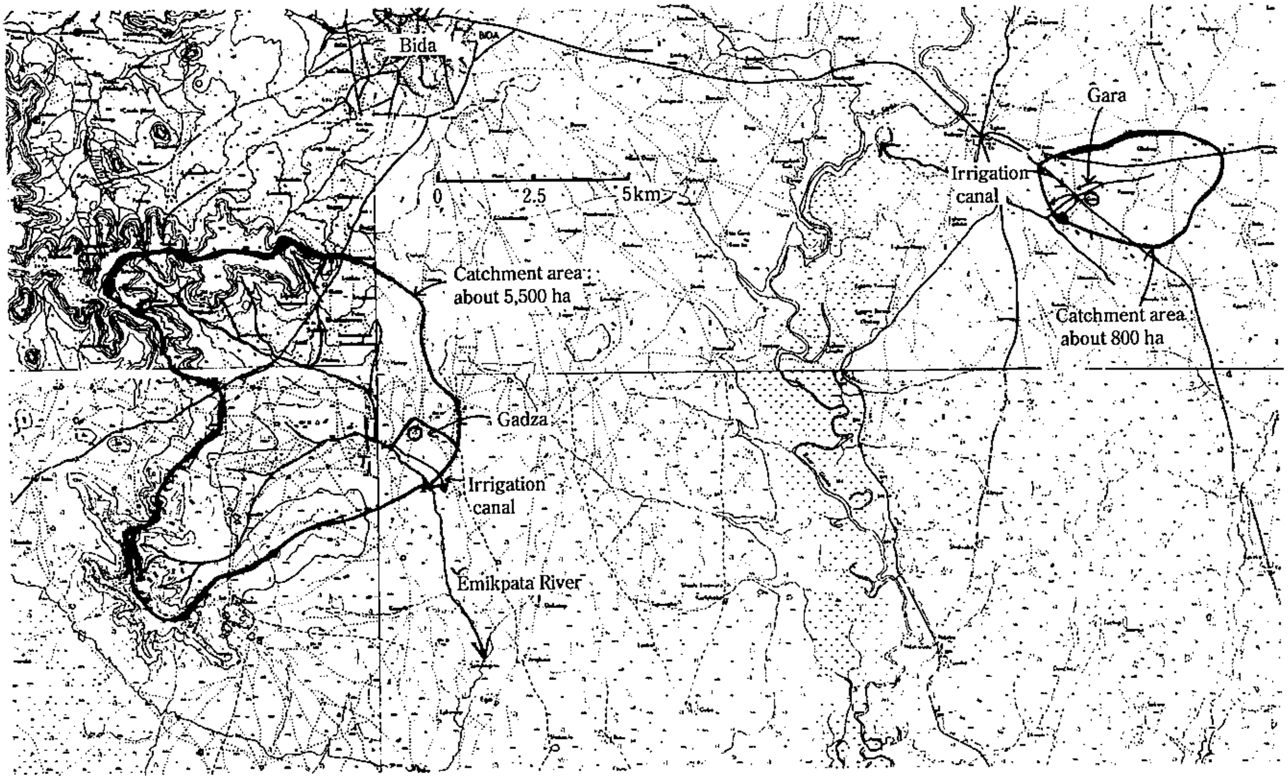


Fig. 6-5 Benchmark sites in the watershed of Gara and Gadza near Bida

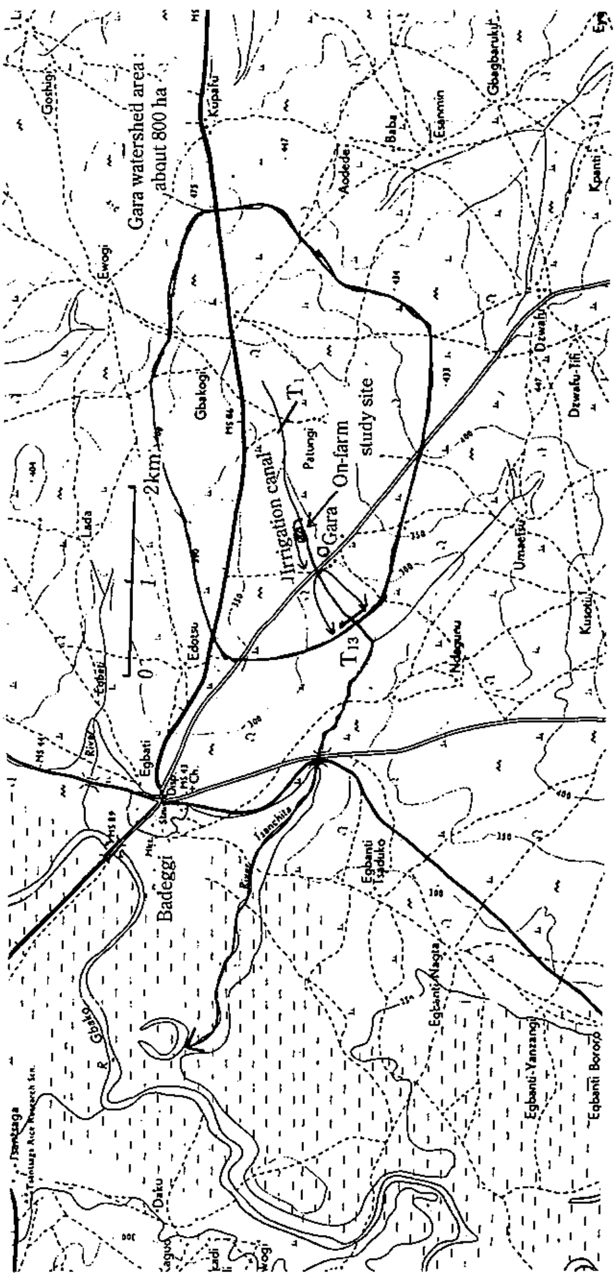


Fig. 6-6 Stream-flow inland valley watershed of Gara for the on-farm study

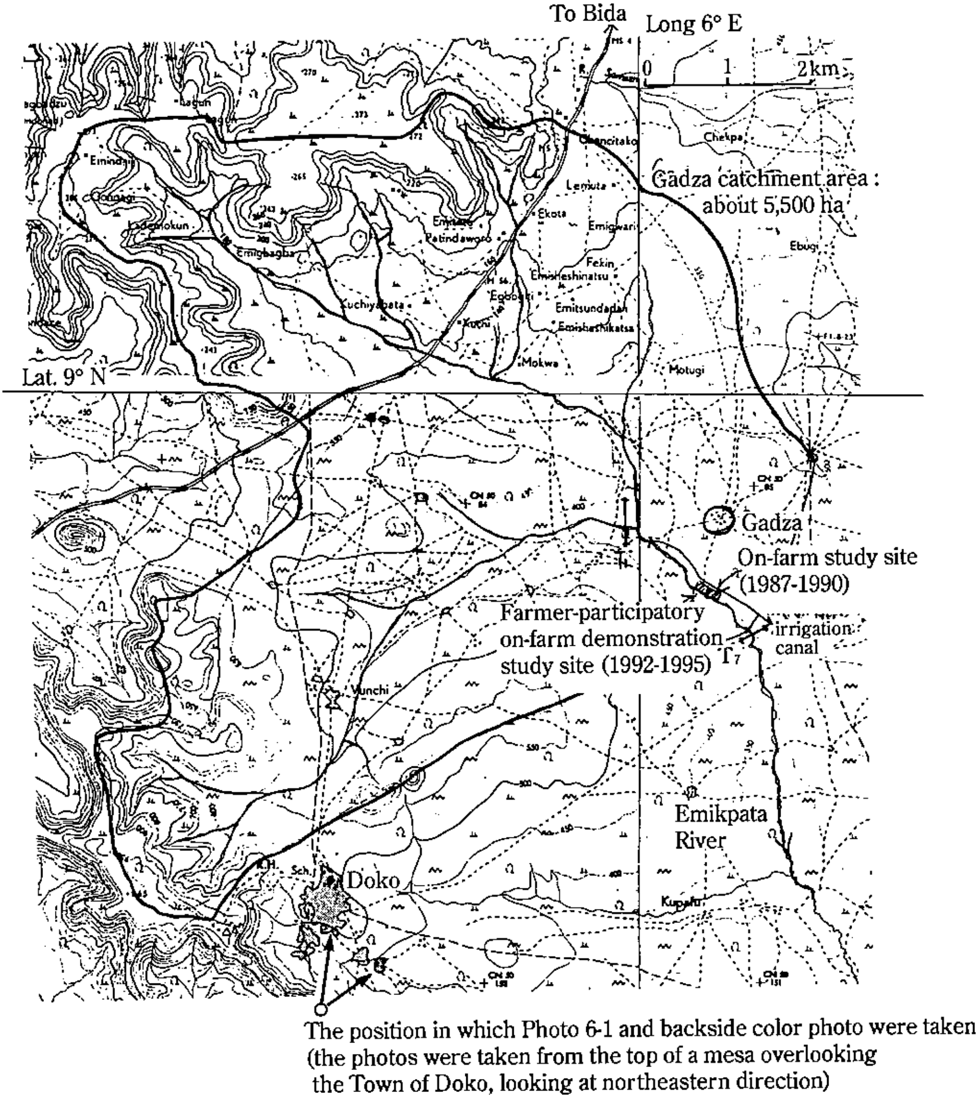


Fig. 6-7 Inland valley watershed (river overflow type) of Gadza for the on-farm study

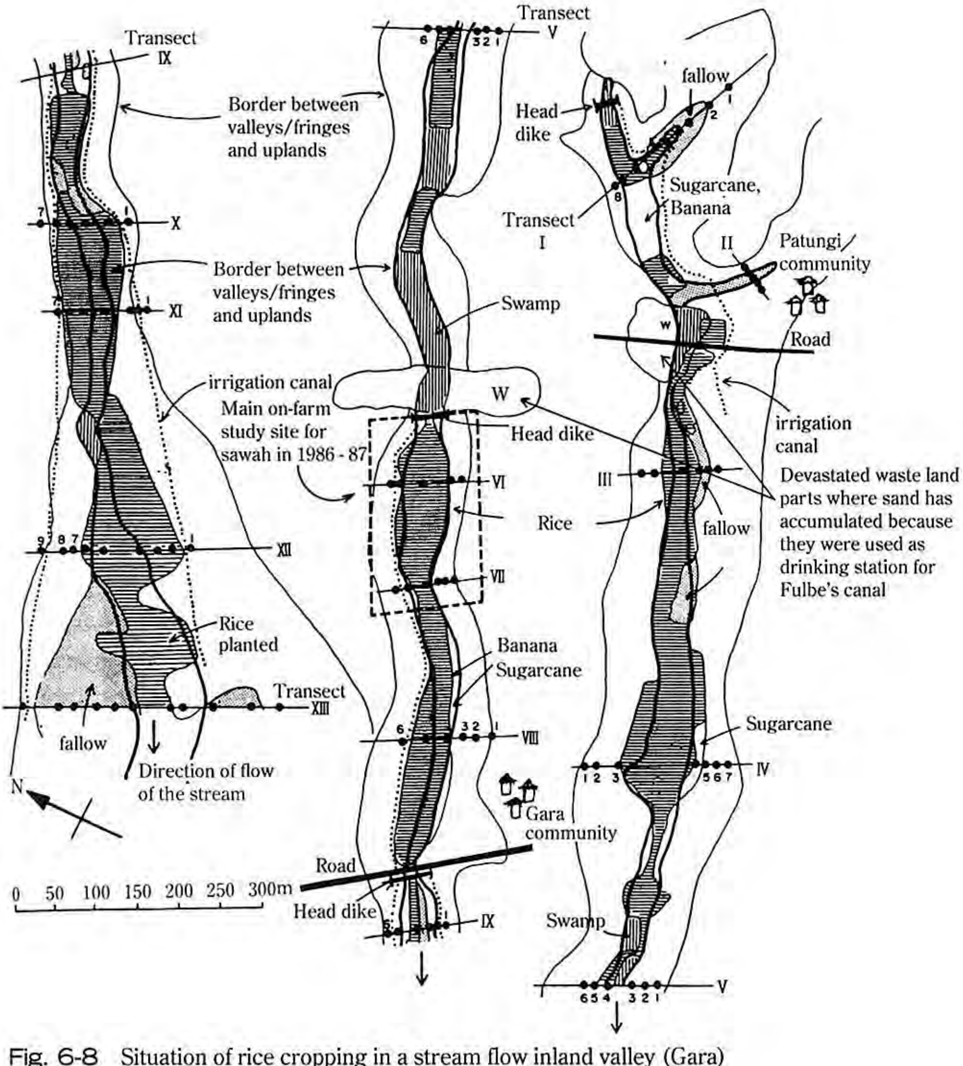


Fig. 6-8 Situation of rice cropping in a stream flow inland valley (Gara)
(groundwater monitoring tubes were installed at Transects I-XIII.)

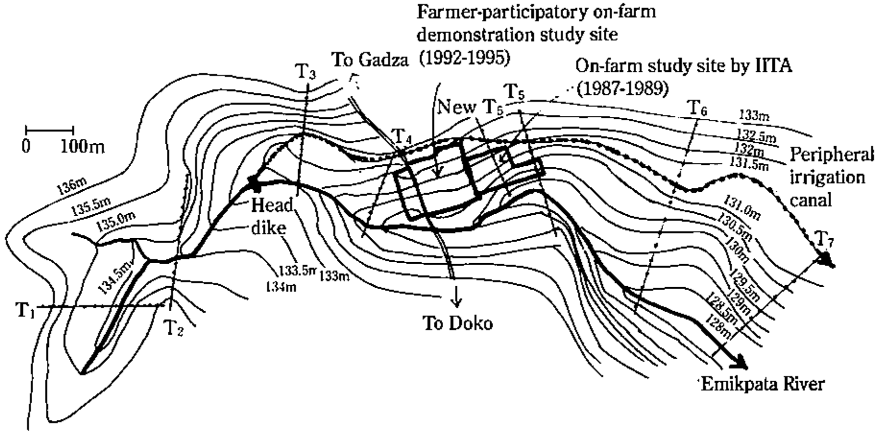


Fig. 6-9 Topographic features of the valley bottoms in a river overflow type inland valley and on-farm study sites in Gadza
(8-18 vinyl chloride ground water tubes were installed at T_1 to T_7.)

Wakatsuki 1995b). Fig. 6-12(1) show the similar the cropping calendars in the Bida area (Palada *et al.*, 1985, Gebremeskel and de Vrie 1985, Gunneweg *et al.* 1986, Shiawoya *et al.* 1986, Smaling *et al.* 1985b, and Wakatsuki 1995). Mean monthly precipitation, evapotranspiration, and mean monthly discharge are also shown in these figures.

Fig. 6-12(2) shows the whole cropping calendar including both valley bottom and upland in the Bida area (Palada *et al.* 1985). In the uplands of small inland watersheds around Bida, sorghum, egusi melon, millet, groundnut, etc. are grown during the rainy season from May to November. Though not shown in the figures, Guinness Beer and other breweries operate large-scale maize farms of several thousands of hectares in the areas near Bida, and even large-scale upland rice is also grown in some parts. Such large scale upland rice cultivation is not sustainable. According to the continuous observations by the author from 1986 to 2001, upland rice was cultivated only in the first two years 1986 and 1987. After that the huge area of land has been made fallow for more than ten years.

In the uplands around Makeni blessed with much rain, as shown in Fig. 6-3(1) (Rogborn-Mankene), upland rice cropping is flourishing. In Matam-Romangoro, the ratio of lowland rice is considerably high. In inland valley watersheds in Sierra Leone, Guinea, Liberia, etc., lowland rice and upland rice are usually grown continuously as Continuum Rice (WARDA, 1988) from uplands to rain fed lowlands. Both of them are mostly planted in the fields with natural ground surfaces that are not leveled and has no bund, i.e., without sawah

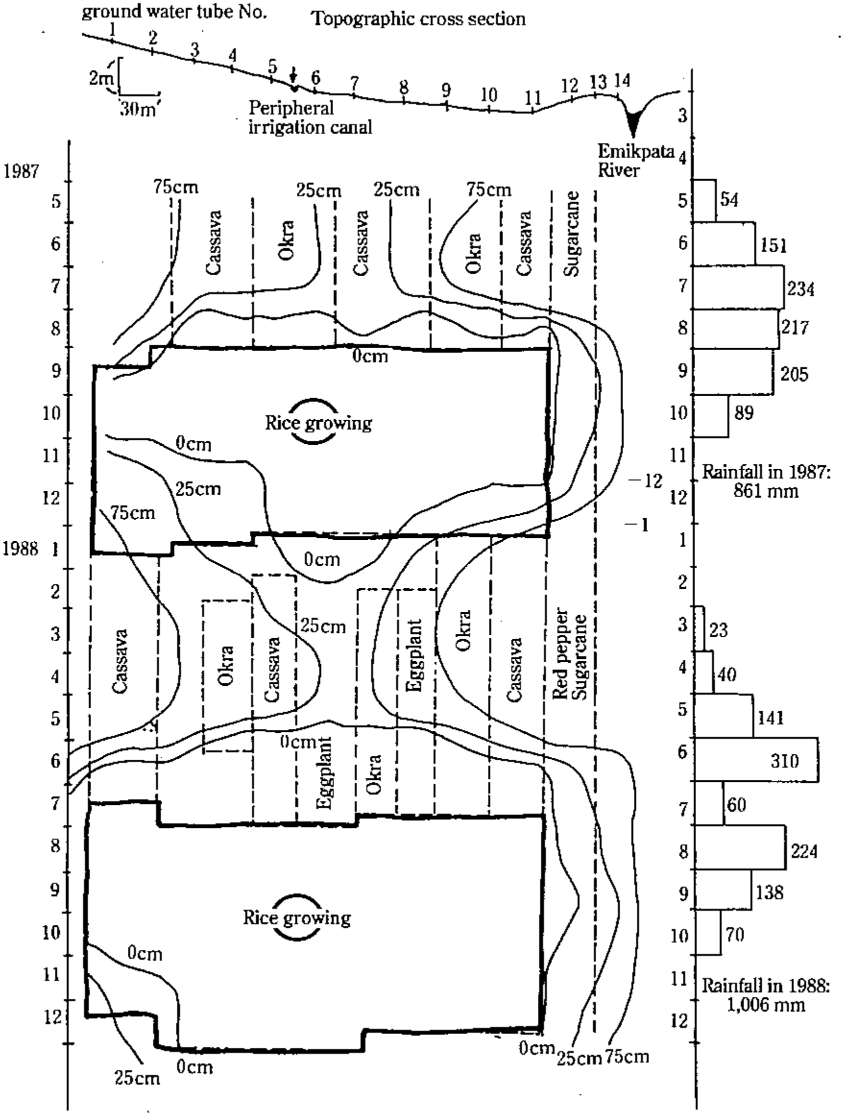


Fig.6-10 Dynamics of rainfalls, groundwater levels and land use in the area near T_6 in the lowland of Gadza that is blessed with water supply. River overflow inland valley (See Fig.6-9)

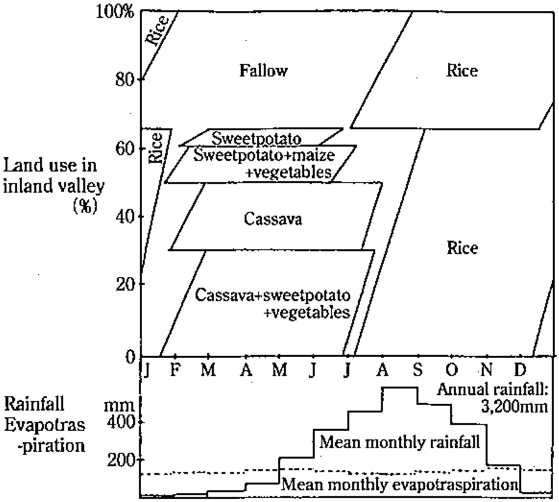


Fig.6-11 Relations of cropping pattern, rainfall and evapotranspiration in an inland valley waershed in Makeni area in central Serra Leone
(Wakatsuki, 1995b; Smaling *et al.*, 1985a; Gunneweg *et al.* (1986); Hekstra and Andriesse, 1983)

systems. Some sawah fields developed by the assistance of Taiwan teams during the 1960s and 1970s and later by the young members of the US Peace Corps in the 1980s are seen in some inland valleys. But almost all of these sawah fields now continue to barely exist with the management and by the efforts of public organizations and their use has spread among local farmers. It is said that some farmers have given up the cultivation of these sawah fields because of the difficulties in maintaining the sawah-based water control systems.

In the uplands in the Makeni area, in addition to upland rice, cassava, groundnut, maize and some other crops are grown from May to November. Using the water remaining in the dry season, sweet potato, cassava, groundnut, etc. are planted on mounds in inland valleys as second-season crops. This cropping pattern, especially in valley bottoms, resembles very much that in the Bida area, even though there is a big difference in annual rainfalls, i.e., 3,500mm in Makeni and 1,200mm in Bida.

The average farmer in the vicinity of Bida grows crops in about 2 ha of upland fields and in about 0.7 ha of inland valleys. Farmers in the Makeni area plant crops in about 1.5 ha of upland fields and in about 0.9 ha of inland valleys. In inland valleys, rice and a variety of second-season crops are grown almost every year without leaving land fallow. Upland fields are let lie fallow for 7-10

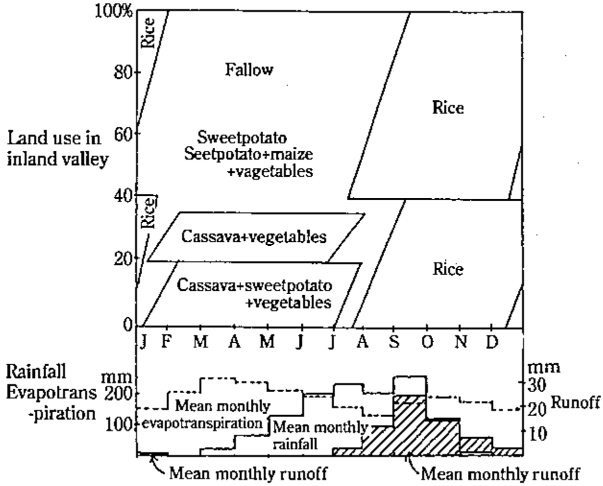


Fig.6-12(1) Relations between cropping pattern, rainfall, evapotranspiration and discharge pattern in an inland valley in Bida area in central Nigeria (Wakatsuki, 1995b; Palada *et al.*, 1985; Gebremeokel and Devries, 1985; Gunneweg *et al.*, 1986; Shiawoya *et al.*, 1986; Smaling *et al.*, 1985b)

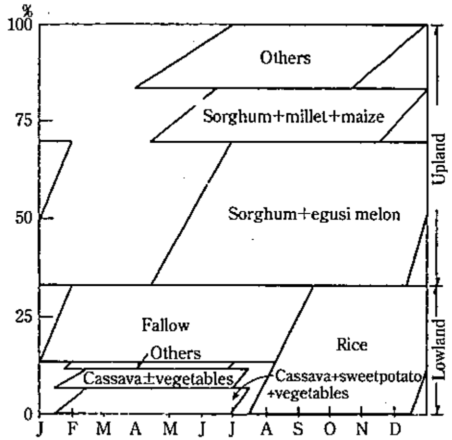


Fig.6-12(2) Cropping calendar in an inland valley watershed including upland in Bida area in central Nigeria (Palada *et al.*, 1985)

years in Bida and for 3-5 years in Makeni. Rice cropping is started in July to August in Makeni and in August to September in Bida when the soils of valley bottoms are saturated and flooding begins. But it is not rare for the start of rice farming to be postponed or moved up one to two months due to changes in the arrival of the rainy season and in the volume of rainfall.

Fig. 6-8 shows part of the results of the survey of land use in the section of about 3 km in a stream flow inland valley in Gara, which is located in a watershed of the upper stream area. This inland valley was selected, together with the Gadza inland valley, as the benchmark sites of IITA's on-farm experiments, and is called Gara inland valley after the name of the village in central Nigeria. Fig. 6-4 and 6-5 show the location of the Bida area, Nigeria, Fig. 6-6, that of the Gara inland valley, and Fig. 6-7, that of the Gadza inland valley. While the Gara inland valley corresponds to a stream flow valley in the diagrammatic figure of inland valleys shown in Fig. 6-1, the Gadza inland valley responds, to a river overflow valley (inland valleys in middle to lower stream having a flood plain-like character).

In the Gara inland valley shown in Fig. 6-8, about 13 transect lines (Transects I-XIII) were set up. Along each transect line which covers uplands, fringes and valley bottoms, plastic tubes about 2.5 inch across and 2 m long with perforations to allow the free inlet of ground water were buried up to a depth of 150 cm. For three years, groundwater levels and flooding levels were measured every two weeks and the land-use situations around each transect line were continuously monitored. In addition, a V-nochi weir was established near Transect XIII and the discharge was measured continuously. Similar observations were also carried out in the Gadza inland valley.

Fig. 6-13 shows the result of the three-year survey (1986-1988) of the dynamics of rainfall, soil water, and land use in the area near Transect Line VIII which is shown in Fig. 6-8 in the Gara inland valley. Since Gara is an inland valley in the upper stream, rice may relatively easily suffer drought damage even in the valley bottom. Water conditions differ according to the location of the inland valley and among the 13 different transect lines shown in Fig. 6-8. The area shown in Fig. 6-13 was one of the areas with an especially worse water supply than other locations of the Gara inland valley. It is of a stream flow type and is frequently damaged by drought.

With a total area of about 800 ha, the catchment area in the Gara inland valley watershed is located in the most upstream section and does not have much water inflow to its valley bottoms. The peak discharges of the valley measured at the time of floods are only about 1 t/sec. The basal discharge during rice growing ranged from several tens to several hundreds of liters per second. Fig. 6-14 shows the dynamics of discharges measured for three years from 1986 to 1988 near Transect Line XIII in the Gara inland valley. The discharge ratio differed from year to year : 13% in 1986, 19% in 1987, and 29%

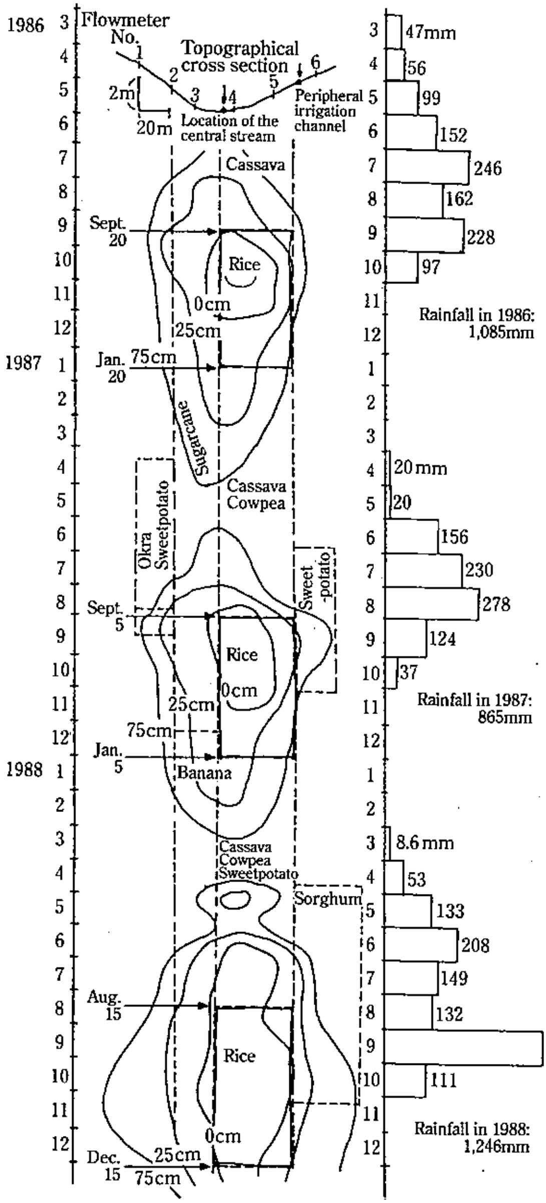


Fig.6-13 Dynamics of rainfall, soil, water and land use at Transect VIII in the Gara Inland Valley. Drought prone stream flow type (See Fig.6-8)

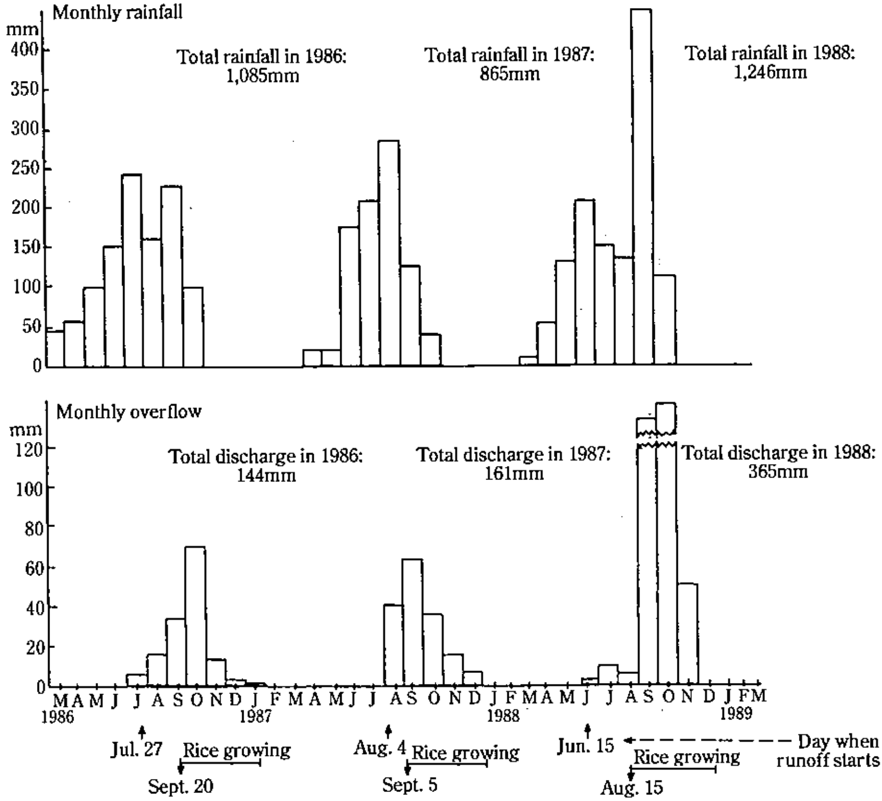


Fig.6-14 Rainfall and discharge patterns in the Gara Inland Valley watershed

in 1988. Roughly 10-30% of rainfall discharged during these three years. However, because of management problem for the monitoring the discharge meter in 1987 and 1988, we used the discharge ratio 13% in 1986 for our study.

The precipitation in 1986 was on an average level but the soil of the valley bottom around Transect Line VIII in the Gara inland valley began to be flooded in mid-September (Fig. 6-13). The rainfall in 1987 was well below the average but flooding started in late August. In 1988 when there was relatively much rain, flooding began in July. Rice growing was started in these months when flooding began. In the survey period of three years, the rice planted in fringes was damaged by drought mainly in the second half of the growth period but that in valley bottoms had roughly sufficient water except in the last part of the growth period. On one side of the stream in the center, sugarcane was grown throughout the year. During the dry season after rice had been harvested, cassava, okra, cowpea and sweet potato were raised on large mounds.

Fig. 6-10 shows the topographical cross section of the left-bank part of the river near Transect VI (T6) in the Gadza inland valley and the dynamics of groundwater levels, land use, and rainfall in the area. The total catchment area of this inland valley is as large as about 5,500 ha and it is the largest inland valleys in this region. The discharge of the river running in its central part reaches a maximum of 10 t/sec in the time of flood, and small natural levees and backswamp-like geographical features can be observed from the cross section. Thus, the area has the characteristics of a flood plain in the middle stream. Even in 1987, the year of drought, most rice fields in this area were kept submerged, with no problem of water shortage, except in the upper fringe. In this area, rice growing is started when the natural flooding of the valley bottom begins but about one to two weeks earlier than in the Gara inland valley shown in Fig. 6-13. The land preparation method for rice cropping in this area differs too. The Gara inland valley had small-lot sawah fields, while the Gadza inland valley had small lot quasi-sawah fields (Wakatsuki, 1990b). The traditional rice growing system of Nupe people, the residents of the Gadza inland valley, has already been described in detail in Chapter 3-2.).

Table 6-1 summarizes the hydrological factors of inland valleys in the Bida

Table6-1 Comparison of hydrological characteristics of inland valleys in the Bida area, central Nigeria, and in the Makeni area, central Sierra Leone (Wakatsuki,1990b)

	Bida area	Makeni area
Range of mean monthly temperatures	26～31°C	26～29°C
Total carchment area	1,000～6,000ha	200～1,000ha
Uplands	950～5,500ha	160～800ha
Fringes	25～150ha	20～100ha
Valley bottoms	25～150ha	20～100ha
Width of valley bottoms	20～300m	20～150m
Slope of valley bottoms	0.3～1%	0.3～0.7%
Mean aunual precipitation	1,200mm	3,200mnl
Range of average runoff ratio	10～15%	20～40%
Volume of runoff	120～180mm (150mm)	640～1,280mm
Total volume of water received by fringes and valley bottoms*	2,400～3,600mm	3,200～6,400mm
Volume of water received by valley bottoms**	4,800～7,200mm (6,000mm)	6,400～12,800mm

Note: *= (Volume of runoff) × (total catchment area) / (total area of fringes and valley bottoms);
**= (Volume of runoff) × (total catchment area) / (area of valley bottoms).
Figures in parentheses are averages.

area, central Nigeria, and in the Makeni area, central Sierra Leone. The density of valleys is higher in the Makeni area that has more rainfall. The ratio of valley bottoms and fringes to the total catchment area is about 5% in Bida (Guinea savanna zone) and about 20% in Makeni (equatorial forest zone). Since the average discharge ratio, which is obtained by deducting evapotranspiration and infiltration into the ground water from rainfall, is estimated at 10-15% in Bida and 20-40% in Makeni, the volume of rainwater that the soils in fringes and valley bottoms can receive reaches to 2,400-3,600 mm in Bida and 3,200-6,400 mm in Makeni. In valley bottoms only, the volume reaches 4,800-7,200 mm a (Bida) and 6,400-12,800 mm (Makeni), which suggests that if an efficient water management system is introduced, it will be possible to secure sufficient water for rice cultivation. This also indicates that unless surface water can be adequately controlled, degradation due to soil erosion will be a serious problem both in valley bottoms and in fringes. The fact that the difference in the water received by valley bottoms is smaller than that in rainfall suggests that the ratio of valley bottoms to the total catchment area and their form are important. Inland valleys capable of rice cultivation exist even in the Sudan and Sahel zones with low rainfall because topographic factors such as those mentioned above work effectively.

1-3 Soil, water and land-use characterization of Dwinyan river watershed, forest transition zone of Ashanti region, Ghana

(1) Introduction

In this site of benchmark watershed the area of forests, including primary and secondary forest, and cocoa plantation, is estimated at only about 30% (Fig. 6-15 and 6-16). Natural vegetation of the project site might be almost 100% forest. The lack of bunding and leveling in the traditional rice cultivation systems accelerates soil erosion, even in the valley bottom. Soil deterioration under present farming systems is clearly seen in comparison with the primary forest as shown in Fig. 1-31. Although the indication of soil degradation is not so clear between the forest and cocoa plantations, both upland mixed farming and lowland rice farming under traditional systems show considerably lower soil fertility than that of primary forests.

The needs to conserve soil fertility and to control weeds and water are major constraints on the utilization of inland valleys for sustainable rice-based cropping (Otoo and Asubonteng, 1995). Research is therefore needed to enhance

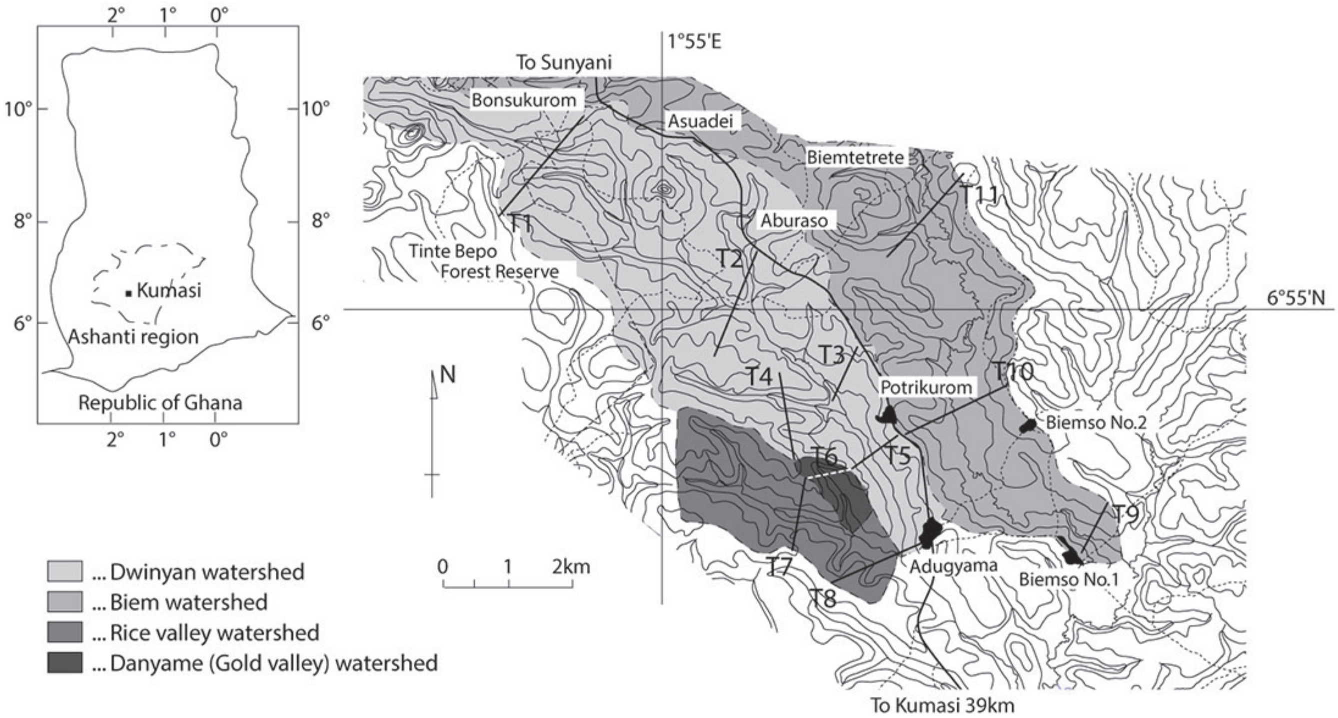


Fig.6-15 Research site showing the locations of transects in the watersheds, Ashanti, Ghana.

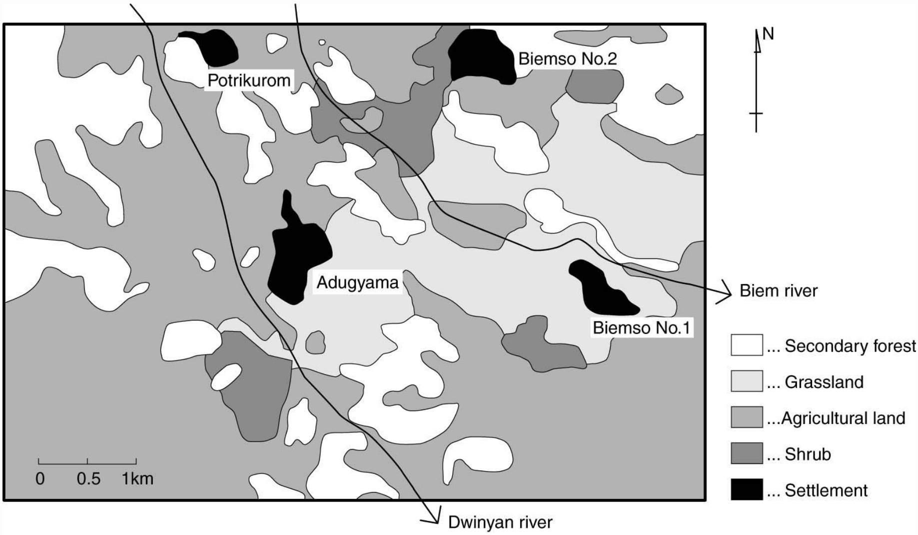


Fig.6-16 Vegetation patterns in the project area, Ashanti, Ghana.

the efficiency of fertilizer use and to promote the development of sustainable and economically viable water control technologies. As practiced in Asian countries, lowland sawah-based rice production is characterized by replenishing mechanisms that intrinsically resist erosion. Geological fertilization due to flooding compensates for the losses of nutrients (Wakatsuki 1994; Kyuma and Wakatsuki 1995; Greenland 1997, Asubonteng *et al* 2001 a).

(2) Study area

Location : The study area, which is part of the Mankran Valley system, is located in the Ahafo-Ano South District of the Ashanti Region. It is in the semi-deciduous forest zone of the country and along the Kumasi Sunyani main road. The coordinates of the study area are 6°55′ N and 1°55′ W (Fig. 6-15). The extent of the key area is approximately 10,000 ha.

Climate : The area falls within a semi-deciduous forest zone with an average temperature of 25.2 °C (23-27 °C in monthly mean). The mean annual precipitation in the three-year period January 1997 to December 1999 was 1363 mm. The area has a bimodal rainfall pattern. The major rainy season lasts from mid-March to the end of July and, after a short dry spell in August, the minor rainy season goes from September to mid-November.

Data collection and analysis : Eleven transects were laid within the study area along the different valley watersheds : the Gold Valley, the Rice Valley, and the

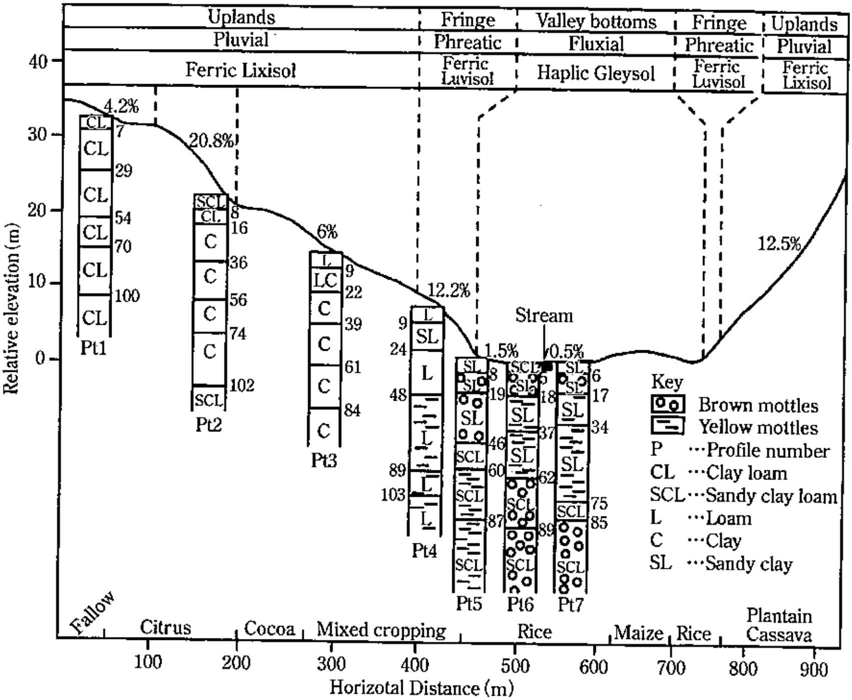


Fig.6-17 A schematic cross-section of the profiles of the major soil series in the Dwinyan watershed, in transect 5, Potrikurom, Ashanti Region, Ghana.

Dwinyama Valley (Fig. 6-15). Seven soil profiles (three in the valley bottoms, one at the fringe, and three on the upland soils) (Fig. 6-17) were selected for profile pits and detailed descriptions of the main soils encountered, according to the FAO Guidelines for soil profile (FAO 1990 a).

Land use : Along the eleven transect lines, land use was described in terms of land cover at a width of 100 m on either side of each transect line every month for a period of three years (1997-1999). Land use maps were drawn for the various inland valleys. Color photo on the cover sheet shows traditional rice cultivation at Rice valley near to Transect 7 in Fig 6-15.

Water table monitoring : Perforated polyvinyl chloride (PVC) pipes were installed for the monitoring of ground water and surface water dynamics along the eleven transect lines for the three-year period. Changes in groundwater depth, land use over time, and a rainfall histogram were plotted on the same graph to show the relationship between groundwater depth, rainfall, and land use within the year. The flood behavior in the valley bottoms and the period of stream flow were also measured.

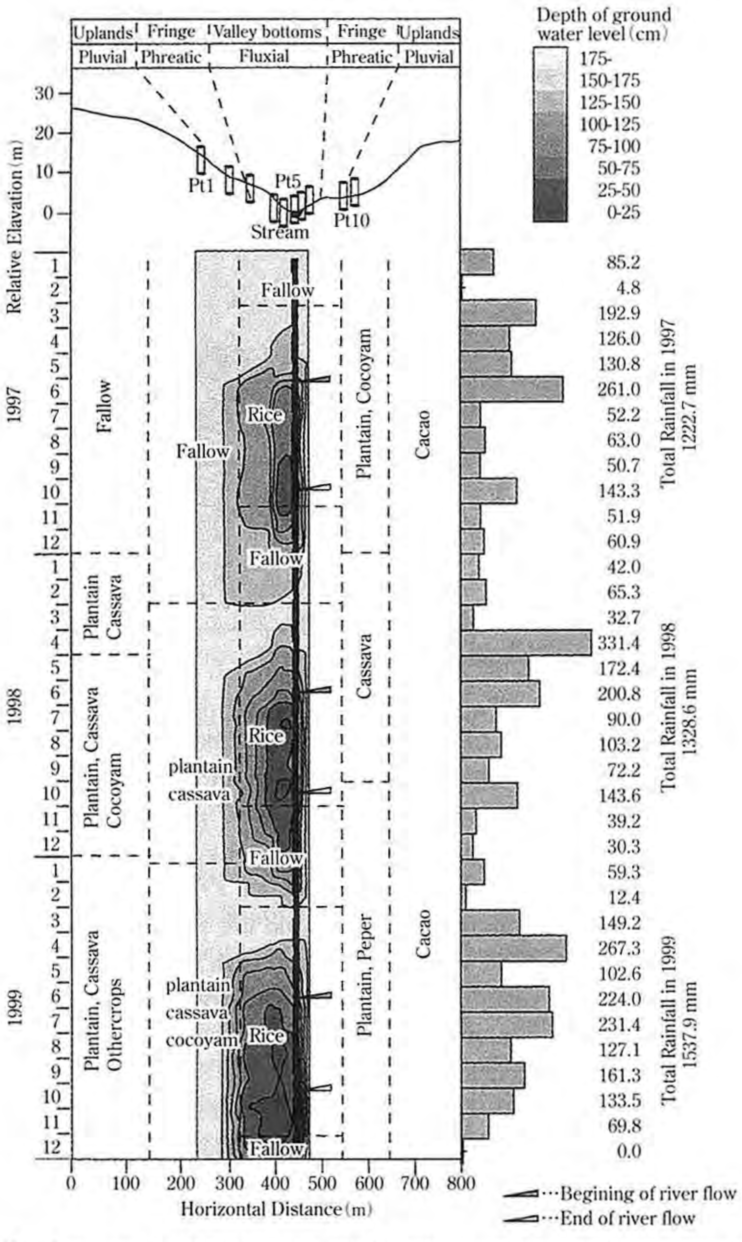
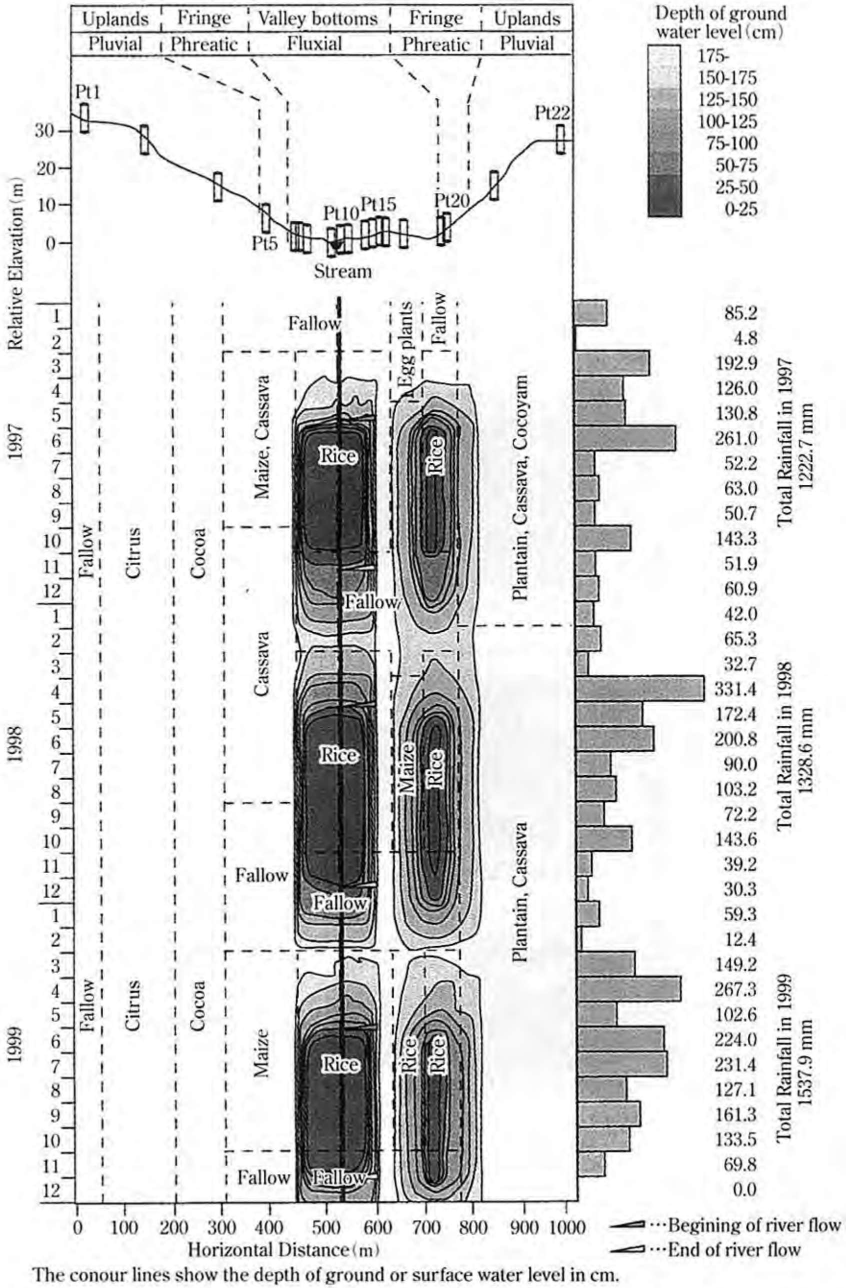


Fig.6-18 Cross-section of topography, rainfall pattern, ground/surface water and land use dynamics in first order valley, stream flow type (Transect 6), Gold Valley watershed, Ashanti Region, Ghana.



The conour lines show the depth of ground or surface water level in cm.

Fig.6-19 Cross-section of topography, rainfall pattern, ground/surface water and land use dynamics in second order, stream flow type inland valley (Transect 5), Dwinyan watershed, Ashanti Region, Ghana.

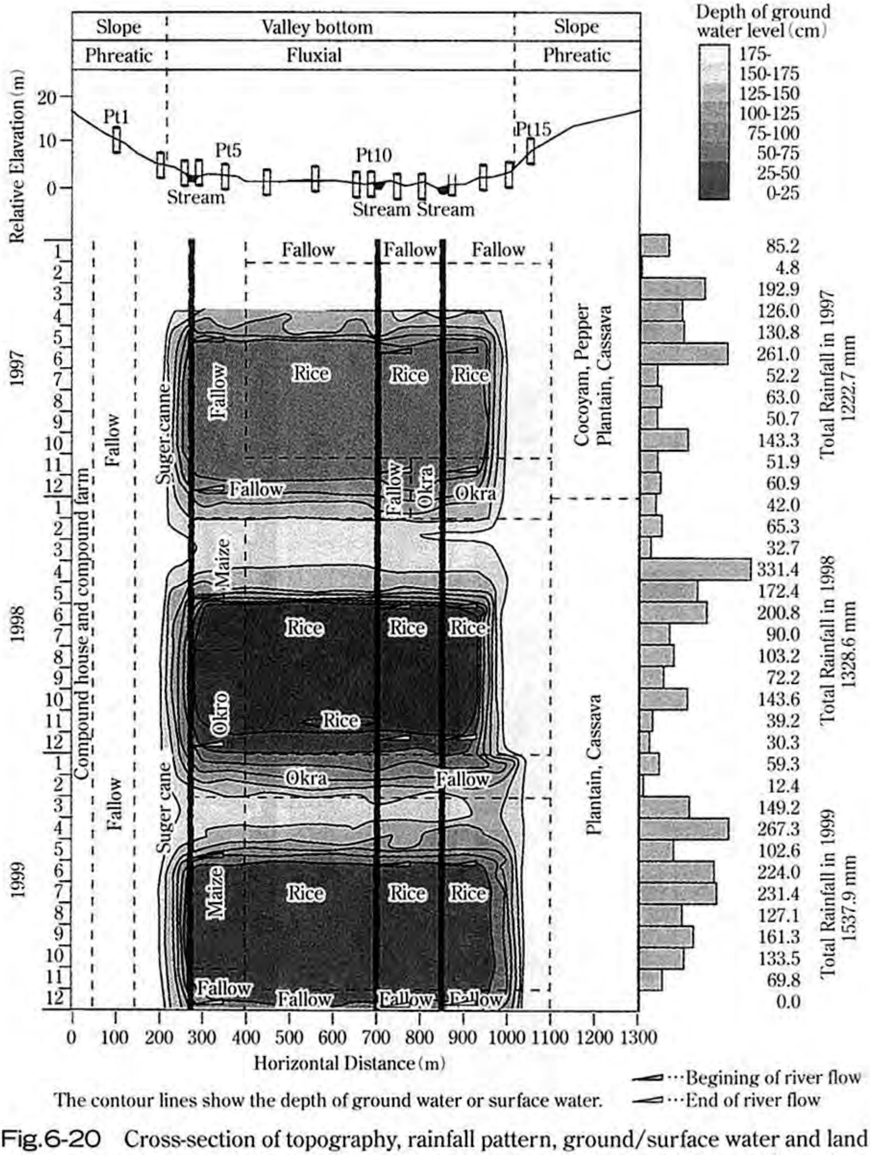


Fig.6-20 Cross-section of topography, rainfall pattern, ground/surface water and land use dynamics in third order Valley, river overflow type (Transect 8), Dwinyam watershed, Ashanti region, Ghana.

(3) Valley Morphology

We defined, tentatively here, that first-order systems are developed in watersheds of less than 500 ha; second-order systems are developed in watersheds of 500-3,000 ha; and third-order systems are developed in watersheds bigger than 3, 000 ha. The first and the second order are equivalent to stream flow type inland valley and the third order valley is equivalent to river overflow inland valley (Fig.2-13). Transects 1, 6, and 7 (Figs. 6-18) are in first-order valley systems. Their valley bottom widths ranged between 10 and 100 m. Transects 3 and 5 (Figs. 6-19) are located in second-order valley systems and have straight slopes. The valley bottoms are almost flat (0-2%), have widths of between 100 and 300 m, and occur normally in the mid-sections of the valley systems. Transect 8 is in a third-order valley system (Fig. 6-20), which occurs in the downstream section of the valley systems. The width of the valley bottom is between 700 and 800 m. Transect 9, 10 and 11 in Biem river are also in a third-order velley system. Valley morphology plays a significant role in land husbandry, especially land leveling and the establishment of measures for water control and management. Hence, valley systems with gentle slopes, concave forms, and fairly broad valley bottoms, such as in Transects 5 and 8 described above, offer great potential for developing sawah.

(4) Soils

Fig. 6-17 shows a schematic description of the profile of the major soil series appearing on the toposequence of Transect 5. Tables 6-2 and 6-3 show some of the physico-chemical parameters analyzed and used in the classification of the soils encountered. Soils of the summit, with a relatively gentle slope, belonged to the Akumadan series, Pt1, which had a strong red colour, 2.5 YR, of the B horizons (Table 6-2). The Bekwai soil series, Pt2, and the Nzima series, Pt3, appeared in the next-lower topographic position. The yellow colour of their B horizons was increased, i.e., 5 YR for the Bekwai series and 7.5-10 YR for the Nzima series. These upland soils (Pt1 to Pt3) were classified as Ferric Lixisol, showing low-activity clay with discrete iron nodules (*ISSS 1994*). They are well drained on the summits and upper slopes, and become moderately well drained on the middle slopes. From the particle-size analysis, the clay contents of the soils of Pt1 and Pt2 under citrus or cocoa tree forest increased down the profile to values ranging between 28 and 58%. The effective cation exchange capacity (ECEC) of clay of subsoil layers ranged from 6 to 23 cmol (+) kg^{-1}. Textures varied from loam (L) at the top through clay loam (CL) to clay (C) within the

Table6-2 Physical and morphological properties of the soils.

Profile No. & Soil type	Depth (cm)	Horizon	Boun-dary	Sand (%)	Silt (%)	Clay (%)	Textural Class	Matrix colours	Mottles	Structure
Ptl	0-7	Ap	as	34.5	37.0	28.0	cl	5YR4/4		m^2gr
Akumadan	7-29	B21tc	ca	30.2	30.2	39.6	cl	7.5YR6/8		m^1sbk
series	29-54	B22tc	cs	24.3	27.2	48.5	cl	5YR5/8		m^2sbk
Ferric	54-70	B23	as	30.2	36.0	33.8	cl	2.5YR5/8		m^2sbk
Lixisol	70-100	B24	as	30.2	38.3	31.5	cl	2.5YR5/8		f^1sbk
	100-160	B25		40.8	33.2	26.0	cl	2.5YR5/8		f^1sbk
Pt2	0-8	Ap	as	43.3	28.9	27.8	scl	5YR5/4		m^1gr
Bekwai	8-36	BA	as	39.6	17.7	32.7	cl	7.5YR6/6		m^2gr
series	36-56	Btcsl	as	27.5	14.7	57.8	c	5YR6/8		m^2sbk
Ferric	56-74	Btcs2	as	24.3	19.5	56.2	c	5YR6/8		m^2sbk
Lixisol	74-102	Btcs3	as	16.5	33.0	50.5	c	5YR6/8		m^2sbk
	102-153	Bcl	as	12.2	40.0	47.8	scl	5YR6/8		m^2sbk
Pt3	0-9	Ap	cs	49.2	37.8	13.0	1	10YR5/3		m^1gr
Nzima	9-22	Bts	cs	35.8	31.5	32.7	Ic	10YR6/4		m^2gr
series	22-39	Btsl	gir	25.1	27.9	47.0	c	10YR7/6	Rusty	m^2sbk
Ferric	39-61	Bts2	cs	23.5	29.5	47.0	c	10YR7/4		f^1gr
Lixisol	61-84	Btsgl	cs	26.0	25.4	46.6	c	7.5YR7/6		m^2sbk
	84-120	Btsg2		28.1	25.9	46.6	c	7.5YR6/8	m^2sbk	
Pt4	0-9	Ap	cs	37.0	42.0	21.0	1	10YR5/3		m^1gr
Kokofu	9-24	AB	cs	44.5	41.5	14.0	1	10YR6/2		f^1gr
series	24-48	Btsgl	cs	49.5	41.0	10.5	1	2.5Y7/6	Rusty	m^2sbk
Ferric	48-89	Btsg2	as	41.0	34.5	24.5	1	2.5Y7/8		m^2sbk
Luvisol	89-103	Btsg3	gir	36.5	39.0	24.5	1	2.5Y7/8		m^2sbk
	103-134	Cgl		44.5	32.0	23.5	1	10YR7/8		m^2sbk
Pt5	0-8	Apg	cs	60.0	29.0	11.0	sl	10YR4/2	Rusty	m^2sbk
Oda series	8-19	Bacg	cs	62.5	29.0	10.5	sl	10YR3/2	Rusty	m^2gr
Haplic	19-46	BCgl	cs	54.5	38.0	7.5	sl	10YR6/2	Yellow	m^2cr
Gleysol	46-60	BCg2	cs	53.5	25.0	21.5	scl	10YR6/1	Yellow	m^2cr
	60-87	Cgl	cs	64.5	21.5	14.0	scl	10YR6/1	Yellow rusty	f^1gr
	87-137	Cg2	c	56.0	14.0	30.0	scl	10YR7/1	m^2gr	
Pt6	0-5	Apg	cs	57.0	31.5	13.5	sl	10YR3/1	Rusty	f^1sbk
Oda series	5-18	Bacg	cs	58.5	29.0	12.0	cl	10YR3/2	Yellow	m^2gr
Hplic	18-37	Bcgl	cs	67.4	21.6	11.0	sl	10YR6/2	Yellow	m^2cr
Gleysol	37-62	Bcg2	cs	53.4	25.1	21.5	scl	10YR6/1	Rusty	f^1gr
	62-89	Cgl	cs	55.0	15.0	30.0	scl	10YR6/2	Rusty	m^2cr
	89-120	Cg2	cs	54.0	16.0	30.0	scl	10YR7/1		f^1gr
Pt7	0-6	Apg	cs	62.0	26.5	11.5	sl	10YR4/2	Rusty	m^2sbk
Oda series	6-17	Bacg	cw	58.1	30.0	11.1	sl	10YR3/2	Yellow	m^2gr
Hplic	17-34	Bcg	cs	65.3	23.7	11.0	sl	10YR6/2	Yellow	m^2cr
Gleysol	34-75	Bcg2	cs	55.4	24.1	19.5	scl	10YR6/1	Rusty	f^1gr
	75-89	Cgl	cs	56.0	14.0	30.0	scl	10YR6/2	Rusty	m^2cr
	89-140	Cg2	cs	53.0	16.0	31.0	scl	10YR7/1		f^1gr

Note: As. abrupt smooth; cw. clear wavy; cs clear smooth; gs. gradual smooth; gir, gradual irregular; sl, sandy loam: ls. loamy sand: s. sand; c. clay; scl. sandy clay loam; f. fine; m. medium; 1. weak; 2. moderate. sbk. subangular blocky; cr. crumbly; gr granular.

Table6-3 Chemical characteristics of the soils (nutrient levels).

Profile No. & Soil Type	Horizon (cm)	pH H_2O	Org.C (%)	T-N (%)	O.M. (%)	C/N	Exchanageble cations Ca (cmol (+) kg)	Mg	K	Na	TEB	Ex. Acid Al+H	ECEC	Base Sat. (%)	Avail. P (mg/kg)	ECEC/clay cmol(+) (kg^{-1}clay)
Pt1	0-7	5.7	3.5	0.31	6.0	11.2	10.0	3.2	0.31	0.1	13.6	0.6	14.2	95.8	6.32	-
	7-29	4.9	1.3	0.13	2.2	9.7	4.0	1.4	0.09	0.1	5.6	1.1	6.7	83.5	7.08	-
Ferric	29-54	4.8	0.7	0.09	1.2	7.4	2.6	1.0	0.06	0.1	3.8	1.5	5.3	71.4	3.52	10.8
Lixisol	54-70	4.7	1.0	0.11	1.8	9.4	2.8	1.9	0.35	0.1	5.1	0.5	5.6	91.1	1.44	16.7
	70-100	4.6	1.3	0.13	2.2	9.8	3.6	2.4	0.46	0.1	6.5	0.8	7.3	89.1	1.00	23.2
	100-160	4.3	0.5	0.07	0.8	6.6	1.8	1.4	0.19	0.1	3.4	1.2	5.2	69.6	1.00	20.1
Pt2	0-8	5.2	3.4	0.47	5.9	7.3	5.4	2.5	0.54	0.8	10.3	0.8	11.1	92.8	4.80	-
	8-36	4.3	0.8	0.09	1.4	8.7	3.0	1.4	0.09	0.2	4.6	0.5	5.1	90.1	8.00	-
Ferric	36-56	5.5	0.5	0.05	0.8	9.4	1.6	1.1	0.04	0.0	2.8	0.5	3.3	84.6	1.86	5.6
Lixisol	56-74	5.7	0.5	0.08	0.6	6.4	4.7	1.7	0.20	0.3	6.9	0.6	7.5	92.0	0.67	13.4
	74-102	5.8	0.5	0.05	0.8	9.2	1.9	2.1	0.04	0.0	4.1	1.8	5.9	69.3	0.50	11.6
	102-153	4.7	0.4	0.06	0.7	7.2	2.5	2.1	0.07	0.1	4.8	1.9	6.7	71.6	0.00	14.0
Pt3	0-9	5.1	2.9	0.33	4.9	8.6	14.8	3.7	0.21	0.2	18.9	0.6	19.5	96.9	5.00	-
	9-22	4.9	1.2	0.2	2.1	6.2	10.1	1.1	0.16	0.2	11.5	0.5	12.0	95.8	7.12	-
Ferric	22-39	4.8	0.4	0.03	0.6	12.0	3.1	0.3	0.02	0.1	3.6	0.4	4.0	89.9	2.10	8.4
Lixisol	39-61	4.2	0.3	0.05	0.6	6.8	4.3	1.0	0.06	0.1	5.4	0.4	5.8	93.1	1.00	12.4
	61-84	4.2	0.4	0.04	0.6	9.3	3.9	1.5	0.03	0.1	5.5	0.5	6.0	91.7	0.96	12.9
	84-120	5.1	0.4	0.04	0.6	8.8	4.6	2.7	0.50	0.1	6.9	0.6	7.5	92.0	0.21	16.1
Pt4	0-9	5.9	2.4	0.31	4.1	7.6	14.8	4.5	0.55	0.2	20.0	0.5	20.5	97.6	6.68	-
	9-24	5.9	1.2	0.16	2.0	7.4	5.9	2.1	0.26	0.1	8.2	1.0	9.2	89.2	5.02	-
Ferric	24-48	5.1	1.0	0.84	1.7	1.2	2.7	1.3	0.02	0.2	4.2	1.0	5.2	80.7	4.04	49.3
Luvisol	48-89	4.3	0.3	0.05	0.5	5.8	3.8	1.2	0.03	0.2	5.9	1.4	7.3	81.5	3.08	29.7
	89-103	4.3	0.2	0.04	0.4	5.0	5.2	1.9	0.07	0.4	7.6	1.9	9.4	80.6	2.11	38.4
	103-134	4.7	0.2	0.02	0.3	8.0	2.3	1.8	0.02	0.6	4.7	2.0	6.7	70.3	2.00	28.6
Pt5	0-8	5.7	2.5	0.38	4.3	6.6	21.2	2.8	0.61	0.2	24.8	0.1	24.9	99.6	8.01	-
	8-19	5.2	1.2	0.13	2.0	8.8	12.8	4.0	0.22	0.3	17.3	0.1	17.4	99.4	9.01	-
Haplic	19-46	4.7	0.4	0.07	0.6	5.1	12.0	1.6	0.16	0.3	14.1	0.2	14.3	98.6	4.04	190.5
Gleysol	46-60	4.6	0.0	0.07	1.8	0.4	12.0	3.2	0.22	0.5	16.0	0.2	16.3	98.2	3.08	75.6
	60-87	4.6	0.1	0.04	0.2	2.5	13.6	4.4	0.26	0.7	19.0	0.6	19.6	96.9	2.11	139.8
	87-137	4.5	0.1	0.14	0.1	0.4	14.8	4.0	0.35	1.0	20.1	0.2	20.3	99.0	2.00	67.8
Pt6	0-5	5.4	1.5	0.13	2.6	11.6	11.9	1.5	0.13	0.1	13.6	0.1	13.6	99.6	10.11	-
	5-18	5.4	0.2	0.03	0.4	7.7	6.9	1.9	0.03	0.1	8.9	0.5	9.4	94.7	9.02	77.9
Haplic	18-37	4.6	0.2	0.05	0.2	3.6	5.5	1.4	0.06	0.1	7.0	0.5	7.5	93.3	5.04	67.9
Gleysol	37-62	5.7	0.5	0.02	0.8	23.0	4.5	2.2	0.06	0.1	6.9	0.5	7.4	93.2	5.01	34.4
	62-89	5.2	0.1	0.02	0.2	7.0	3.5	3.4	0.06	0.1	7.0	1.2	8.2	85.3	3.02	27.2
	89-120	5.2	0.1	0.01	0.2	10.0	2.5	3.0	0.05	0.1	5.6	1.2	6.8	82.3	4.01	22.7
Pt7	0-6	5.3	2.9	0.21	5.0	13.8	12.6	3.5	0.29	0.5	16.8	0.9	17.6	95.2	9.70	-
	6-17	4.7	0.5	0.15	1.0	3.4	7.4	1.5	0.20	0.4	9.4	0.9	10.3	91.6	8.40	-
Haplic	17-34	4.6	0.3	0.08	0.6	4.0	4.7	1.2	0.14	0.4	6.5	1.2	7.7	84.3	6.04	69.5
Gleysol	34-75	4.6	0.2	0.07	0.4	2.9	7.7	1.7	0.29	0.2	9.9	2.7	12.6	78.5	4.01	61.6
	75-89	4.5	0.1	0.07	0.2	1.6	5.6	0.9	0.55	0.1	7.0	3.6	10.6	66.5	3.20	35.3
	89-140	4.2	0.1	0.06	0.2	1.7	5.4	0.8	0.55	0.1	6.8	3.0	9.8	69.5	4.00	31.7

subsoil. The topsoil of Pt3, of the Nzima series, however, showed only 13% of clay under maize, cassava, cocoyam, and plantain mixed cropping. This may mean that once forest cover is removed, upland topsoils are susceptible to erosion.

Table 6-3 shows that the upland soils had reactions varying from slightly acidic (pH 5.4-5.9) in the topsoil to strongly acidic (pH 4.0-4.3) in the subsoils. ECEC values were between 6 and 20 cmol (+) kg^{-1} in the top 30 cm. However, ECEC decreases within the profile, showing the importance of organic matter. The organic matter content was high only on the topsoil (2-6%) but decreased sharply in the subsoil, to 0.06%. The C/N ratio was below 10 and the nitrogen content was higher in the topsoil but decreased in the subsoils (0.84-0.02%) in all the horizons. The topsoils showed low to moderate values of available phosphorus (Bray No 1). The topsoil values were much higher than the subsoil values, showing the effect of mineral cycling from the citrus and cacao trees. The fringe soil, Pit No. 4, shows higher clay activity, in the range of 29-49 cmol (+) kg^{-1} of clay. The soil was classified as Luvisol (ISSS 1994).

The colours of the B horizons were dominated by red in upland (Pt1, Pt2), yellow in fringe (Pt3, Pt4) and grey in valley (Pt5, 6, 7) (Table 6-2). Although some morphologies, such as mottle characteristics, were similar to those of the upland soils, soil texture and general fertility characteristics, including available phosphorus, were more similar to the valley bottom soils (Table 6-3). The soils of the valley bottoms Pt5-Pt7 were slightly acidic in the topsoil (pH 5.2-5.9) but more acidic in the subsoils (4.2-4.5). The valley bottom soils are better supplied than the upland with exchangeable cations, especially the more mobile cations Ca and Mg. The soils have light to medium textures. The higher level of exchangeable cations may be attributed to the frequent supply of basic cations from runoff and floodwater, and through ground water. The moderate to high levels of organic matter associated with the soils' hydromorphism may partly contribute. Activities of clay, which in Table 6-3 are calculated as ECEC divided by clay content, were much higher in the lowland soils than in the upland soils. This suggests a difference in mineralogical characteristics between lowland and upland.

The nitrogen levels in the lowland soils, however, showed a trend similar to that of the upland soils. Although the topsoils were relatively rich in nitrogen, the subsoils were extremely poor in both T-N and organic C. The soils had low to moderate values of available phosphorus, ranging from 2-10 mg kg^{-1}, with decreasing levels from the topsoil to the subsoils. However, the available phosphorus in subsoils of the valley bottoms was much higher than that in subsoils of the uplands, showing the effect of alluvial and colluvial deposition. By virtue of their geomorphic position, the soils are poorly drained, as reflected in their matrix colors (Table 6-2). These soils would, therefore be very useful for rice cultivation in the wet season and vegetable cultivation in the dry season. The most deficient nutrient was phosphorus, followed by nitrogen. Some lowland soils, such as Pt6 soil, also showed very low available potassium.

(5) Water Table Dynamics

The water tables at the study area were effectively monitored for 3 years from January 1997 to December 1999. Monitoring points along each transect line are shown on the lines of the topography survey in Fig. 6-18 to 6-20. At the time when the measurements started in January 1997, the water table was still falling due to a lack of rain, increased solar radiation, and a rise in temperatures. Therefore, the evapo-transpiration effect was enhanced as a characteristic of the dry season. The water table started to rise steadily at the beginning of the rains, from toward the end of March to May, despite the fact that rainfall did not stabilize until June, when the first peak was attained in all the valleys.

The movement of the water table corresponds approximately to the flow of water in the seasonal streams. The streams dry up in the dry season, until the ground water table rises to the surface in the riverbed in late May or early June in this area, depending on the intensity of the rainfall that year. As the water table graph shows, water starts flowing in the riverbeds when the rains stabilize in June, but water flows in May if, in any year, the rains are heavy and stabilize early. The flow of water falls as soon as the rain stops in Rice and Gold Valleys, because their catchment areas are smaller. The water flow in the Dwinyan watershed remains up to the end of December, depending on the time the rain stops. The stream in the first-order valley flowed for about four months during June to October (Fig. 6-18), whereas the second-order valley stream flowed about 6 to 7 months during May to November (Fig. 6-19). The third-order valley stream flowed about 7 to 8 months during May to December (Fig. 6-20).

(6) Interaction of water table and land use

From the schematic cross-sections of the different valley orders, a close relationship between water table movement and land use is apparent, especially in the valley bottoms. The largest valley bottom was found on Transect 8 (Fig. 6-20), a third-order valley. It has the best moisture regime during both the wet

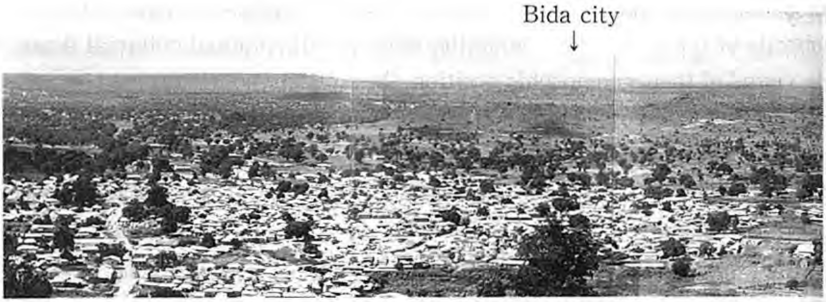
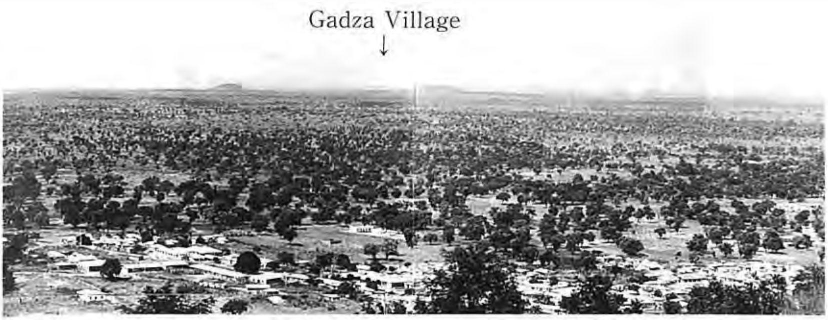


Photo 6-1 Overlooking the Town of Doko
(this photo was taken from the top of a mesa overlooking the Town of Doko, looking in the

and dry seasons. Although the fringe area is very small compared to the big valley bottom, the valley bottom is used suitable and for the cultivation of rice from April to December. It is also used and suitable for the cultivation of vegetables during the dry season because of the residual moisture available during that season. The valley fringes are used mainly for cereal, vegetables, root and tuber crops, and legumes. In the second valley order found on Transect 5 (Fig. 6-19), the land use pattern follows that of Transect 8. Rice is cultivated in the valley bottoms and the fringes during the wet season, but the valley bottoms are left to fallow during the dry season. The first-order valleys on Transects 6 and 7 are the driest and, as such, the valley bottoms are used mainly in the wet season for the cultivation of upland rice, maize, and sometimes oil palm (Fig. 6-18). The uplands of all of the valley systems are used to cultivate cereals (maize), root and tuber crops (cassava and cocoyam), and perennial crops (cocoa, citrus, oil palm, plantain). The lower slopes and fringes are used mainly for upland rice, vegetables, and cocoa cultivation.

(D. Kubota, O.O. Fashola, K.O. Asubonteng, and T. Wakatsuki)



direction of the catchment area of the Emikpata River and Gadza)

2. African Based Sawah Agriculture in Inland Valley — A Case Study at Nupe Land, Guinea Savanna Zone of Central Nigeria

2-1. On-farm demonstration study in Gadza village with farmers' partial participation : 1992-1995

(1) Subsequent situations of the IITA on-farm study fields

Photo 6-1 shows the view of the catchment area of the Emikpata River where the IITA on-farm study was conducted during 1986-1990. This photo was taken from a mesa overlooking Doko shown in Fig. 6-7 in the direction of Bida and Gadza areas.

IITA's on-farm studies in Gara and Gadza ended in 1990. These studies had two main aims. One was the study, mainly on the initiative of researchers, to evaluate the productivity of the rice varieties bred at IITA and other institutes, including their reactions to fertilizers. The other was the experiment on the growing of these new varieties in an effort to spread them among farmers : the varieties were distributed to farmers to give them the opportunityto raise them by their own management. The studies laid emphasis on the newly bred varieties of rice themselves. And these studies included an attempt to introduce totally new concepts of rice farming, that is, the development of sawah-fields and a sawah based agriculture, which would urge farmers to change their traditional system of soil and water management (See chapter 3). However, the IITA research and management staff in those days did not well understand the fact that to study improving farmers' fields into sawah fields and the creation of a cultivation environment for water control were as important as experi-

Photo 6-2 Sawah fields farmers voluntarily developed in the Gara inland valley (September 1990)

Photo 6-3 Leveled Sawah fields developed in Patungi,the village next to Gara (August 1995)

ments on varieties and fertilizers. Because of this, the on-farm studies on the introduction of sawah fields were limited only to the personal efforts of the author, as an expert sent by JICA. There was no sufficient communication not merely with local researchers and extension staff but also farmers. The studies were "studies" in literal terms. The author considered that if the farmer saw demonstrations with their own eyes, they would try them voluntarily (as in the case of Japan).

In Gara (Fig. 6-6), sawah fields were created in July 1986 and the first growing experiment was conducted from August 1986 to January 1987 under the guidance of the IITA resident staff, followed by the second experiment in 1987. After the experiments, the sawah fields were returned to farmers' management. In Gadza (Fig. 6-7 and 6-9), sawah fields were completed in July 1987, and the

Photo 6-4 Inland valley in Gadza before the IITA on-farm experiments (August 1987)

Photo 6-5 On-farm experiment site at the same location as above (October 1987)
Various high yielding varieties tested showed the yields of 4～6 t/ha

Photo 6-6 Same location as above; banks of Sawah fields have been scraped away and are disappearing (August 1992)

first cultivation experiment was performed from August 1987 to 1988 and the second one, from August 1988 to January 1989. The author left IITA at the end of May 1988, so he conducted experiments for only two years in Gara and for one year in Gadza. After that, IITA used the sawah fields until 1990, mainly for the growing experiments on rice varieties, and handed them over to farmers.

In August 1992, the author revisited Gadza and Gara to conduct an international joint study of the Japan Society for the Promotion of Science (JSPS) : " Restoration of Agricultural Ecosystems in the Savanna Zone in West Africa, 1992-1993." The sawah fields developed at Gara in 1986 are managed fairly well by farmers, while farmers in the neighborhood areas voluntarily developed good sawah fields (Photo 6-2). These voluntarily developed sawah fields were found not only in Gara but also in Patungi, the next village (Photo 6-3). But the absentee landowner, who lived in Badeggi (Fig. 6-6), realized that the developed fields had a higher productivity and demanded that the farmer who had created the fields should return the land. Because of this dispute, when the author visited the village in September 1995, he found that the farmer was unable to plant rice in the fields. Land ownership and sawah field development are fundamentals of agricultural policies and problems that should be tackled from a long-term viewpoint.

On the other hand, in Gadza, the sawah fields(Photo 6-5) of 1 ha created IITA's on-farm trials in July 1987 in a bush-state lowland (Photo 6-4) had returned to traditional small-lot quasi-sawah fields with their bunds scraped out. What was noticeable was that the oil palms planted on the bunds in 1987 when the fields had been developed had grown tall (Photo 6-6). The farmer who owned the land where the bunds of sawah fields were scraped out explained : " We have no small power tiller like IITA's and so cannot plow such large-lot fields. Moreover, large lots require more water to flood them. Because we considered this wasteful, we scraped the bunds and returned the fields to traditional small-lot quasi-sawah fields."

(2) Sawah field development and repairing and improvement of irrigation facilities in Gadza by farmer participation

In the IITA on-farm studies in the 1986-1990 period, IITA's regular employees from other areas developed sawah fields and IITA field assistants played a central role in the variety and cultivation experiments, which were carried out according to IITA researchers. Considering that in those studies there had been little communication with Gaza farmers though the fields were created in their

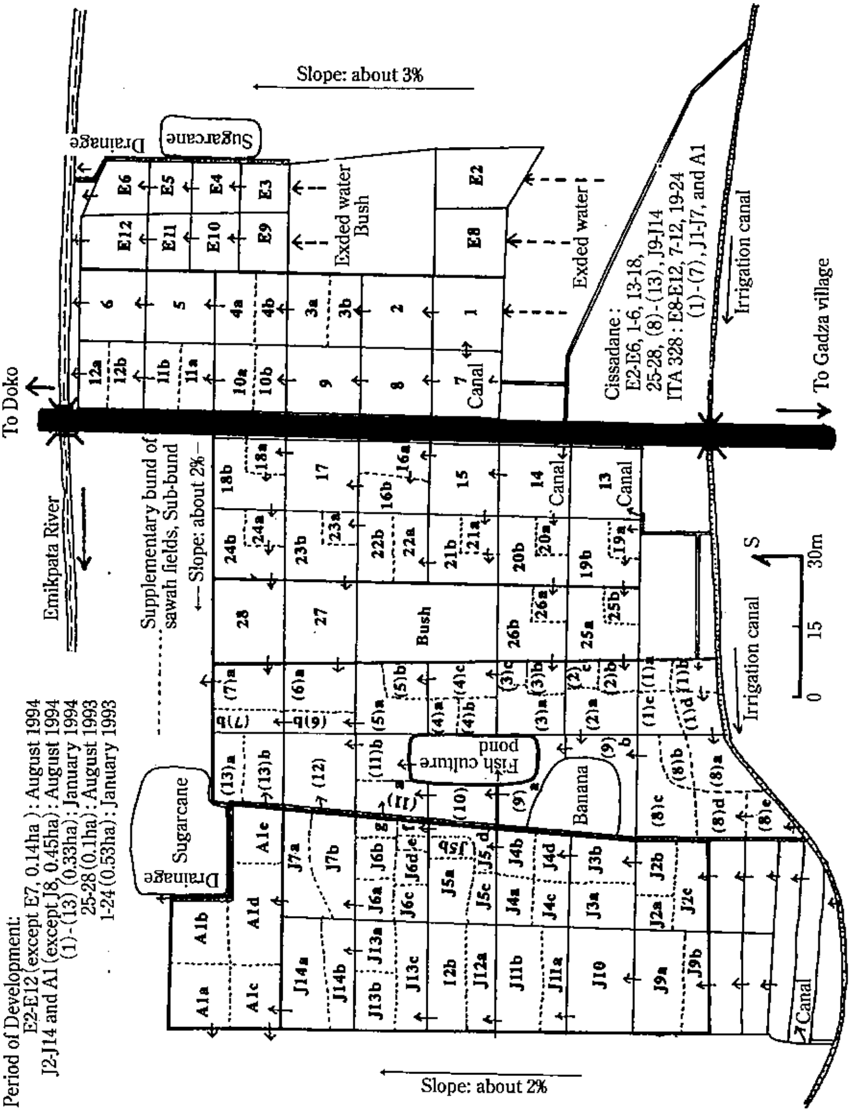


Fig.6-21 Sawah field and fish culture pond developed in the valley bottom in Gadza

Note: See Figures 6-7 and 6-9 for location.

Photo 6-7 On-farm experiment on sawah field development by farmer participation in Gadza (August 1993)

Photo 6-8 Women in Gadza take part in the transplanting of rice seedlings (September 1994)

Photo 6-9 Transplanting work by women in Gadza (September 1995)
In the field on the top,the left half is submerged and the soil is exposed in the right half because land leveling is insufficient.

village farm, it was decided to attempt again "on-farm demonstration studies with farmer participation." These on-farm demonstration studies coincided with the demonstration survey started in 1993 by the Grant-in-Aid for Scientific Research of the Japanese Ministry of Education, Science, Culture and Sport (international scientific survey headed by Shohei Hirose). Duirng 1992-1995, collaborative work was also conducted with the team of the JSPS's international joint study started in 1992 and with the team of AICAF, Association of International Cooperation for Agriculture and Forestry, Japan, for the studies on "Rice Cultivation Plan for Sawah Fields in Valley Bottoms in West Africa (Survey for Formulation of Sustainable Agricultural Development Plans for Africa)."

More specifically, the survey for selecting a benchmark site was carried out in September 1992 with the help of the staff at the Agricultural Development Project in Bida (BADP) and Gadza was finally selected as the benchmark site. The AICAF team carried out the first phase of sawah field development in January 1993 during the dry season, creating fields of about 0.5 ha on both sides of the road linking Gadza and Doko (Fig. 6-21 and Fig. 6-9). These fields are the plots of Nos. 1-24 in Fig. 6-21. Though located in the bottom of an inland valley, the area along the road is a little higher than the surroundings and so water supply was insufficient. Because of this, farmers had avoided cropping in this area. The fact that the site selection was performed in the dry season and priority was given to the demonstration effect of sawah fields were reasons why the results of subsequent cultivation experiments in the on-farm study were considerably worse than those of the IITA studies during 1986-87 (ITTA 1987, 1988, 1989, 1990, 1992). With cooperation from villagers, the Hirose project team developed 0.1 ha of sawah fields in August 1993 and 0.45 ha in August 1994, on the basis of the sawah fields created by AICAF (Photo6-7). Then in January 1994, the AICAF team developed 0.33 ha of sawah fields. In August 1995, although poor the leveling of these fields was also carried out.

The work performed by the Hirose team for the on-farm demonstration experiment on sawah field development was actually conducted by only one member of the team both during August to early September in both 1993 and 1994. Major activities were nursery preparation, weeding, land preparation for rice growing, fertilizer application, transplanting, repairing of canals and introduction of irrigation water into sawah fields. These operations were carried out at the same time as the building of bunds for sawah fields and the land leveling in part of the fields. These tasks were performed with the cooperation of about

50 adult men in Gadza and the staff of BADP responsible for irrigation and cultivation. Women in the village cooperated in transplanting work (Photos 6-8, 6-9). Because these activities were conducted as a part of short scientific surveys (about 1～2 months), immediately after complete the transplanting of rice, the Hirose team had to leave the project site. Therefore there was no proper guidance given to the farmers "participated" who "managed"up to the harvest in December.

The AICAF team carried out the preparation of the first sawah fields in January 1993 during the dry season using 50 adult men in Gadza. These men were paid daily wages of 50 naira (= US$ 1). This development was implemented according to the agreement made with farmers that during the demonstration survey from 1993 to 1995, the village community would own the created fields that would thereafter be returned to the original farmers. Because of this, daily wages of about US$ 1 (50-80 naira) were paid the work of developing, repairing and leveling the sawah fields. But a half of these wages were donated to the village community and were supposed to be spent as the community's assets for Gadza's common development purposes. This wage paying was the serious problem for sustainable participatory sawah development.

(3) Economics and theories of large-scale and small-scale development projects

In the case of sawah field development as a usual official development assistance (ODA) project, the cost of developing 1 ha of fields is $20,000-30,000. The budget for the Lower Anambra Project, a large-scale project for sawah field development carried out in the Enugu area, Nigeria, by with aid from Japan, totaled to about ¥14 billion, including large pumps, large-scale irrigation canals and rice mills. Since this project finally created 4,000 ha of fields, the cost per ha was about $32,000 (supposing $1 = ¥110). In such a large-scale project, the development fund is provided as a loan from other countries (e.g. yen loan from Japan through JBIC or OECF, oversea's economic cooperation Fund). Thus the country receiving the assistance (Nigeria in this case) will incur debt to the donor country in exchange for good sawah fields being created. It is common for a technical cooperation project to be then carried out to provide farmers with skills on the management and use of the sawah fields. Actually, such technical cooperation was offered for a long term in the Lower Anambra Project in Nigeria and in the Lower Moshi Project in Tanzania.

On the other hand, in a small-scale development project such as the on-farm

Table6-4 Labor force spent for sawah field development and trials of sawah agriculture

August 1993 :	(Man-days)	
Sawah field development (0.1ha)	33	
Canal repairing	90	
Sawah field repairing (0.53ha)	61	
Land preparation (0.63ha)	80	
Nursery making/transplanting (1.55ha)	130	
August 1994 :		
Sawah field development (0.59ha)	81	
Canal repairing	80	
Sawah field repairing (0.63ha)	64	
Land preparation (1.55ha)	173	
Nursery making/transplanting (1.55ha)	130	
Fish culture pond ($300m^3$)	40	
August 1995 :		
Canal repairing	90	
Sawah field leveling/repairing (0.63ha)	130	
Land preparation (0.80ha)	100	
Transplanting (0.80ha)	100	
Fish culture pond ($100+200+100m^3$)	60	
Avarage 1993-1995 :	(Man-days)	(naira)
Sawah field preparation	250	=20,000 (≒$250/ha)
Sawah field repairing	110	= 8,800 (≒$110/ha)
Land leveling*	210	=16,800 (≒$210/ha)
Canal repairing	5	
Land preparation	120	
Transplanting	140	
Fish culture ponds	70	

Note : Daily wages per farmer : 50-80 naira (≒$1).
* Based on the details examination at the Ashanti site, Ghana (Table 6-11), leveling work needs 2~3 times soil movement comparing to bunding.

demonstration study discussed here, the cost was only about $600 per ha (Table 6-14), although the quality of the sawahs developed was very poor. The cost is includes the wages paid to farmers at the development stage. Since these wages remain in the hands of the farmers, they may be spent to pay the cost of subsequent development. In addition, their participation in sawah field development will itself give them on-the-job training and so will lead to voluntary creation of fields, sawah field management, and the practice of sawah agriculture in the future. It is thus considered that small-scale development projects have many advantages not found in large-scale projects. However, more examination will be needed of the problems of projects with farmer participation, such as the payment of wages, provision of materials, and machines, and coordination of the community's joint work and individual farmers' farming activities. These factors were examined in details at the joint study project in Ashanti region, which is describes in the subsection 3 of this chapter.

Photo 6-10 Sawah field leveling work (August 1995)

Table 6-4 summarizes the labor force employed for sawah field development, repairing of canals and fields, land preparation for rice cropping, transplanting and other work performed in August 1993, August 1994, and August 1995. The main task of sawah field preparation, which needed about 250 man-days/ha, was bund building. In the IITA on-farm study fields, where the slope was gentler and the soil was more clayey, bund preparation was the main work of sawah field development. In this on-farm study, a small power tiller (the price : about $1,500 in 1986) was used for leveling and land preparation work for rice growing. However, leveling and puddling were incomplete in the on-farm trials from 1993 to 1995. This might be one of the major reasons why rice yields were so poor

Photo 6-11 Maintenance work of irrigation canal by the joint efforts of community members (August 1995)

compared to the data which were conducted as researcher-managed on-farm (about 2t/ha) experiments by IITA (about 4-6t/ha).

In the sawah fields created in the 1993-1995 study, almost no land leveling was carried out in the first two years. Because of this and also because slopes were steeper, many plots were very uneven; half of some of these plots was submerged 30 cm or more deep, while the other half had no water with the surface soil exposed (Photo 6-9). Land leveling was performed in the third year for the first time but villagers found it considerably hard work (Photo 6-10). Moreover, because no puddling work was possible, the fields had only poor water holding and clods of earth remained uncrushed in many fields, and prevented efficient transplanting work. Considering the high labor cost for land preparation and leveling of 330 man-days, the introduction of small power tillers as in the Ashanti site, will well deserve examination. The management and repairing of small irrigation canals and dead dikes (Photo 6-11) have a relatively large beneficiary area (about 20 ha) and so the labor requirement per ha is smaller. But the state of the rural community is very important because no proper work will be possible, which may result in the collapse of the entire irrigation system, unless the community is organized and well united. The activities during 1992-1995 were considered as still tentative. Full scale-examinations were only possible at the benchmark site in Ghana, which were conducted during 1996-2001 as described in the section 3 of this chapter

(Toshiyuki Wakatsuki)

(4) Agronomic Evaluation on the Preliminary trials on Sawah farming in Gadza during 1992~95

The traditional rice cropping system practiced in Gadza has a long history in this village. It is carried out in small-lot quasi-sawah fields having low and narrow bunds, and is characterized by rainfed farming, ridge making and direct sowing. Since Fusako Ishida has already treated this system in Chapter 3, 2., will not be discussed in detail here.

In contrast, the characteristics of the sawah agriculture are high bunds, artificial irrigation, larger sizes of fields (200-250m² per lot) and transplanting. This subsection will compare these two rice-farming systems and try to identify the problems of rice production in West Africa.

1) Preparation of sawah fields : In the traditional rice growing system in Gadza, land preparation work is performed when rain begins to fall in the rainy season.

Table6-5 Outline of the rice cropping experiments on sawah fields and small-lot quasi-sawah fields (local fields) in Gadza

	Sawah fields		Local fields	
	1994	1995	1994	1995
Variety	Cisadane ITA 328	Cisadane ITA 324	Ena'tiwasa Egawazankpa Manbechi	Mas (ITA 2404)
Age of transplanted seeding	22-26 days	16-17 days		
Planting density	25×20 cm ; 3-5 seedings per hill	Same as in 1994	Random direct sowing, hill sowing of about 10 grains	
Fertilization	Basal dressing : N-P-K : 30-30-30kg or 30-70-30kg Top dressing : Urea: 30kg	Some quality of fertilizer applied (precise quarity unknown)	Some quality of fertilizer applied (precise quarity unknown)	
Harvesting	115 days after transplanting	122 days after transplanting	120 days after transplanting	
Management work	Weeding and water control as needed		Weeding as needed, continuous irrigation	
No. of samples for yield survey (hills)	Cisadane : 20 ITA328 : 29	Cisadane : 17 ITA324 : 19	4	3

It is usually carried out in the following order : (1) rough plowing and simple land leveling work; and (2) preparation of small-lot (3-10m²) quasi-sawah fields, each enclosed with low bunds made of clods of earth that remain after the leveling work. Since these bunds are low and have openings in some parts, water flows are observed in sawah fields at all times. Because the location of bunds is changed each year, the fields cannot be regarded as fixed fields.

The sawah field can be summarized as follows. (1) Bunds usually 50 cm wide and 50 cm high are built. (2) The area of each lot is about 15 m x 15 m (225m²), much larger than the traditional farmers'fields in Gadza. (3) Small rivers are dammed up by head dyke and canals are built; vinyl chloride pipes about 10 cm across are set at the inlet and outlet of water to introduce water into fields and carry out plot-to-plot irrigation. (4) While the surface of fields is plowed, land-leveling work is insufficient and no subsoil compaction and puddling are performed, as already stated.

2) Rice growing in sawah fields : An outline of the rice-growing experiments

Table6-6 Gender distribution in farm work in the Bida area*

(Figures are the ratios in % of the male and female children and female adults who are engaged in each of the farm work. For example, land preparation work for sorghum is carried out by 25 % of boys and 2 % of adult women,which suggests that this work is mostly done by adult mem. The figures obtained by deducting these figures from 100 show the portions of work perfprmed by adult men. The processing of Egusi melon is carried out by 85 % of adult women,which mesure that adult men are little engaged in this work.)

		Sorghum	Groundnut	Egusi melon	Rice tenant farming
1. Land preparation	Males (children)	25	36	22	30
	Females (〃)	0	3	1	0
	Females (adults)	2	2	4	0
2. Sowing/ transplanting	Males (children)	31	36	36	33
	Females (〃)	11	13	5	4
	Females (adults)	11	13	3	4
3. Weeding	Males (children)	28	32	25	33
	Females (〃)	0	3	2	4
	Females (adults)	0	1	4	0
4. Harvesting	Males (children)	29	32	33	30
	Females (〃)	6	30	42	33
	Females (adults)	9	43	56	3
5. Processing	Males (children)	26	32	33	30
	Females (〃)	57	66	55	63
	Females (adults)	86	81	85	78
6. Transportation	Males (children)	30	33	29	32
	Females (〃)	49	43	54	43
	Females (adults)	57	57	71	54
7. Preservation	Males (children)	9	15	12	16
	Females (〃)	7	6	25	13
	Females (adults)	14	5	44	10

Note: N. Hahn (1986), unpublished data.

conducted in Gadza in 1994 and 1995 is shown in Table 6-5. The locations of the sawah fields developed can be found in Fig. 6-21 and Fig. 6-9. In Gadza, men are responsible not for merely the preparation of sawah fields and sowing but for harvesting and most of threshing work as well (Table 6-6). Women are in charge only of winnowing and milling (with a mortar and pestle). But when we invited women in the village to take part in transplanting work for wages equivalent to $1 in an attempt to expand the scope of rice cropping and to provide practical training, all of the female members of the community took part in the work (Photos 6-8, 6-9).

3) Cultivation management and growth of rice: No extention worker was available who could stay in Gadza to guide farmers on the sawah rice growing available, and so the sawah fields were totally managed by the rural community. In other words, while the fields were developed according to sawah system, their management was performed by Nupe's traditional method. In addition to this, the sawah itself was poor quality. One of the main cultivation management tasks during the growth period is water control. In late 1994 (October and November), insufficient rainfall caused some scrambles for water between the sawah fields created and the small-lot quasi-sawah fields. Water shortage resulted in the fields drying-up, promoting weed growth. A higher priority was given to the management of farmers' quasi-sawah fields than to the sawah fields developed under the control of the community. During the period from just after transplanting to the harvest survey (early September to mid-December) when the Japanese staff in charge were away from the village, the sawah fields little management was given to. Moreover, the unevenness of the fields' surface owing to incomplete leveling and the failure to do soil puddling made the growth of rice irregular (Photo 6-12).

The survey of hills per unit area at the harvest in each lot of fields showed that the harvest was only 78% of the original planting density on average for Cisadane, and a decrease in in the number of hills was evident (Photo 6-13). The density of hills in 1995 was lower than that in 1994 : 67% for Cisadane and 75% for ITA328. Farmers planted new seedlings to make up for lost plants but these seedlings did not take root well and remained ungrown until the harvest period. In 1993, a farmer took a great deal of earth from the bank of the irrigation canal to use it for land preparation for his own rice cropping. That part of the bank was terribly hollowed out (about 1.5 m deep) and turned into a gully because of heavy rain. It was hard for farmers to repair the bank because they had only

Photo 6-12 Uneven soil fertility of sawah fields due to a failure to do puddling (The plant grew better on mounds bulit for dryseason crops. (November 1995)

Photo 6-13 Lost hills of rice in sawah fields

Photo 6-14 Repair work for the destroyed bank of the irrigation canal

African hoes (Photo 6-14). Later in 1994 and 1995, the irrigation canal collapsed at least once when there was heavy rain, mainly at this part. The Nigerian researcher and farmers reported damage to growing rice from gall midge and iron toxicity (bronzing).

4) Yield of rice and yield components : The yield of improved varieties grown in the sawah fields and that of local varieties raised in the small-lot quasi-sawah fields was investigated in December and January 1994 and 1995. In the investigation, quadrat sampling was conducted in the 4m² section of each of the fields and the average yield per ha was calculated (Table 6-7). In 1994, the figure was 2. 75 t/ha for Cisadane, 2.14 t/ha for ITA328, and 2.41 t/ha for the local variety, ITA328 showing the lowest yield. In 1995, all of the three varieties achieved yields on or about 2.2 t/ha and no significant difference was observed between them. These results were only about one half to one-third of results from IITA

Table6-7 Comparison of the yield of the improved and local varieties in 1994 and 1995

Vatiety and sawah field system	Grain yield (t/ha)	
	1994	1995
Cisadana[1)]	2.75±0.64	2.22±0.81
ITA328[1)]	2.14±0.92	-
ITA324[1)]	-	2.26±0.60
Local variety[2)]	2.41±0.88	2.27±0.20

Notes : 1) Sawah fields.
2) Small-lot quasi-sawah fields.

Table6-8 Correlations between yield and the charasters afecting yield and yield components

Character	Cisadane		ITA328	ITA324
	1994	1995	1994	1995
Yield-plant hight	0.5002*	0.9048**	0.6070**	0.6728**
Yield-No. of hills per m²	0.2739	0.0836		0.1620
Yield-No. of ears per m²	0.5988**	0.7134**		0.6105**
Yield-No. of grains per m²	0.6136**	0.6223**		0.6912**
Yield-No. of ears per hill	0.5651**	0.4762		0.4103
Yield-weight of 1,000 grains	0.2621	0.4731		0.2315

Note : **, *=significant on 1% and 5% level.

on-farm experiments during 1986-1987. Then the relations between yield and the characters affecting yield and yield components were investigated (Table 6-8). The yield was higher in the plots where the plant length was greater, that is, in those where the plant growth was better. In the plots where there were many lost hills, the number of ears per hill was larger and compensatory action was

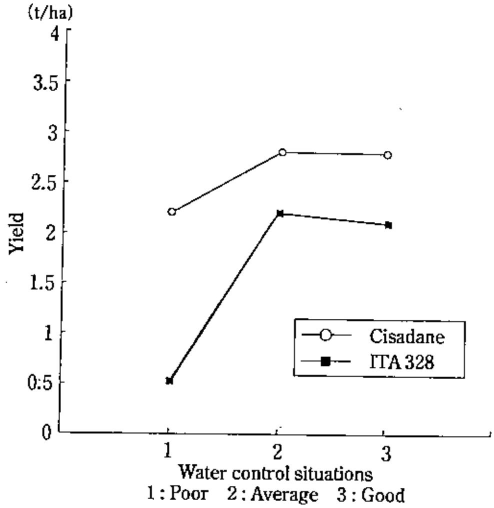


Fig.6-22 Relations between water control situations and yield

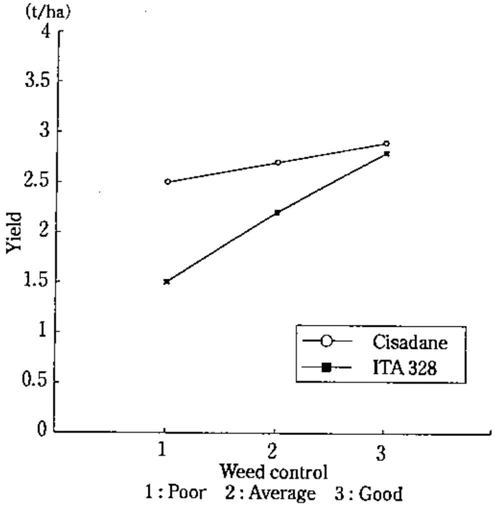


Fig.6-23 Relations between weed control and yield

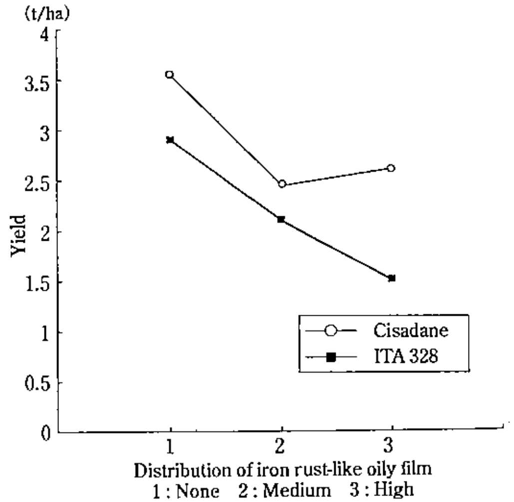


Fig.6-24 Relations between the distribution of iron rust-like oily film and yield

observed. There was a high positive correlation between the number of ears and grains per unit area and yield. From these results, it is evident that securing a sufficient number of ears per unit area is, naturally enough, important. In the 1994 survey, to study the relations between yield and cultivation management during the growth period, water control, weed growth, and the distribution of an oily film like iron-rust on water surface (a measure of accumulated reduced iron) were investigated for two varieties about 40 days before ripening, using three-stage indicators. Then the values for each of the three indicators in the plots surveyed were averaged and the relations between these values and the yield were examined. The results are shown in Fig. 6-22, 6-23 and 6-24.

The survey period was in early November, just before the heading time. According to the survey, since the rainy season had already ended, the yield was lower in the plots where water control was also poorer, even if the fields were irrigated. The yield was also low in the plots in which weeding was inadequate. In addition, the yield of the two varieties was lower in the fields where the value of the indicator of iron accumulation (Photo 6-15) was higher.

Iron toxicity is a phenomenon known in lowland rice fields in West Africa (Winslow *et al.*, 1989; Yamauchi, 1989, 1992; Windmeijer and Andriesse, 1993). Ferrous iron in a reduced condition affects the growth of rice, and this is known to be induced by low soil fertility and prevented by potassium fertilizer application. To see if this distribution of an oily film like iron-rust really shows excess

Photo 6-15 Distribution of iron rust-like oily film in sawah fields

iron in the soil, the observation of discoloring (bronzing) process in rice plants and the analysis of their nutrient concentration as well as soil analysis are needed. However, the above results from observation were considered effective as an indicator for determining the yield of rice. Iron toxicity is actually not the cause of poor growth of rice and a secondary cause is deficiency in other nutrients. The most important cause of the symptom is the poor quality of sandy soil that has generally low contents of nitrogen, potassium, phosphorous and other nutrients. Moreover, some of the seepage water from uplands has a very low concentration of calcium, magnesium, potassium and other bases and a high aluminum concentration. In the sawah fields where groundwater gushes out, subsoil is exposed and the soil is sandy in general. In such soil, iron films produced by the oxidation of ferrous iron are often seen on the water surface. It is known that rice in a normal state of nutrition is not affected by ferrous iron in the soil solution at a concentration of 300-1,700 mg/l. On the other hand, Kosaki and Juo *(1986)* reported a typical case of iron toxicity in West Africa and stated that heavy iron toxicity was observed at the average ferrous iron concentration of 50 (maximum : 80) mg/l. This suggests that "iron toxicity" generally mentioned in West Africa is not a cause of poor rice growth and is instead the secondary result of nutrition troubles, such as potassium deficiency, phosphorous deficiency and aluminum toxicity.

5) Yield-increasing measures : Although, it is clear that the yield of rice can be raised if sawah field are properly developed and managed and necessary materials and machines are used. But the problem is wheather farmers can obtain and maintain such technology, and materials and machines continuously

and if they are ready to do so.

According to the results of the cultivation experiments, the yield of the improved varieties grown in the sawah fields was not significantly higher than that of the local varieties raised in the small-lot quasi-sawah fields. Moreover, the improved varieties showed great differences in yield from plot to plot and failed to give a good exhibition of their capacity as improved varieties. Considering this, attempts were made to find measures to increase the yield of rice, focusing on the problems of developing and managing large-sized sawah fields.

① Problems of sawah field development: As already noted, to create large fields in the lowlands where rice has been grown in small-lot quasi-sawah fields, a considerable volume of surface soil has to be taken to build sufficiently high bunds. Because these lowlands have slope of 1-3%, the development of large-lot fields there will inevitably result in subsoil exposure and uneven and irregular topsoil in some parts.

In such circumstances, the minimum thickness of topsoil should be secured by making bunds with less than the desirable height and width. Unevenness of topsoil may gradually be eliminated in the course of time by the repeated building of mounds for off-season crops in the dry season and their leveling for rice cropping in the rainy season (Photo 6-9). But some effects of off-season crop raising will be unavoidable. For example, the rice crop is good at the former site of mounds built in the dry season (because of topsoil accumulation; Photo 6-12), while it is clearly poor in the area where top soil has been scooped away to make mounds. Subsoil compaction may be omitted but the most important problem will be that puddling cannot be carried out in large sawah fields. In the IITA on-farm studies, during 1986-87 small power tillers were used to perform careful puddling work, and this, combined with adequate water management and fertilization, seems to have contributed to high yields of 4-6 t/ha.

② Problems of sawah field management: In the cultivation of rice in Gadza, the farmers' organization played a central role in sawah field management. Because of this, it can hardly be considered that sufficiently good management was made for seedling culture, transplanting, fertilization, water control, weeding, harvesting, and other work. First of all, there were great fluctuations in the number of hills per unit area and only 60-70% of the hills initially planted could be harvested. The main reasons were that the surface of sawah fields was not soft enough for transplanting because no puddling was carried out and farmers' inexperience in transplanting prevented seedlings from taking root well. At the same time, some parts of sawah fields were submerged too much for seedlings to be transplanted. Moreover, according to the interviews in 1995, farmers said that they planted seedlings to make up for lost hills but the seedlings failed to take root. This is probably because excess reduced iron that had accumulated in the soil during submergence inhibited the rooting of the seedlings transplanted. Since farmers were not experienced in irrigation water control, many of the sawah fields had poor water management, aggravating damage from weeds. As already noted, the soil of inland valleys in this area is usually very poor and its content of exchangeable Ca, K and clay and its CEC is all low. Therefore, high hopes can not always be placed on the effect of basal dressing and top dressing 60 days after transplanting because of the easy leaching of chemical fertilizers, coupled with coarse texture the physical property typical of lowlands.

As mentioned in Chapter 3, Gadza farmers continue a variety of farming activities throughout the year in upland fields, lowland fringes and valley bottoms, and by seasonal migration to mid-basin flood plains (Table 3-10). The choice of activities for top priority differs from farmer to farmer. While they recognize the importance of rice as a cash crop, they cannot lay emphasis only on rice growing. It was thus expected that even if Gadza farmers considered sawah farming to be an important element of their farming, they might not manage their sawah fields properly because they will have to allot labor for other activities as well. This was an important factor that brought no increase in the yield of rice.

IITA's experiments on toposequence and the yield of improved varieties in the 1987-1989 period at the same site attained a yield of 6-7 t/ha (Fig.6-9). This achievement was the outcome of the on-farm trials managed by IITA's researchers. This suggests that if cultivation management is good, a high yield could be obtained from improved sawah fields and improved varieties. It can also be expected that in the other rural communities in West Africa having farming conditions different from those of Gadza, sawah fields could accomplish good results even under the management of farmers as we described in the subsection 3 in this chapter. This is why it is important to plan and introduce the technology suited to the social, economic and natural conditions of the area.

(Shohei Hirose)

2-2 Farmers' evaluation of the on-farm trials in Gara and Gadza village : 1992-1995

(1) Historical background of the activities before 1992

Water availability is a major factor in increased rice yield in inland valleys. Inland valley farmers practice the random basin system based on the construction of small basins with small bunds to retain rain and seepage water and a poorly developed water delivery system (small-lot quasi-sawah). These basins look alike but Ishida *et al. (1996)* identified, as shown in Chapter 3, seven forms of land preparation for lowland rice by Nupe farmers in the Bida area. The land forms are *Togogi* or *Togoko kuru*, *Togogi* or *Togoko Naafena*, *Ewoko*, *Baragi* and *Gbaragi*. The authors found a close relationship between each land form and microtopography. For example, the *Togogi Kuru* and *Togoko Kuru* look like divided closed square blocks inside which are also subdivided ridges. They are differentiated by the longer side of the Togoko and constructed at different positions in the valley. *Togogi Kuru* land forms are commonly found in sloping and convex positions so that water can be retained for long periods hence they have closely spaced ridges. The *Togoko Kuru*, on the other hand, have widely spaced ridges within the blocks on relatively flat areas in the valley where excess water is a problem. The other land forms serve similar purposes, either to drain excess water or retain water for long periods, depending on their positions in the valley toposequence.

In order to improve upon this traditional system, past research was based primarily on on-farm water conservation and small-scale drainage control and flood protection measures. Oosterbaan *et al.* (1987) identified and described several small-scale water management systems for rice cultivation in inland valleys during the rainy season. These include :

- the central-drain system that is sometimes used in the humid tropics,
- the interceptor-canal system, not often practiced
- the head-dyke, sometimes applied in the savanna zones, like head-dyke of Savvides (1981) built in the valleys around Bida, and
- the contour-bund system that is also not often utilized.

Each of the above systems requires different levels of control and of inputs, especially, of labor and social organization. For example, the head-dyke system consists of a head dyke built upstream of the valley, one or two peripheral canals with water control structures, and the stream channel used as the main drain (Fig. 6-25). From the peripheral canal are pipe outlets spaced 10m apart

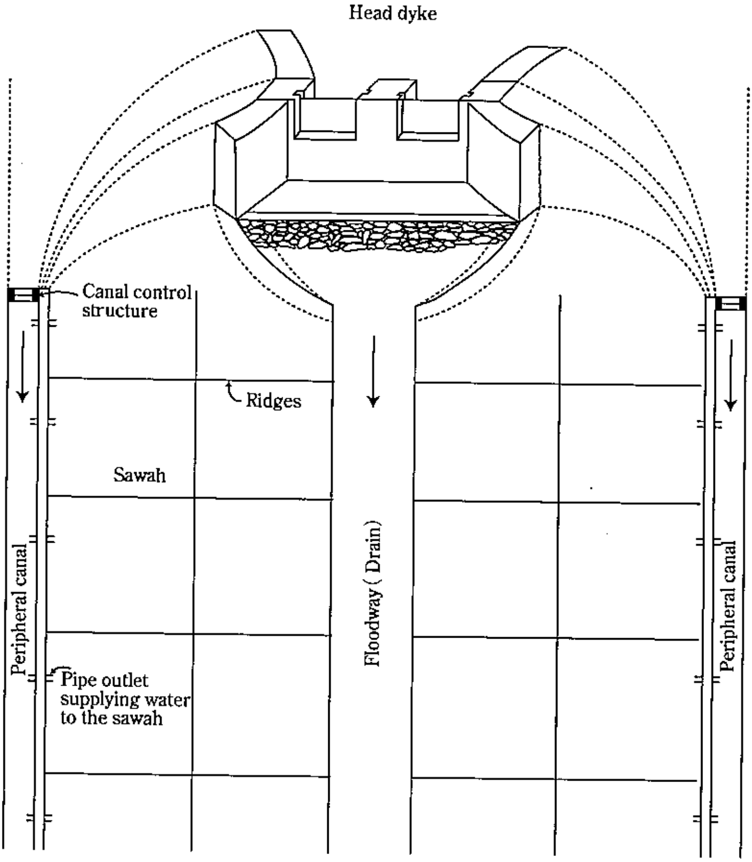


Fig.6-25 Typical layout of a water control system by head dyke (Savvides 1981)

along its length to supply water to each farmer's field. Thus, the social organization required may constitute a constraint if there is no cooperation in the community for the maintenance of the head dyke, main canal, and water control structures. In this case, the head-dyke system is a facility for the community to control water at a point, while the individual farmer uses the random basin to control water at the level of the watershed. Therefore, in order to improve upon the individual water control system, an on-farm research program was initiated in 1986 for the introduction of sawah technology as part of the IITA research activities of the Rice Working Group in the inland valley agroecology in Bida area.

Small-scale trials were conducted in the Gara and Gadza valleys near Bida between 1986 and 1989 for rice fields improvement. Farmers'rice fields were improved to construct sawahs with regular shapes and larger sizes than farmers' *Togogis* and *Togokos*. The improvement consisted of constructing compact bunds that are 50cm at the base and about 40cm at the top. This is to prevent water from leaking out of the sawah. The improvement also included leveling and puddling which was done witha turtle power tiller. The optimum size of a sawah depends on its position in the toposequence. The steeper the slope, the smaller the size of the sawah. The construction of the sawahs at both sites resulted in more than 100% yield increase over the farmers, water control practices (Ashraf *et al*, 1988; Palada *et al*. 1989; Carsky and Masajo, 1992). The higher rice yields obtained over the trial period were expected to encourage the farmers to try out the technique but this was not to be. Some farmers in both villages abandoned the sawah plots, despite the fact that traditional hand hoes were needed to perform all operations in the construction of the sawah plots except puddling, for where the power tiller used.

(2) Farmers' evaluation of the on-farm demonstration trials: 1992-1995

The sawahs constructed during the on-farm trials were discussed by the farmers after the 3 year-trials. There was no follow up by the researchers until a consortium of Japanese universities (Hirose Project) came in collaboration with another Japanese organization, the Association International Cooperation of Agriculture and Forestry (AICAF) in 1992. Farmers were again involved in the sawah technology under the AICAF/Hirose Project. At this time, the functions of the sawah were explained to the farmers as a means of trapping the finer soil particles in irrigation water as water is ratained longer and soil fertility is increased (the geological fertilization concept).

One hundred male and female farmers were used for the demonstration. They were expected to voluntarily participate under the supervision of Japanese scientists and ADP extension workers in building bunds, leveling land in some cases, and in building and repairing the peripheral canals and head dyke and the water control structures in the valley. The reward for services rendered was in cash or in kind to the village community in Gadza. During the first year, one hectare of sawah consisting of leveled and bunded rice fields was constructed with 580 man-days using hoes and cutlasses although the quality of sawah were poor. During the following year, 1994, only 220 man-days were required to constructanother hectare of sawah. This was an encouragement for the scientists who felt that, with experience, the labor requirement for sawah construction would be reduced enough for farmer adoption. Rice seedlings were transplanted into the basins and maintained by the farmers. There was, however, no difference in grain yield between the sawah rice and the farmers' rice fields. Also it was found that when the same area was put to dry season cropping of cassava and sweetpotato, lower yields were obtained from the sawah than from farmers' fields (Olaniyan *et al.* 1995). This was the trend for the 3-year demonstration. It was however, observed that after the payment in cash or kind for the construction of sawah, the farmers were expected to obtain benefits from the proceeds of the sawah. This time around, the technology again did not pass the demonstration stage as the sawah plots were either disused or destroyed after 1995. Participatory on-farm examinations after 1995 are continuing to 2001. Because of space limitation of this book, the results will be described in the next book under preparation. (G. O. Olaniyan)

3. African Based Sawah Agriculture in Inland Valley — A Case Study at Ashanti, Ghana

3-1. On-farm demonstration study at Adugyama and Biem river watershed*

*This section was based on the report for the evaluation team of JICA/CRI joint study project on "Integrated Watershed Management" August 2000

(1) Introduction

Inland valley systems and hydromorphic fringes cover about 50 million ha in West Africa, of these, about 10 million ha have the potential for small-scale irrigated sawah-based rice farming. In Ghana, the potential area for small-scale irrigated sawah in inland valley watershed is estimated at 700,000 ha, 3% of the total land area. If flood plains are included, the total potential area for irrigated sawah may reach one million ha in Ghana.

In Ghana, rice is cultivated under three systems, rainfed upland conditions, irrigated conditions, and rainfed lowland conditions in inland valleys. Production under rainfed upland conditions has been very risky due to the unreliable rainfall, and shallow, erodible soils of low fertility. Production under big irrigation schemes has not been very encouraging. The numerous small inland valleys found scattered across the country, where water management is the main problem, offer the best rice ecology.

The Valley Bottom Rice Development project was initiated in 1989 to

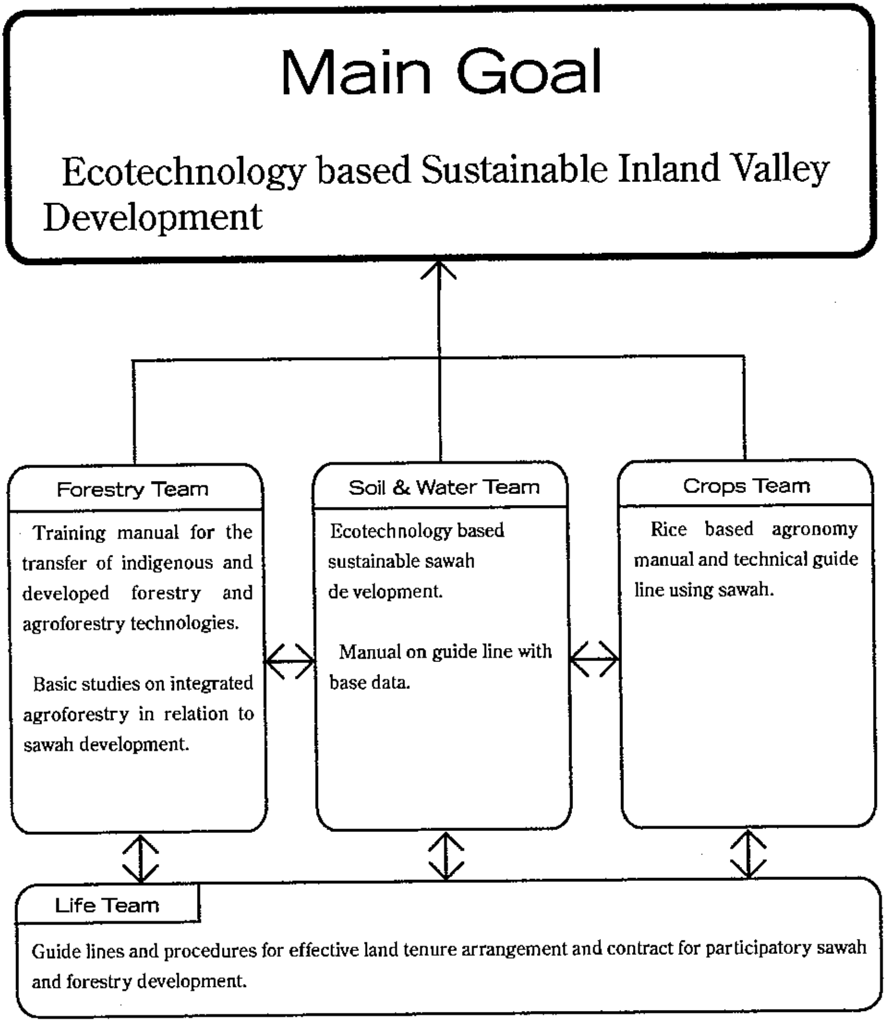


Fig.6-26 Main goal of the project.

develop sustainable technologies for integrated soil, water, and crop management in the production of rice and other crops in the inland valleys. Although considerable progress has been made in addressing some of the researchable constraints, there is the need to devise simple, low cost, and environmentally friendly systems for managing the inland valleys that can be adapted by the resource-poor farmers. Sawah development in tropical Asia where they have long experience of the system that looks not only at the valley bottoms but at the total watershed. The system is worth considering to the inland valleys in Ghana.

(2) The main goal of the on-farm trials

The main goal of the project is the development of sustainable production systems at watershed level which allows intensification and diversification of the lowland production system and the stabilizing improved production systems on the upland. Furthermore, the project will lead to the development of a tool for land-use planners and decision makers for integrated watershed development. As shown in Fig. 6-26, the joint study was able to successfully achieve the examination of various sawah systems developed in the inland valley.

(3) Comparison of large scale, small scale and traditional systems with ecotechnology based systems in Ghana

Irrigated sawah systems were introduced into Ghana by the experts from Taiwan during the period 1968 to 1972. So far, Ghana Irrigation Development Authorities (GIDA) has 22 irrigation projects, with a total area of about 10,000 ha throughout Ghana. However, it is now very difficult to build new irrigation projects because of the high cost of irrigation and its apparent low net return.

As shown in Table 6-9, a large-scale irrigation project, such as Tono irrigation, is very costly. Although the total sales of produce are between 1,000 and 2,000 dollars per ha, the running cost including the use of big machinery such as tractors are very high. Due to the high construction cost, the economic return has been negligible or rather negative for a long period of time (20-30 years).

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

Owing to various problems outlined in the large-scale scheme described above, small-scale irrigation schemes are considered more suitable to develop at present. However, with the present small irrigation schemes, the construction cost is comparable to that of large schemes as far as their development depends

Table6-9 Comparison of past large scale, present small scale, traditional system and ecotechnology based sustainable irrigation development in Ghana

	Large Scale Development	Small Scale Development	Ecotechnology Base Sawah Development	Traditional System
Development cost per hectare	20,000-30,000 US$ per hectare	20,000-30,000 US$ per hectare	3,000-4,000 US$ per hectare	20-30 US$ per hectare
Economic returns of rice and vegetable etc.	1,000-2,000 US$ per hectare	1,000-2,000 US$ per hectare	1,000-2,000 US$ per hectare	100-300 US$ per hectare
Possible income (Economic Returns)	Negative	Negative	1000 US$/ha	100-200 US$/ha
Maintenance cost for the system	high	Medium	Low	Zero
Running cost including machinery	Medium to High (300-500 $/ha)	Medium to High (300-500 $/ha)	Medinm (200-300 $/ha)	Low (10-20 $/ha)
Farmers partricipation	Low	Medium	High	High
Type of farmers	New migrants	Old/New migrants and indigenous	Old migrants and indigenous	Old migrants and indigenous
Project ownership	Government	Government/ Farmer	Farmer	Farmer
Type of Technology	High input rice based agronomy including machinery	High input rice based agronomy including machinery	Sawah Ecotechnology and medium input rice based agronomy including small machinery	Low input
Adption Technology	Long, Difficult	Short, relatively easy	Medium to short, needs intensive demonstration and On the job Training (OJT) programme	Little technology transfer
Sustainable development	Low	Low	High	Medium
Environmental effect	High	Medium	Low	Medium

mainly on engineering work by experts. Therefore the project ownership still belongs to the government (engineers) rather than the farmers. Target technologies which should be adopted are similar to those used in the big schemes. However, because the schemes are small, technology transfer, i.e, high/medium input irrigated rice-based agronomy including machinery, will be relatively easy. The sustainable development of the present small-scale schemes, however, is debatable, because of the very expensive initial construction cost. The production level of rice farmers could not compensate for the high construction cost.

(4) Design, construction and evaluation of various sawah systems

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

(a) Sawah trials

Seven sites of various sawah trials during the project period, 1997 to 2,000, are shown in Fig. 6-27 (for the overall locations see Fig. 6-15). The area of sawah developed and paddy production in 1999 and the estimated area including newly developing sawahs in 2000 are presented in Table 6-10. Mean paddy yields for Adugyma Club-C were 3.9t/ha in 1997, 3.5t/ha in 1998, and 4.3t/ha in 1999. The rice variety used was SIKAMO, newly released from Crops Research Institute of CSIR. The sawah area developed in Potrikurom (Ps) was 0.27ha in 1997 and 0.64ha in 1998. The Ps site was also used for agronomic research trials.

During April to August, 1999, Biemso No.1 sawah development trials were established in the Biem river watershed. Ten farmers came together to form an association for this site. An area of 1.22ha of sawah as well as dykes and

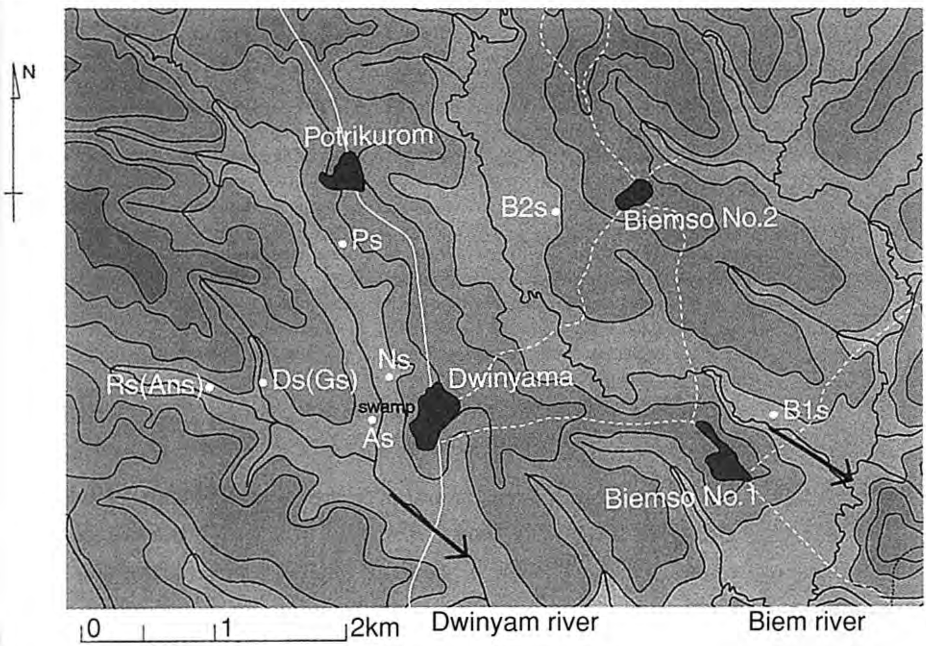


Fig.6-27 Various pilot sawah trials in Benchmark site. Ds (Gs) is Danyame (or Gold valley) site, Rs (Ans) is Rice valley (or Anthony's) site, As is Afreh's site, Ns is Nicolas site including Club-T site, Ps is Potrikurom site, B1s is Biemso No.1 site and B2s is Biemso No.2 site.

Table6-10 Land area and yield from the sawah project sites

Sites/farmers group	Symbol in Fig. 6-27	Area development and cultivated 1999	Total paddy yield 1999	Total* Selling 1999	Developed & cultivated area for Year 2000
Adugyama Club C					
			4000kg (4.3t/ha)	¢5 million	
Danyame (Gold valley),	Ds (Gs)	0.29/ha	including 800kg	1,406$/ha	0.29/ha
Anthony (Rice Valley),	Rs (As)	0.16/ha	Ratoon rice		- (1)
Afreh	As	0.08/ha	(yield Calculation		- (2)
Club-T	Ns	0.06/ha	including ratoon		0.06/ha
Nicolas	Ns	0.33/ha	rice)		0.54ha
Sub-total		0.92/ha			0.89ha
Biemso No. 1 Sawah group	B1s	1.22ha	5500kg (4.6t/ha)	¢5 million 1066$/ha*	(1.8ha)
Biemso No.2** Sawah group	B2s	-	-	-	0.61ha
Potrikrom	Ps	0.62ha	Research trials	Site	0.62ha Research trials
Total ha		2.76ha			3.92ha

Note: In 1997, 0.49ha Sawah yielded 1896kg paddy rice; 3.9t/ha at Gs, As and Ps
In 1998, 0.70ha (1.37ha including research site of Ps) Sawah yielded 2425kg paddy rice; 3.5t/ha at Gs, as and Ns
(1) No cultivation in year 2000, because of the withdrawal of Mr. Anthony. Management and availability of water is also a problem.
(2) No cultivation in year 2000, because of the problem of water availability
( ): Including the area estimated for newly developed sites
* Mean exchange rate of 1 dollar for 3865 cedis during December 1999～April 2000

- Club C sold at about 1400 cedis per kg, relatively good price
- Total selling excluding family consumption and for the land, about 5000kg.
  Biemso sawah group sold at about 1000 cedis per kg paddy, relatively low price.

Milled rice and Paddy rice ratio is about 65%
**Newly developed group and site.

800m of canal were developed. Total paddy production was 5600kg, of which 430kg (5.5 tins= 275kg) of milled rice was given to the landlord of the sawah and 100kg taken for family use. The mean yield of 4.6t/ha was remarkable. The remaining 5000kg of paddy were sold. Total sales was 5 million cedi, which was equivalent to 1300 US dollars. This is equivalent to $1060 per ha. Adugyjama Club-C also increased the total area to 0.92ha, which produced 4000kg of paddy, including 800kg of ratoon paddy. Mean yield also increased to 4.3t/ha, including ratoon paddy. Total sales came to 5 million cedi, which is equivalent to 1250 US

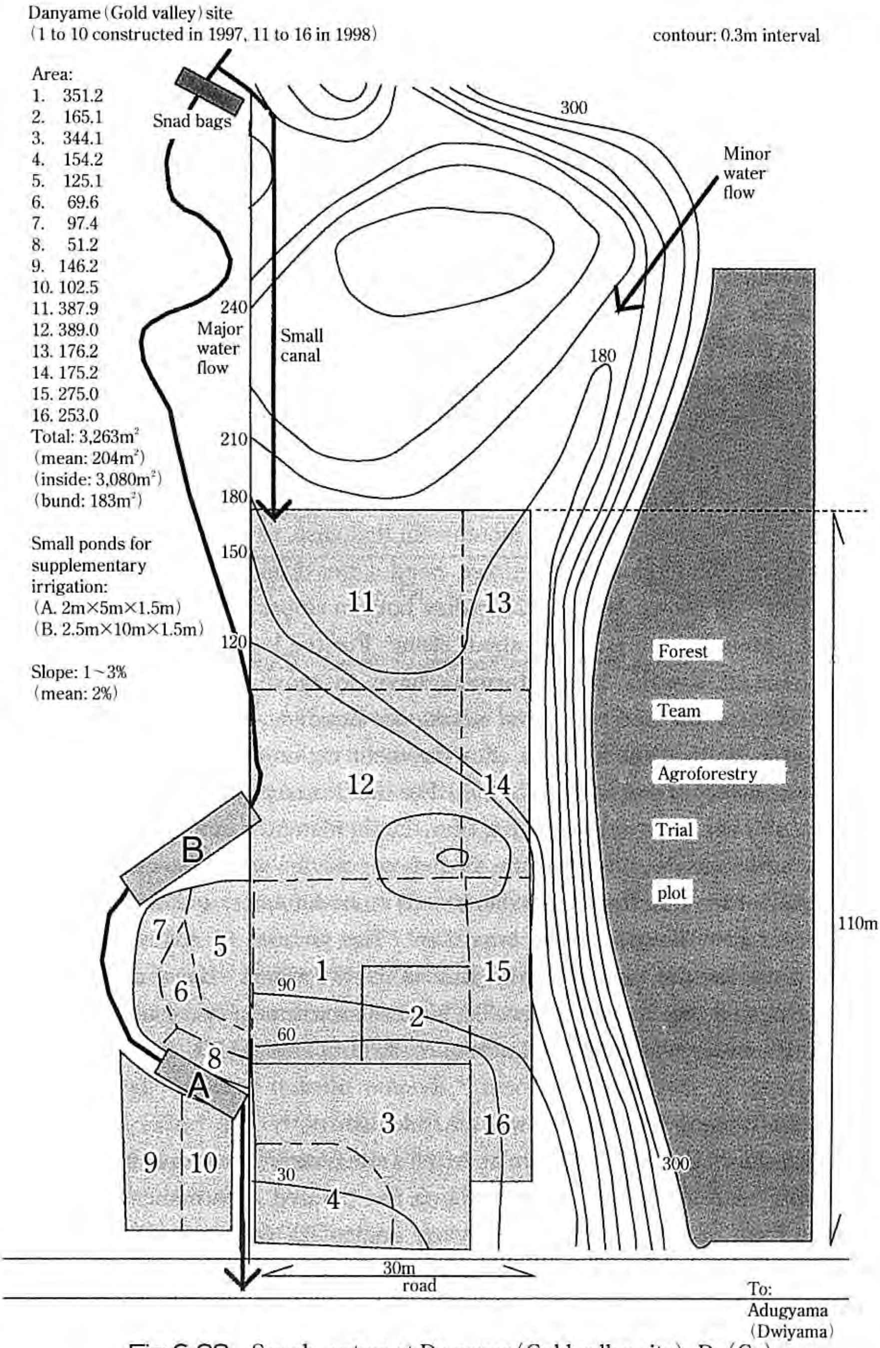


Fig.6-28 Sawah system at Danyame (Gold valley site), Ds (Gs).

dollars using the mean exchange rate between December 1999 to March 2000. This is equivalent to $1406 per ha. The higher sales of the Club-C group was the result selecting a time of a good market price, in December 1999. Relatively lower sales of the Biemso sawah group was the result of the poor market price in March 2000.

(b) Description of various sawah systems

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

Fig. 6-28 shows the sawah at Danyame valley (Gold valley) with a watershed of about 100ha. The central stream is very shallow, not well developed, and does not flow continuously. Major flow occurs during June -July and September. Although some water from the upland flow can be collected at the sawahs during June and September, rice plants in the sawahs suffer from shortage of water during the other growing months. In that case, rice has to be irrigated by pump from a small pond. Sometimes pond water dries up during the dry spell in August. As shown in Fig. 6-28, valley bottom slopes are 1-3%, with a mean of 2%. Mean sawah size was about 200m^2. For the leveling of sawah of such mean size of sawah, 200m^2, farmers have to move about 12.3m^3 of soil. Therefore, for the one hectare of sawah development, farmers have to move about 615m^3 of soil for leveling. For the construction of the bund, $0.4 \times 0.4 \times 0.8$m, about 400m^3 of soil have to be dug. For the construction of two small ponds, 53m^3 of soil has to be dug out per 0.33ha, that is 161m^3 for one hector. Although it was not necessary, three termite mounds per 0.30 ha were also removed. The mean size of the termite mound was 10m (bottom diameter) and height, 2m. The volume of one termite mound was 52m^3. The amount of soil movement to destroy the termite mound per ha was $53 \times 3 \times 3$= 477m^3. If we assume three termite mounds per ha will be leveled, total soil movement necessary to develop one ha of sawah was estimated at about 1333m^3 (Table 6-11).

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

Fig. 6-29 shows the sawah system at Afreh's site (As). For location, see Fig. 6-27. A timber road stretching from Adujama has created a permanently swampy area in front of Afreh's site. Small water pumps, 60-100 liter per minute, were used for the irrigation of the site using swamp water. Although the swamp water lasted long, up to December, irrigation efficiency was poor, because it was necessary to race the water 2m and carry it 30-40m. Furthermore, due to

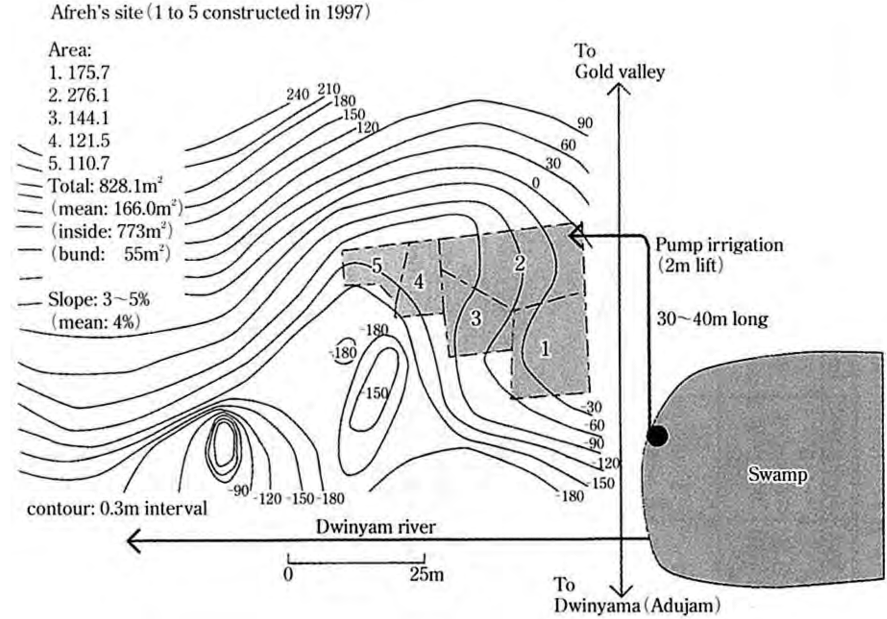


Fig.6-29 Sawah System at Afreh's site (As).

very sandy nature of the soil and some holes which are seen in Fig. 6-29, water permeability of the plow layer of the sawahs was extremely high. Thus, the water requirement of the sawahs was estimated to be higher than 5 cm per day. All these factors make pump irrigation very poor in this site.

The slopes of the sawah site were 3-5%, with a mean of 4%. Mean sawah size was 166m² in our trial, based on the participating farmers' work. Necessary soil movement for the leveling was 1,067m³ and for bunding 420m³ per ha. Two termite mounds were leveled which necessitated the movement of about 105m³ of soil for 0.08 ha, i.e, for one ha 1,316m³. Total soil movement was estimated at 1,645m³ (Table 6-11), including 158m³ for the three termite mounds. If we try to remove all existing termite mounds, mean number about 10 per ha, an additional 1,158m³ of termite soil will have to be moved per ha of sawah (although this is not necessary).

(b)-3 Spring water sawah : Nicolas's site

Fig. 6-30 shows the sawah system at Nicolas's site (Ns) as shown in Fig. 6-27. A permanent spring source was available which is used for drinking water by the Adugyama villagers and for a fish pond owned by the Club-C leader. The spring

Table6-11 Comparison of engineering parameters of various sawah systems tested

	Rainfed type			Pump type	Spring type	Integrated type	Dyke canal type
Site	Ds	Rs	B2s	As	Ns	Ps	B1s
Mean slope	2 (1~3) %	0.75 (0.5~1) %	0.95 (0.4~1.5)%	4 (3~5) %	1.5 (1~2) %	0.6 (0.2~1) %	0.55 (0.1~1) %
Sawah+bund area (ha)	0.29+0.02	0.16+0.01	0.61+0.02	0.078+0.005	0.39+0.02	0.62+0.02	1.22+0.05+0.06*
Mean sawah size (m^2)	200	335	485	166	276	531	444
Soil Movement (m^3/ha)							
Leveling	615	286	436	1067	518	287	213
Bunding	400	320	288	420	336	267	273
Pond	160	235	250+		(973)*	25	
(Termitaria)**	158	158	158	158	158	158	158
Dyke	-	-	-	-	-	-	12
Canal	negligible	negligible	-	-	-	56	200
Total (m^3/ha)	1,333	999	1,132	1,645	1,012	793	856
Total labor cost (dollars/ha)***	3,999	2,997	3,396	4,935	3,036	2,379	2,568
Drought problem	severe	severe	severe	severe	No	sometimes	No
Flooding problem	No	No	?	No	Slightly (flush)	Sometimes (standing)	Slightly (standing)
Fuel cost for pump	High	High	High	Very High	Low/Medium	Midium to High	Low
Operation of power tiller	Somewhat difficult	Easy but long distant	Easy	Somewhat difficult	Somewhat difficult	Easy	Easy
Soil fertility	High	Medium	Low	Low	High	High	High
Occurrence of valley tpye	Many	Many	Many	Many	Few	Many	Many
Priority to Sustainable sawah development	Medium	Medium	Medium	Low	High	High	High
Remarks	Long distance from village. Depends on the incentives of farmers. How to solve the drought problem			Poor Ecotechnology site. Mainly pump depended	Easy water control	Likely to depend on pump	Dyke and canal maintenance. Initial cost for dyke materials (Wooden piles, cement blocks, plastic and jute bags) were one million cedi (=400dollars. May. 1999) for 5 ha

Note: Ds; Danyame valley, Rs; Rise Valley, B2s; Biemso No. 2, As; Afreh, Ns; Nicolas, Ps; Potrikurom, B1s; Biemso No. 1
*area occupying by termite mounds, Pond at Ns is for fish pond.
**Assumind 3 termite mounds per ha are destroyed
***Labour cost for soil movement per cubic meter was about 3dollars, which was equivalent to 7500 cedi before May 1999. In August 2000, 1dollar=6000 cedis.

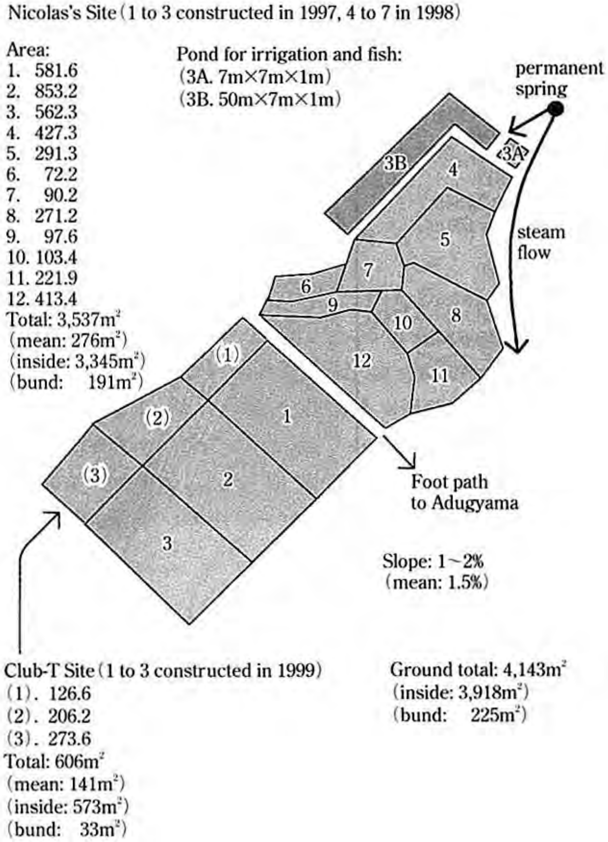


Fig.6-30 Sawah system at Nicolas site (Ns) and Club-T site

may partly originate from Adugyama village or township, with a population of 4000 people. The spring flow rate was estimated at 2-5 liters/sec, mean of about 3 liter per second, of which roughly half was used for the fish pond. The remaining 1.5 liter per second will be available for the sawah. This amount of water can make about 1.5 ha of sawah irrigation. So far about 0.39ha of sawah had been developed by the end of August 1999, and 0.60ha by the end of July 2000.

Slopes of the sawah site were 1-2%, with a mean of 1.5%. Mean sawah size was 276m². Necessary soil movement was 518m³ for leveling and 336m³ for bunding. Total soil movement was about 1012m³ per ha, including 158m³ of termite mound treatment.

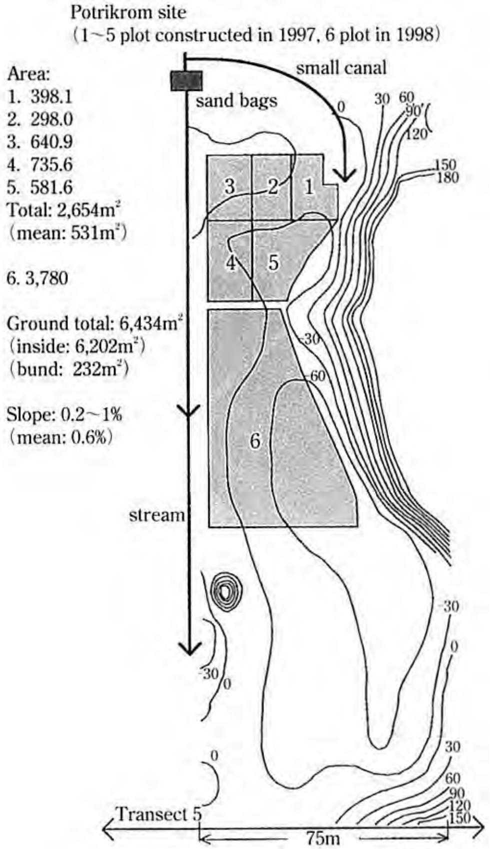


Fig.6-31 Sawah System at Potrikurom Site for research field.

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

Fig. 6-31 shows the sawah system at Potrikurom site (Ps) as shown in Fig. 6-27. Since the catchment area of the site is about 2500ha, second order valley, the flow of the central river is usually sustainable between June and November. A small dyke made from sand bags, a canal and supplementary pumping directly from the stream can manage the sawah system. Therefore, this sawah never suffers the shortage of water. Rather, because of its topographical position, i. e., just after the junction of the two major streams as shown in Fig.6-27, this sawah sometimes to suffer deep flooding, approximately 30-50cm, for 1-2 weeks during June.

The slope of this site is about 0.2-1%, with a mean of 0.6%, and the mean size of the sawah was 531m². Necessary soil movement was 287m³ for leveling and 267m^3 for bunding. Although two small ponds, 2×4×1m, were necessary, the additional soil movement was only 16m^3 per 0.64 ha, i.e., 25m^3 per ha. A small canal was dug out 0.6×0.6m and 150m long. This required soil movement of about 36m^3 per 0.64 ha, i.e., 56m^3 per ha. Total soil movement was therefore about 793m^3 per ha for the development of the sawah, including 158m^3 of termite mound treatment.

(b)-5 Dyke irrigation sawah : Biemso No. 1

Fig. 6-32 and 6-33 show the sawah system at B1s, Biemso No. 1 site ; the location is shown in Fig. 6-29. This system, composed of an overflow type dyke, a canal and the sawah, offers full irrigation. The dyke was constructed with 60 wooden piles (locally available hard wood), 5×10cm wide and 1.5 to 3.5 m long, which were pushed into the river bed up to 1m depth. The four lines of wooden sticks were roughly interconnected using long, slender bamboo poles. The central part of the wooden sticks were fixed to each other using the same 3.5m long wooden

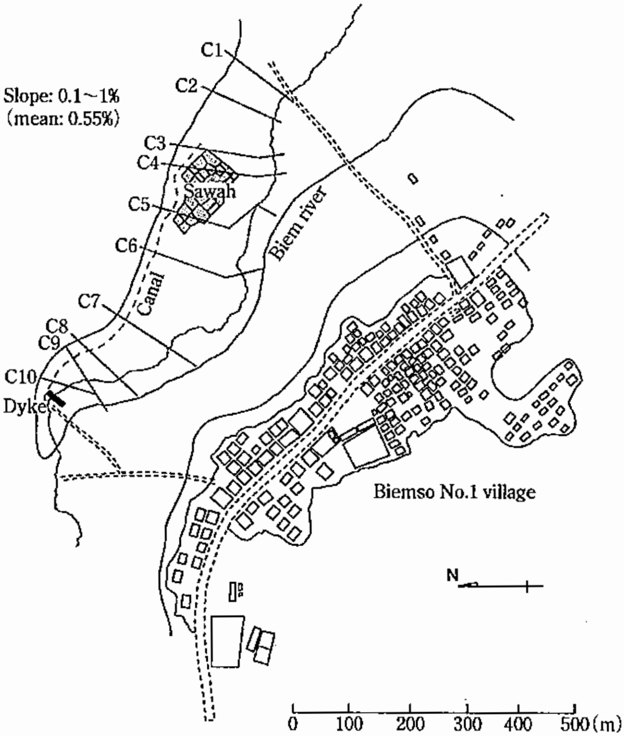


Fig.6-32 Biemso No.1 sawah system with cross section lines(C1~10).

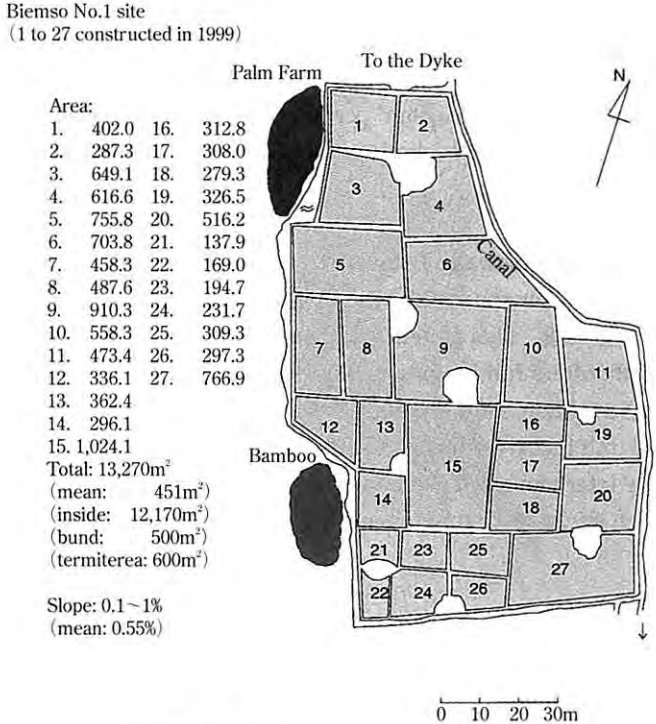
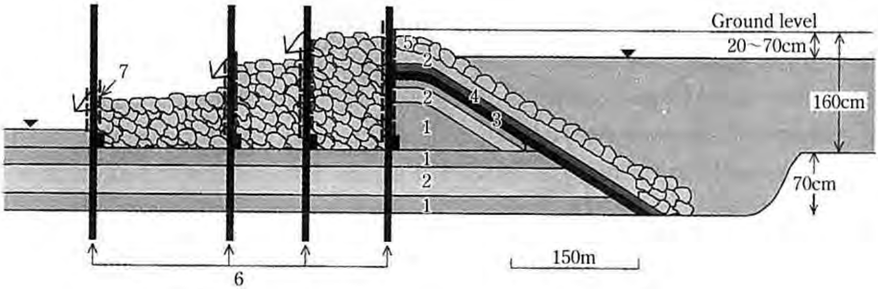


Fig.6-33 Sawah system at Biemso No.1.



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

Fig.6-34 Biemso No.1 Dyke, side view from the canal side.

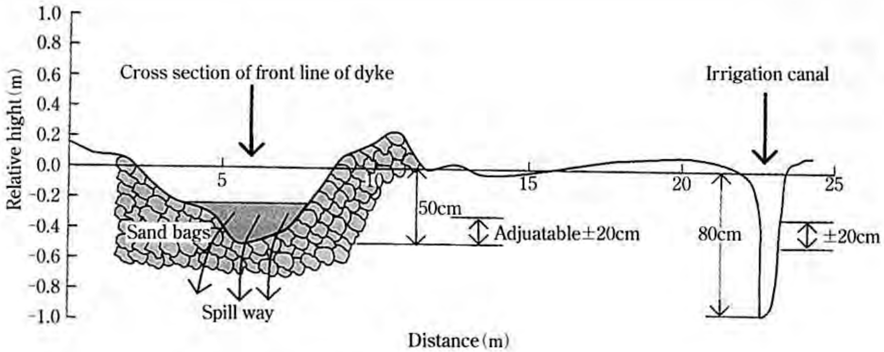
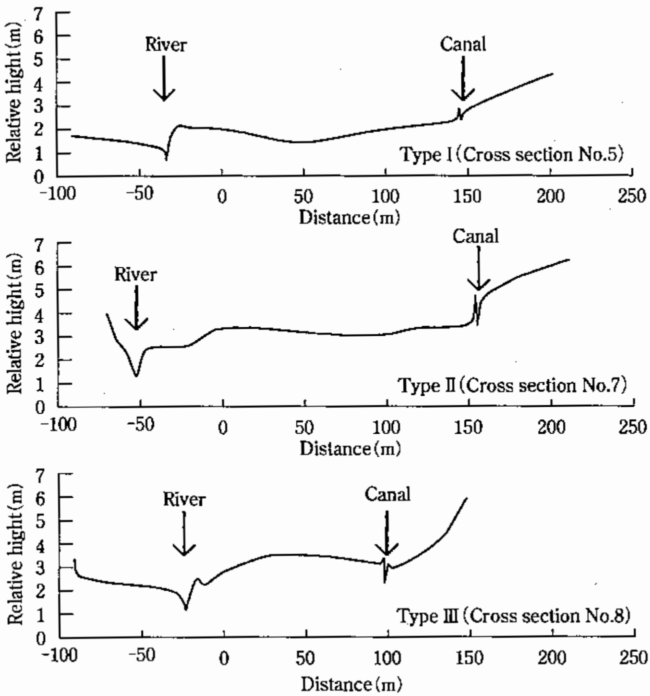


Fig.6-35 Adjustable canal flow system using sand bags.



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

Fig.6-36 Cross section of lowland in Biemso No.1.
See the position of cross sections (C5, C7, C8) in Fig.6-32.

pile. The bottom part of the dyke was constructed using soil from the nearby upland. Clayey soil was paddled with the foot untill it became very plastic. This was used to seal the pores within the first bamboo dyke that received the direct impact of the river force (Fig. 6-34). Sandy-clay soil from the river bed was excavated from a distance of 1.5m from the dyke. This was heaped and compacted to form a triangular shape. The detailed of structure of the dyke are shown in Fig. 6-34. Fig. 6-35 shows how to control the canal flow by adjusting the bottom height of the spillway using sand bags.

A 800m long canal was dug, width 1.5×1.0m and mean depth 0.8m. Total soil movement for the construction of the canal was 800m^3. Since a depth of 1m would be better, the total soil movement for the canal excavation was estimated at 1000m^3. The slope of this site was 0.1-1%, with a mean of 0.5% and the mean size of the sawah was 444m^2. Necessary soil movement per ha was 213m^3 for leveling and 273m^3 for bunding. Total soil movement was 486m^3 per ha. Since Biemso No.1 farmers developed 1.22 ha for the first year, actual soil movement was 587m^3. Based on this potential, total soil movement per ha of the sawah system was 856m^3. The break down was 12m^3 for dyke construction, 200m^3 for canal excavation, 213m^3 for leveling, 273m^3 for bunding, and the treatment of three termite mounds (of 158m^3).

The measured maximum amount of water intake through the canal was about 40 liter per second. If we assume water loss of about 50%, and mean of possible intake of 20 liter per second, then the potential irrigated area will be more than 5ha. As shown in Fig. 6-36 and Fig. 6-32, the area between the cross-section C7 and C1 (and beyond) has a potential for the development of irrigated sawah. By August 2001, the sawah group farmers at Biemso No1 developed of 3ha sawah (Wakatsuki et al 2001b).

(c) Comparative evaluation of various sawah systems tested

The engineering and economic parameters of various sawah systems tested in this study are summarized in Table 6-11 and 6-12. The rainfed type of Gs and Rs (also B2s) needs considerably more work for soil movement because of the relatively steep slope of 1-4%. It seems that the slope difference between Potrikurom/Biemso No.1 and the Gold valley/Rice valley is negligible (1-3% to 0.1-1%). However, for sawah development, the difference was significant as the soil movement needed for leveling was more than double. If all necessary components are included, such as bunding, pond digging, dyke construction, canal excavation, and the minimum treatment of the termite mounds, the amount (m^3) of total soil movement in each system per ha of sawah system are Gs 1,333, Rs 999, B2s 1,132, As 1,645, Ns, 1,012, Ps 793, and Bls 856. The cost estimation for the sawah system development based on the soil movement (about 18,000 cedi, which is equal to 3.0 dollars, per cubic meter on August 2,000 at Kumasi) was as follows., 3,999 dollars for Gs, 2,997 for Rs, 3,396 for B2s, 4, 935 for As, 3,036 for Ns, 2,379 for Ps, and 2,568 dollars for B1s. This is a reson why the sawah development at Adugyama Club-C site was smaller in size and the area developed per year compared to the Potrikurom and Biemso No.1 site.

The drought-prone nature of the rainfed type sawah is another problem that we have to consider. Even using excavated ponds, the amount of available water is small, therefore it is difficult to manage large sawah. The drought problem reduces the major advantage of the sawah system, i.e., weed control by flooding. Therefore, rice plants may suffer from both a shortage of water and weeds under drought conditions. This is another reason why the Gs and Rs sites cannot be made into a larger sawah. Fuel cost for pumping from the pond will be considerable. Relatively steep slopes made the operation of the power tiller somewhat difficult. The relatively long distance from the village to the sites of Gs and Rs as shown in Fig. 6-27 is another problem, since the power tiller and the pump have to be carried to the site. Soil fertility is medium to high. Although valley bottoms of these kinds are extensive (under survey), their priority for sustainable sawah development will not be so high.

To get the irrigation water for the Afreh's site, 100% operation of the pump is necessary. Because of the sandy nature of the soil, the water requirement is very high. This makes fuel cost also very high. Apart from the fuel cost, this site has the steepest slopes among those tested. Therefore soil movement for the construction of the sawah was the highest, 1645m^3 per ha without the excavation of the pond or canal. Also soil fertility was poor. The site has since been abandoned (2000) after 3 years of cultivation as shown in Table 6-10.

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

In terms of sawah development, the Potrikrom site will be the easiest, since soil movement will be minimal. Soil fertility is also high. A minimum scale dyke, made by just using small sandbags, can supply enough irrigation water for the sawah. Supplementary irrigation from a small pond is also available. The only problem of this site is flooding, which may continue for more than 2 weeks. This happened in June, 1998, one year among the four tested in this project. Transplanted young rice plants suffered considerably and fertilizers were flushed away. Since this kind of valley is wide-spread in the valley bottom in this area, the priority for the development is very high.

Biemso No.1 system has the full facilities constructed for irrigated sawah. Since the slope is minimal, leveling and bunding are the easiest among the sawah tested. The dyke was broken twice in the first year, June and August 1999, but was repaired and improved in March and April 2000 by the Biemso No. 1 group of farmers in participatory manner with Ghanaian counterparts as described in Fig. 6-34. By 18 August 2001, after minor repair work in April 2001, the newly repaired dyke was working without any problems even in the second season. Because expansion was so easy, the area of the sawah reached about 3 ha by the end of August 2001. Since the dyke and canal system is new for the farmers, the project has to carry out special on-the-job training for 1 or 2 years. Once the participating farmers can master basic ecotechnology for the development and maintenance of the system, expansion will be easier. The distribution of the valley bottom adopted to this system is widespread (under survey), therefore, the sawah system has a high priority for the watershed development in this area.

Table 6-12 summarizes the economic parameters of various sawahs tested. Labour mandays for soil movement per ha were Gs 2,530, Rs 2,370, B2s 1,866, As 2,920, Ns 2,040, Ps 1,182, and B1s 920. These figures can be compared with the total soil movement as shown in Table 6-11. Since labor cost was about 2 dollars per manday, estimated costs for the construction of the various sawahs were (dollars/ha) Gs 5,060, Rs 4,740, B2s 3,732, As 5,840, Ns 4,080, Ps 2,264, and B1s 1,840. In addition to these labor costs, the costs of fuel for pump and powertiller for the development were estimated at (dollars/ha) Gs 48, Rs 48, B2s 57, As 102, Ns 38, Ps 23, and B1s 46. In the case of B1s, materials for dyke construction were purchased. Total cost was about one million cedi, equivalent to 400 dollars for the dyke, which has a capacity to irrigate more than 5ha. Therefore the cost per ha was 80 dollars. Total costs for the development of the various sawah

Table6-12 Comparision of economic parameters of various sawah testei

	Rainfed			Pump	Spring	Integrated	Dyke and canal
Sawah types sites	Gs	Rs	B2s*	As	Ns	Ps	B1s
Sawah (ha)	(0.29/ha)	(0.16/ha)	(0.61/ha)	(0.078ha)	(0.39ha)	(0.062ha)	(1.22ha)
Sawah+Bund (ha)	(0.31/ha)	(0.17/ha)	(0.63ha)	(0.083ha)	(0.41ha)	(0.64ha)	(1.27ha)
Soil Movement (man. days/ha)							
Clearing	150	150	150*	150	150	150	150
Leveling and bunlding	2,120	1,840		2,770	1,890	950	600****
Pond	260	380	400*	-	(1,460)**	40	-
Dyke	-	-	-	-	-	-	20
Canal	-	-	-	-	-	42	150
Total (man. days/ha)	2,530	2,370	1,866	2,920	2,030	1,122	920
Actual works in man days for each site development	921 1176 (2 termites)	403 (one)		382 (2 termites)	972 (2 termites)	826 (2 temites)	1,975 (2 termites)
Fuel for pump at construction /ha	74,500	74,500		196,000	52,000	25,000	25,000****
Fuel for power tiller for (cedi/ha)	45,000	45,000		59,000	38,000	32,000	90,000****
Total cost in dollars per ha for sawah development	5,100	4,800	3,790	5,900	4,100	2,400	2,000
Agronomic works in man days /ha***	283	283	276	304	277	266	260
Fuel for pump	21,000	21,000	42,000*	124,000	24,000	21,000	5,000
Fuel for power tiller	46,000	44,000	30,000	44,000	36,000	30,000	30,000
Fertilizer	152,000	136,000	150,000	137,000	183,000	137,000	108,000
Chemicals	21,000	25,000	23,000*	39,000	30,000	29,000	29,000
Maintenance of machine	175,000	175,000	175,000	175,000	175,000	175,000	175,000
Total (in cedi/ha)	195,000	469,000	420,000	519,000	448,000	392,000	347,000
(in dollar/ha)	166	188	168	208	179	157	139

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

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

*** For the breakdown, see Table 6-15. These values shoud be reduced through the improvement of agronomic skills of farmers

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

***** Power tiller was used for moving muddy soil by attaching wooden plate (See color photo) which accelerate leveling work considerably. Pump was used only at the period when dyke was broken in June-July, 1999. There were no pump operation during the sawah development in 2000

Table6-13 Cost estimation for sawah development in dollars per ha

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

*Area developed by August 2000

Note: Machinery Cost (Life Span=5years)

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

Total 1,080$/ha

Table6-14 Rice Production Cost in man days/ha based in 1999. (man days/ha)

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

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

** no data available, only estimation

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

systems were therefore (dollars/ha) Gs 5,100, Rs 4,800, B2s 3,800, As 5,900, Ns 4,100, Ps 2,400, and Bls 2,000.

Table 6-13 summarized the cost estimation for the sawah development in dollars per ha based both on estimated mandays for the development (*Wakatsuki et al*, 2001b) and on the volume of soil movement (Table 6-11). The mean cost including fuel and materials was (dollars/ha) was Gs 4,570, Rs 3,900, B2s 3,600, As 5,470, Ns 3,600, Ps 2,400, and Bls 2,350. If the cost of power tiller is 4,000 and pump 500 dollars, the life span of the machines is five years, and the maintenance is 20% of the total cost of machinery, then machinery cost per ha of sawah development will be 1,080$. Therefore the grand total will be Rs 5,650, Gs 4,980, B2s 4,680, As 6,580, Ns 4,680, Ps 3,480, and Bls 3,430 dollars.

Cost estimation of various agronomic practices for rice farming in mandays was also summarized in Table 6-12. The breakdown of the various agronomic practices is shown in Table 6-14. Since the participant farmers were all new in sawah-based rice farming, these figures will be reduced through improvement in the farmers' agronomic skills.

Among the costs which the farmers have to bear for rice production, fertilizer and spare parts come first, then fuel. The total cost in dollar equivalent per ha was estimated at $139 for B1s site, the lowest, and $208 for As site, the highest. Although at the moment we cannot properly estimate the cost of maintenance for the pump and power tiller, those will be the most expensive.

3-2 Participatory ecotechnology approach for sustainable sawah development

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

<u>Possible funding for sawah development to make the ecotechnology approaches sustainable in Ghana and West Africa</u>

1. Call for sawah group formation of about 10 farmers
2. $6,000 loan for one group : breakdown
   $4,000 for power tiller
   $500 for tools for development and rice cultivation
   $5,00 for small pump
   $1,000 for annual running costs including fuel, spare parts, fertilizer, sand and pesticides
3. Provision of free technical advice. The development of sawah system, rice cultivation by sawah group without payment.
4. 1 ha of sawah development ; 5ha per five years during the five years of no loan payment. During 6-11 years, loan payment with 5% interest. Total payment will be $7,050 and annual mean payment will be $1,175.
5. 1st year : income will be $1,350, assuming a rice sale of $ 1100 from 3.5t/ha

of $200 from and dry season vegetable.

6. 2-5th year: total sales will be $2.600-6,500 and running cost, $600- $1000 annually. 7. 6th year : yield will increase to 4.5t/ha, vegetable production will also increase by same rate. Then total sales will be $7,300 per group. The net income will be $5125 after paying mean annual loan, $1,175, and depositing the necessary annual running cost, $1,000. Mean annual income per each farmer will be $500 (currently about $250).
8. Continue to produce more sawah up to about 10 ha. Then annual income will be $1,000.
9. During the project period, plots of multipurpose tree species and other useful trees are enlarged. Fishponds (see color photo) are constructed and tilapia, catfish, etc., are cultured there.

This participatory ecotechnology approach for sustainable sawah development in inland valleys in Ghana and West Africa can be applied, for example, as follows. The Ghana government has plans to develop 5000ha of irrigated sawah in various parts of inland valley bottoms of Ghana with a $20million loan from the African Development Bank. This participatory ecotechnology approach will be one possible option to examine. Since the major investment is to buy a small power tiller to develop sawah, KR-2* donation by the Japanese government will be an other possible option to integrate the ecotechnology approach. Based on the results of this joint study project, we propose to examine the possibility of a new approach for Project Type Technical Cooperation under an ODA scheme of Japanese government. Since the essence of the participatory ecotechnology approach is training and education in the field, we have to develop new types of technical cooperation to integrate (1) institutional backstopping to facilitate training and education for sawah development in the field, (2) integrated technical cooperation in agronomy, engineering, and environment, (3) KR-2* donation for sustainable agricultural development, (4) loan-based projects of JBIC, AfDB, USAID, and/or World Bank, and (5) Asian/African collaboration.

(D. Kubota, E. Otoo and T. Wakatsuki)

*KR-2, Kennedy Round two, is a form of ODA of Japan, which supply materials and equipment to increase food production in developing countries.

3-3 Farmers' evaluation on the on-farm trial

(1) Introduction

Although as described in the previous section, the project is a joint study project, not real development project, to find out a new ecotechnology approach for sustainable sawah development, this section examines the impact of the sawah field development projects conducted in rural areas in southern Ghana from the viewpoint of the residents' recognition of and opinions about different types of spaces (sawah fields, traditional rice fields, mixed-cropping fields, and cacao farms). The purpose is to study the opinions of the participating and non participating farmers (residents) on the scenery of sawah fields in the project sites from various angles. The survey sites are two villages, Biemso No. 1 and Adugyama, where the development of small-scale sawah fields has been attempted with farmer participation since 1997. In these villages, the groups of local farmers are making sawah fields equipped with small-scale irrigation facilities. This section examines what effects these sawah fields have had on residents and participating farmers as well as on the villages' scenery and attempts to forecast what problems will arise and how the rural communities will change in the future.

Subsection (3) examines what impact the sawah field development has had on residents and what impressions it has given to them. Subsections (4) and (5) deal with the relations between the sawah field spaces and residents' awareness of these spaces. They study differences in images of sawah fields between residents and participating farmers and whether rural people regard the newly appearing spaces (sawah fields) as special, or see these spaces just as part of farmland and feel no particular impact. Subsection (6) studies the prospect of farmers participating in projects for sawah fields by sounding out their feelings about a sawah field development plan.

(2) Outline of the survey sites

The survey sites, Biemso No. 1 and Adugyama, are located about 40 km northwest of Kumashi, the capital city of Ashanti, Ghana (Fig. 6-15). Belonging to the tropical semi-deciduous forest zone, this district has a yearly precipitation of 1,200～1,400 mm. The year is divided into the rainy season from March to October (a short dry season comes in August) and the dry season from November to February or March. Biemso has a population of about 1,900 and Adugyama about 4,000. Both are medium-scale villages according to the

Ghanaian standard (Gog, 1995). Recently, is the declines in numbers of young people in their twenties is remarkable. This clearly shows the outflow of young people to cities and needless to say, is one of the main reasons for depopulation in rural districts. Ninety-five percent of the villages' population is engaged in farming, and main farm products are cassava, yam, maize, plantain, consumption and other crops for home consumption plus cocoa and rice, the cash crops. Rice is grown in inland valleys by the traditional method dependent on rainwater.

(3) Interview survey on the residents' opinions about sawah fields

1) Purpose

This interview survey was conducted to investigate, first of all, how far residents in the project sites were interested in and aware of sawah fields. In addition, it analyzed how residents' interest in sawah fields had changed in the village in the third year of sawah field development (Adugyama project started at 1997) and in the first year (Biemso project started at 1999), how different such interest had been between the sexes, between rice farmers and those not growing rice, and between settled-down and migratory groups. The survey investigated what background situations existed for different types of interest, and people's reasons for having interest in sawah fields.

2) Survey results 1 : Questions and answers

Table 6-15 shows the resulsts of questions and answers of residents in the two villages by birthplace, gender (sex) and rice-growing experience. More then 70% of the respondents on average have heard the word "sawah." But almost all of them say that they heard the word first in their village and that they heard the word but do not know what it is. To the question, "Do you know what the Japanese and other people from other areas are doing ?" 93% of the respondents in Biemso, the village in the first year of sawah field development, and all of them in Adugyama, the village in the third year of the project, correctly answered, "They are doing a rice-growing project" or "They are growing rice." Those who said "I don't know at all what they are doing" were found only in Biemso, accounting for 7% of the respondents, and all of them were women. About 50% of the respondents in Biemso and nearly 90% of those in Adugyama had seen the sawah fields on some occasion or other, and the ratio of those who had taken the walk to go to see them was higher in Adugyama than in Biemso. This indicates that residents' awareness of the project increased with the

Table6-15 Answers of residents in the two villages by sex, ethnic group and birthplace (%)

Question	Bl *1	Ad *2	Sp *3	Mp *4	M *5	F *6	Wr *7	Wo *8	Av *9
Know what the project is doing	93	100	95	97	100	92	96	93	88
Have heard the word "sawah"	58	71	75	54	67	62	66	49	71
Know the difference between sawah and traditional rice growing to some extent	84	96	68	71	72	67	76	57	74
Have seen sawah	51	88	93	85	95	84	92	61	81
* How did you see sawah ?									
Took the walking for seeing them	43	63	49	58	62	45	60	48	54
Happened to pass by the sawah	57	37	51	42	38	55	40	52	46
* Do you know the members of the project ?									
Know some of them but don't know the total number correctly	60	71	64	67	67	64	67	75	64
Know all the members and can say the total number	20	27	30	16	16	28	19	25	24
Don't know at all who are doing the project	18	3	5	17	17	7	15	6	11
Are you interested in the project ? (Yes)	85	84	84	85	87	81	92	63	83
* Why ?									
Want to earn more money	43	52	43	53	50	45	44	28	45
Can learn sawah techniques	86	41	65	62	64	63	66	42	61
Attracted by the machines	14	11	14	9	22	1	14	26	14
Want to find a job	28	26	33	20	31	22	23	19	25
Intensive method for rice growing	93	85	87	87	94	82	87	89	88
Beautiful	13	10	16	10	1	25	8	19	13
Others	11	16	11	15	16	11	13	17	14

(*1 Biemso No.1, *2 Adugyama, *3 Settled-down Ashanti people, *4 Migratory Zongo people, *5 Mean-males, *6 Mean-females, *7 Those with rice growing experience, *8 Those without rice growing experience, *9 Average)

passage of time (Fig. 6-38). While those who actually saw the sawah fields made up 70% of all the respondents, as many as 90% of them were able to describe roughly the differences between sawah fields and the traditional rice-growing system (e.g., the use of small machines, such as power tillers and pumps, dikes and canals, planting method, banks). This suggests that though residents do not see sawah fields, they can get knowledge about them from other residents.

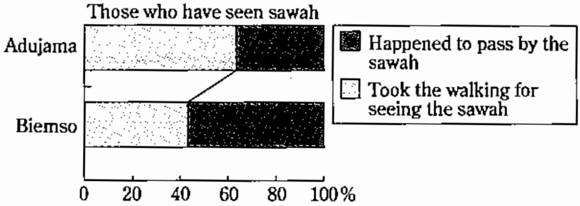


Fig.6-37 Opportunities to see sawah

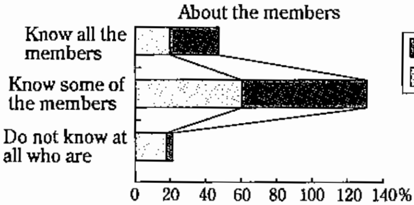


Fig.6-38 About the project members

Those who knew the differences or had some knowledge about sawah fields had a higher ratio in Adugyama, showing that this knowledge was more widespread in the village.

In Biemso, 18% of the respondents said they don't know at all who are doing the project but the ratio was only 3% in Adugyama. As evident from Fig. 6-38, residents' knowledge of the project increased as time passed. Both in Biemso and in Adugyama, 85% of the respondents said that they wanted to take part in the project if they had a chance. The reasons most often mentioned are that they want to learn sawah field techniques and the sawah field system is more intensive (or more profitable). There are also many people who find the introduction of machines attractive, who have an interest because of a better appearance (sawah fields are beautiful) and who considered that the project and the participating farmers had an employment contract. Other main reasons include that it is attractive to work with foreigners or to work as a group. Some answered "Because it is possible to grow off-season crops in sawah fields" or " Because the rice from sawah fields has a better taste." These reasons show that the knowledge villagers generally have about the sawah field system is that it has a high yield and so is more profitable than the traditional system and that it uses new technology.

The indigenes Ashanti people in the villages have more knowledge of sawah fields than the migrants. This is partly because the villagers who took part in the sawah field project were almost all those permanently living in the villages but also because the sawah fields are far from the areas where migrants live. Despite this, the migrants went seeing the sawah fields more positively than the indigenes, this shows that the migrants (many of whom are engaged in farming, mainly rice growing) have a stronger interest in sawah fields.

Men tend to get information both by the "ear" and by the "eye" more positively than women and so it can be said that men are more interested in sawah fields than women. Behind this is probably the fact that far more men than women are project members. Though men have a little bit higher interest than women, both of them show a fairly great interest in sawah fields. More women admire sawah fields "beautiful" than men and the fact is interesting that they consider sawah fields to be "beautiful". Men are more interested in machines than women. These facts indicate that the outward appearance of sawah fields and sawah agriculture is one factor for arousing their interest. No differences in the desire to learn sawah field techniques are observed between men and women.

Those who have experience of rice growing clearly have a greater interest in sawah fields than those who do not. This difference is larger than that with regard to sex and birthplace, indicating that interest is greatly affected by experience in rice cultivation. In addition, those with experience know the project members better. Those having no experience tend to judge sawah fields more by outward appearance (the machines are attractive; sawah fields are beautiful), whereas experienced people have the tend to have more interest in technical sides.

3) Advantages and disadvantages

This subsection studies how villagers consider the advantages and disadvantages of sawah fields and makes an objective analysis of their knowledge of sawah fields. Fig. 6-39 summarized the opinions of villagers. Eighty-three percent of the respondents in Adugyama and 76% in Biemso gave at least one advantage or disadvantage. The answers of respondents from Biemso about the strong and weak points of sawah fields have smaller range than those from Adugyama. The latter respondents do not understand sawah fields fully but their opinions are more diverse and their reply ratio is higher. This suggests that residents in Adugyama get more information and knowledge firsthand.

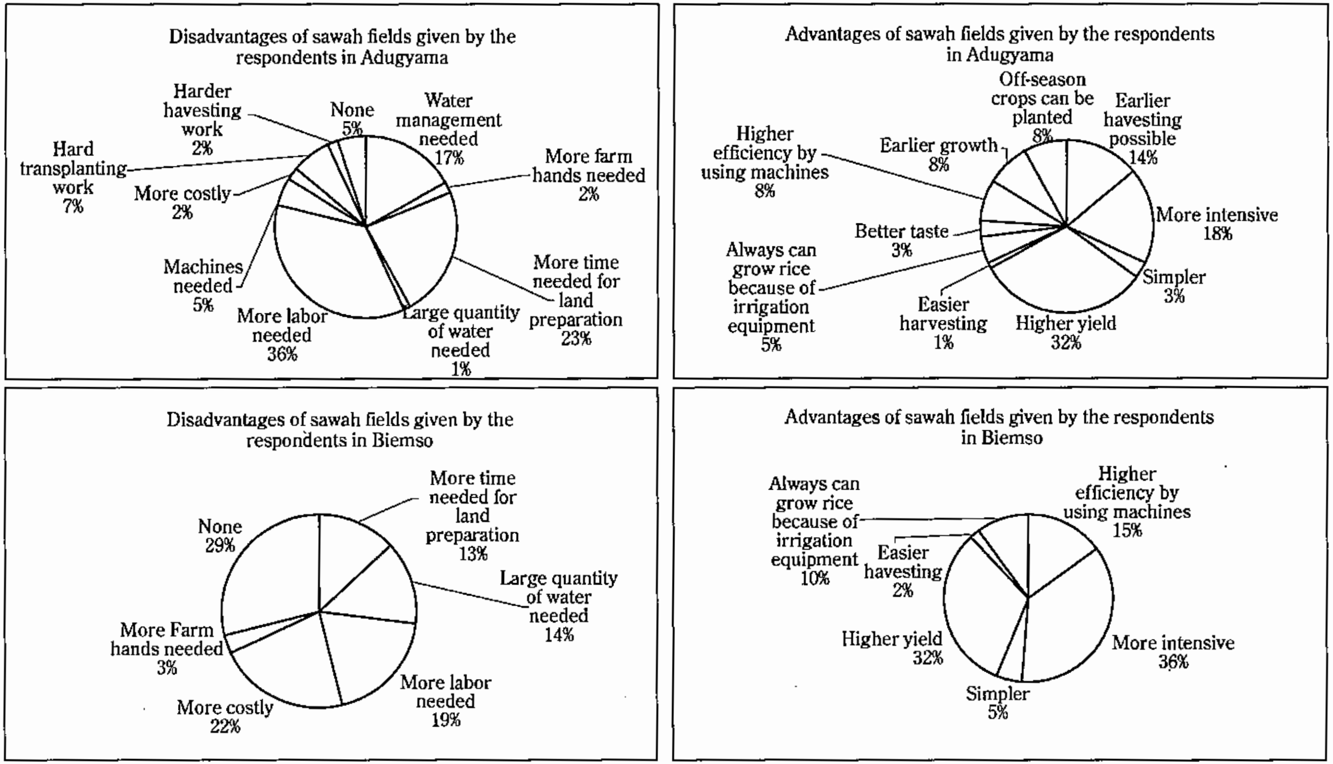


Fig.6-39 Advantages and disadvantages of sawah pointed out by residents

4) Summary

At the time of survey Biemso was in the first year of introduction of sawah fields but the survey showed that many residents in the village were aware of sawah field and were interested in them. But they do not understand the advantages and disadvantages well and most of them have positive images only of sawah fields. One reason that"rumors" about sawah fields spread quickly is probably because the village is a relatively small community of about 1,900 residents. It was also found that the use of machines, group working and the existence of foreigners and people from other districts helped heighten impact on the inhabitants. In general, it can be said that they have a great interest in sawah fields and feel a lot of attraction to sawah fields techniques, intensive ways of rice farming and possibilities of making more money (getting a job).

Similarly, people in Adugyama have a considerable knowledge of and a fairly high interest in them. Many of the respondents correctly point out the advantages and disadvantages of sawah fields and have a rough understanding about them. "Making sawah fields is the task that needs hard work and much money but is interesting because it is profitable"-This is the general image of sawah fields that the residents of Biemso and Adugyama have. They seemed to have a firm belief that rice cultivation is profitable and that rice is a cash crop.

The respondents' interest is affected more by experience in rice growing than by sex and birthplace. Their knowledge and awareness of sawah fields increased as more years have passed since the start of sawah field development. But the number of those who showed an interest or wanted to take part in the project is not affected much by the duration of the project. This indicates that getting more knowledge about sawah fields would not lead directly to a increased intention to participate or a higher interest ; instead, interest in sawah fields is inducing the people to get more knowledge about them.

(4) Farmers' images on sawah fields : "Are sawahs more beautiful than cocoa farms ?"

1) Outline

What images do the participating farmers and residents have of newly created views of sawah fields relative to traditional cocoa farms, mixed-cropping fields and other cropland ? The semantic differential (SD) method (used to measure the mental reactions of persons who have seen and experienced a certain kind of space) was used to measure the reactions of the farmers and other residents to sawah fields, cocoa farms, mixed-cropping fields and traditional rice fields. The survey also examined whether their images differed according to sex and whether they took part in the project or not.

2) Survey method

①Summary of the survey method

First of all, a preliminary survey is conducted to obtain factor axes. Then the representative scales composing the factor axes are used to conduct the main survey. The adjectives frequently mentioned by the respondents for the interview survey on the residents' opinions on sawah fields that was conducted in January 2000 were used as the factor axes. What is important here is to take care not to miss the adjectives likely to be used to describe the target spaces and to choose the opposites of such adjectives (Architectural Institute of Japan, 1987).

② Evaluation scales

The evaluation scales were designed as shown in Fig. 6-40. The factor axes used are the following seven: beautiful (ugly), impression of newness (old-fashioned impression), impression of rich (impression of poor), wet (dry), machine power (human power), intensive (extensive) and easy systems (difficult systems). As noted above, these were selected from among the words the respondents used frequently in the questionnaire survey.

③ Target spaces

The target spaces are sawah fields, traditional rice fields, mixed-cropping fields and cacao farms.

④ Respondents

The respondents are the 48 men and women living in Biemso. The "sawah group" consists of the eight who took part in the sawah field project (hereinafter referred to as the "sawah group"). Of the respondents, 80% are those with experience in rice growing and 70%, those having experience in cacao cultivation (including day laborers). The sex ratio is 1 : 1.

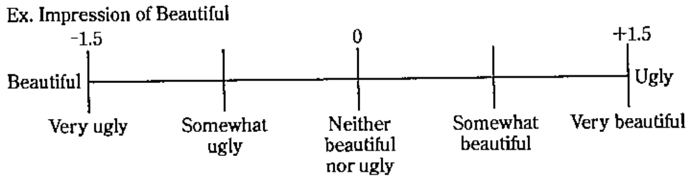


Fig.6-40 Evaluation scale

⑤ Evaluation experiment

In the SD method, the respondents are usually given the chance to experience the target spaces and are asked to evaluate the spaces either at the same time as or just after the experience (Architectural Institute of Japan, 1987). But since the present survey aimed only at analyzing the images that the respondents already had, the respondents were not given any opportunity to experience the four types of the target spaces. About 60% of them had already seen sawah fields and those who had not were asked to answer giving the images built up from the information obtained.

3) Result and discussion

For each of the target spaces and evaluation scales, average values were calculated and the data of all the respondents were plotted on the graphs of each evaluation scale. The respondents' opinions on mixed-cropping fields, cacao farms, traditional rice fields, and sawah fields were analyzed. As seen from Fig. 6-41, the respondents said sawah fields are more beautiful than any other types of farmland. There are no significant differences in opinions between men and women. According to the answers of all the respondents, sawah fields are the most beautiful, followed by mixed-cropping fields, cocoa farms, and traditional rice fields. The sawah group considers traditional rice fields to be "not beautiful" or "somewhat ugly," which suggests that this group lays a greater stress on the factor "beautiful" than the other farmers.

As evident from Fig. 6-42, the respondents have impressions of newness about sawah fields but feel that all the others are old-fashioned. All the

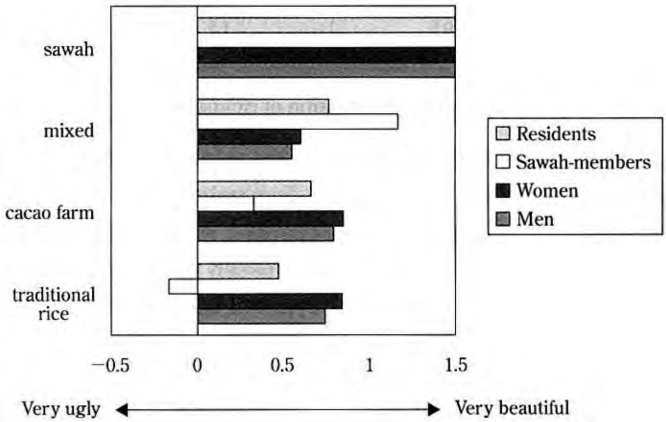


Fig.6-41 Impression of Beautiful

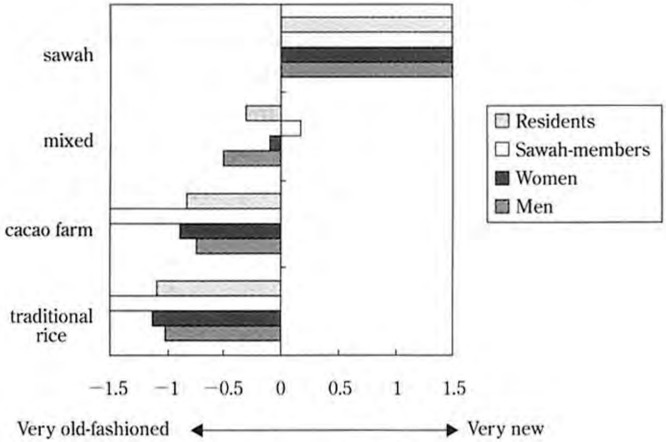


Fig.6-42 Impression of newness

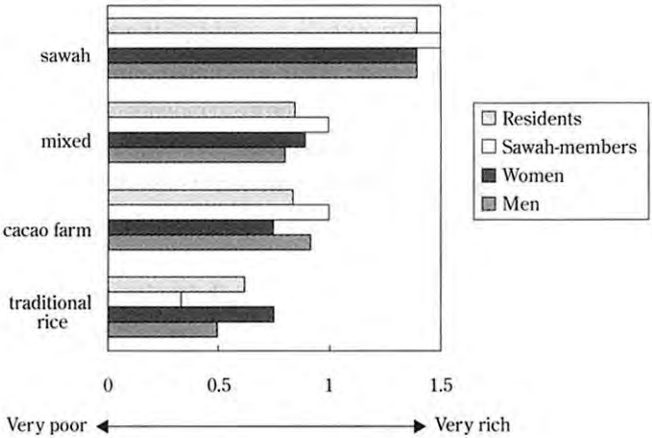


Fig.6-43 Impression of richness

respondents regard traditional rice fields as the most old-fashioned, followed by cocoa farms, and mixed-cropping fields. In particular, the sawah group and women have an image of these as old-fashioned more than the other groups. Attention should be paid to the wide gaps between the sawah group's image of sawah fields and that of the three other types of farmland.

The respondents have the impression that all of the four types of farmland are more or less rich and do not consider that any of them are poor. They have the image of sawah fields as the richest, followed by mixed-cropping fields, cocoa farms, and traditional rice fields. Here again, the sawah group evaluates

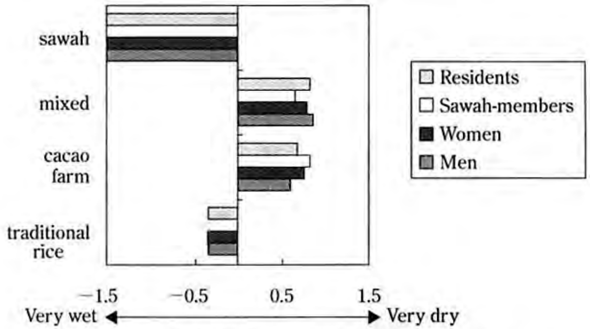


Fig.6-44 Impression of wetness

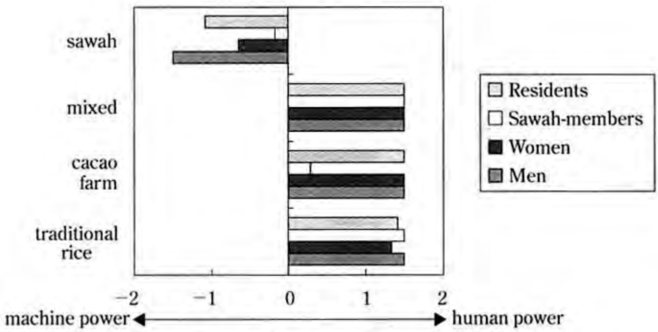


Fig.6-45 Impression of machine power

sawah fields as far richer than the other types of farms and the gaps in its impression are very wide between sawah fields and all the others(Fig. 6-43).

Sawah fields give the respondents an image of being much wetter (more watery) than traditional rice farms. By contrast, mixed-cropping fields and cocoa farms give them an image of being dry. The sawah group feels that compared with much watery sawah fields, traditional rice fields are neither wet nor dry. This somewhat differs from the impressions of the other respondents who do not know sawah fields very well (Fig. 6-44).

All the respondents have the impression that sawah fields use "machine power" and the others, more "human power", first the mixed-cropping fields, the traditional rice fields and cocoa farms. As for sawah fields, men are more impressed by machine power than women. But the sawah group does not have so strong an image of sawah fields as a machine power-using system ; they tend to consider that sawah field development needs human power as much as machines. In fact, the group's image of cocoa farms is a more mechanical one than that of sawah fields (Fig. 6-45).

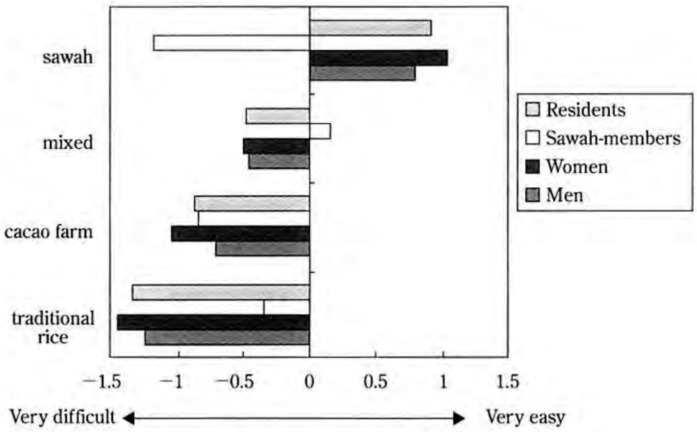


Fig.6-46 Impression of simplicity

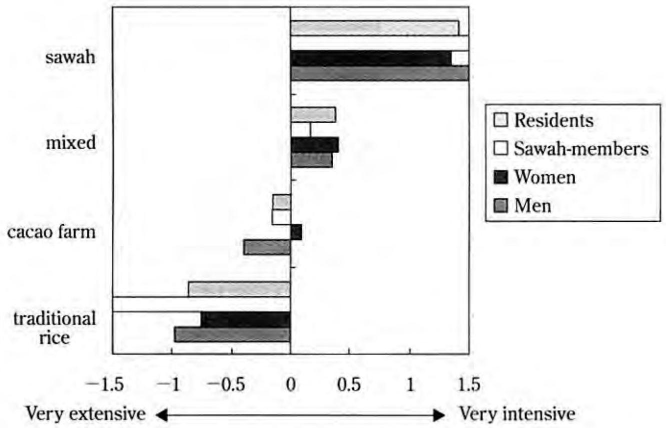


Fig.6-47 Impression of intensiveness

The respondents who did not take part in the project think that work in sawah fields is easier than other types of farm work. By contrast, the sawah group considers that compared with the management of sawah fields, that of cocoa farms and traditional rice fields is not so difficult and the management of mixed-crop fields is simple. On average, the respondents regard work in sawah fields as the easiest and think that workload is the heaviest in traditional rice farms, followed by cocoa farms and mixed-cropping fields. It is noteworthy that the answers of the sawah group differ greatly from those of the other respondents (Fig. 6-46).

According to the answers of all the respondents, sawah fields are the most

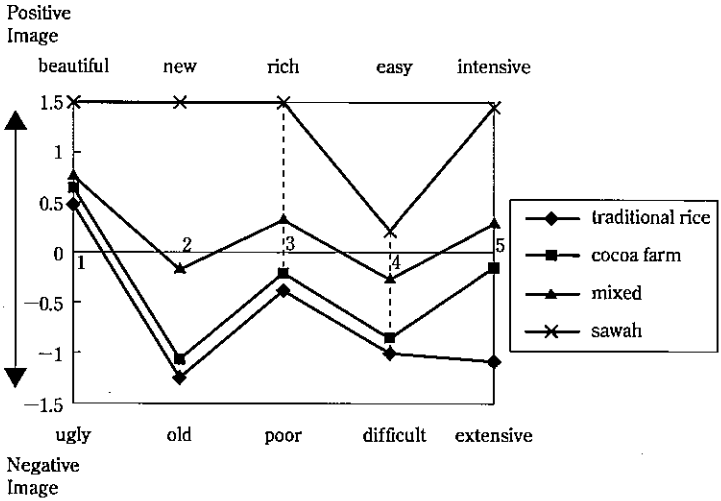


Fig.6-48 Respondents' overall images of four types of farm

intensive, mixed-cropping fields are somewhat intensive and cocoa farms and traditional rice fields are extensive. The sawah group's image of traditional rice fields differs greatly from that of the other respodent, sawah group consider the traditional rice fields to be extensive (Fig. 6-47).

Finally, the survey data were summarized by putting the images considered positive on the lower half of the graph (section for minus factors). In Fig. 6-48, the lower the point showing a space, the more favorable image the respondents have of the space. But regarding the factor axis of machine power/human power, it was hard to judge which would be more positive and the impression of machine power supposed to be the more positive one before the survey data more processed. From this chart, it may be concluded that the respondents have the best image of sawah fields, followed by mixed-cropping fields, cocoa farms, and traditional rice fields. Their impression of sawah fields is much better than that of the other types of farmland. The main reason that traditional rice fields are given the lowest evaluation is probably that the respondents directly compared them with sawah fields, the new system that had impressed the residents as an intensive system. The survey results show that, in general, the farmers in the villages have a more favorable impression of sawah fields than of the other types of farms. While it will become possible to analyze the farmers' awareness in more detail by increasing the factor axes and evaluation scales, it will be necessary to get across various barriers (differences in national sentiments, in languages, etc.) and devise better methods in advance. Also it will be necessary to combine the language method such as the one used here and the illustrative technique described in the next subsection and to examine the attitude of residents from many sides.

(5) Structure of residents' recognition of different spaces in the villages

1) Purpose and survey method

To examine how people recognize spaces or spatial elements and the mechanism of their perception and recognition of spaces and to study the process of their understanding of spaces are effective methods for approaching the problem of how they consider the position of sawah fields in the entire spatial structure from a psychological side.

There are roughly two methods for taking the psychological space of individuals and using it as study materials: to get information about the subjects' internal image by interviewing them ("language method") and to obtain information about their image by using some materials and illustrating the image on a piece of paper ("illustrative method"). In this subsection, the latter technique was used.

The tools often used in the illustrative method-the method by which the subjects' images are illustrated-are image maps. If the subjects are asked to draw an image map, they will illustrate, concretely and visually, the structure of the spaces they draw in their mind based on daily behaviors and experiences. Thus such an image map is very effective and interesting (Architectural Institute of Japan, 1987). More specifically, the subjects are asked to draw the spatial elements they know on a sheet of paper.

The investigator specifies the scope of the areas to be drawn. The present investigation aimed at seeing whether sawah fields, new spatial elements, are recognized by residents as special spaces, or as just a type of farmland, having no effect on their understanding of spaces. Because of this, residential areas and farmland, the areas of their daily activities, were specified for the investigation. In specifying the scope of illustration, the investigator did not mention any specific places or farmland, such as sawah fields and cocoa farms, and left the selection of the areas to be drawn totally to the subjects. Plane charts were used as the method of illustration and the subjects were shown sample drawings in advance to help understand the method. The mention ratios of component elements, such as roads and houses, were calculated to know the subjects' awareness of spaces. Finally, their recognition of spatial structures was summarized.

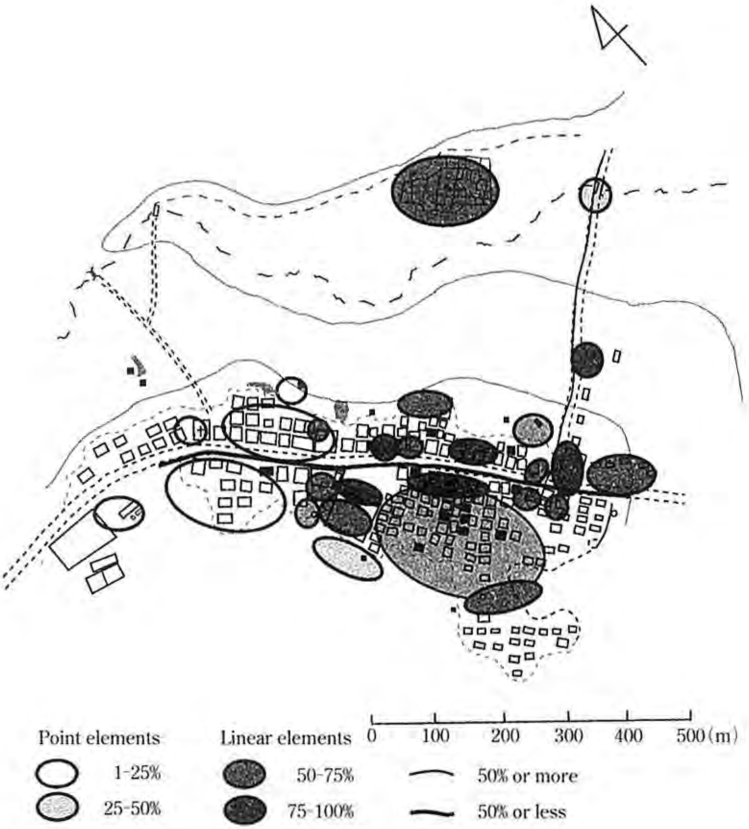


Fig.6-49 Layout of Biemso No.1 and point/linear elements (compare Fig.6-32)

2) Subjects

The subjects of the investigation are the 13 men and women in Biemso, their ages ranging from 14 to 40. Four of them are the members of the sawah group. The locations of their houses are shown in Fig. 6-49 (those painted out with black).

3) Result and discussion

The component elements were selected from the free drawings of the subjects (an example is shown in Fig. 6-50, the free drawing is modified by publisher) and their mention ratios were calculated. The result is shown in Table 6-16. The different locations of farmland were mentioned but they are totaled in the table. The data were divided into those of the sawah group and those of the other subjects and were plotted on the maps (Fig. 6-51, 6-52). The spatial elements are

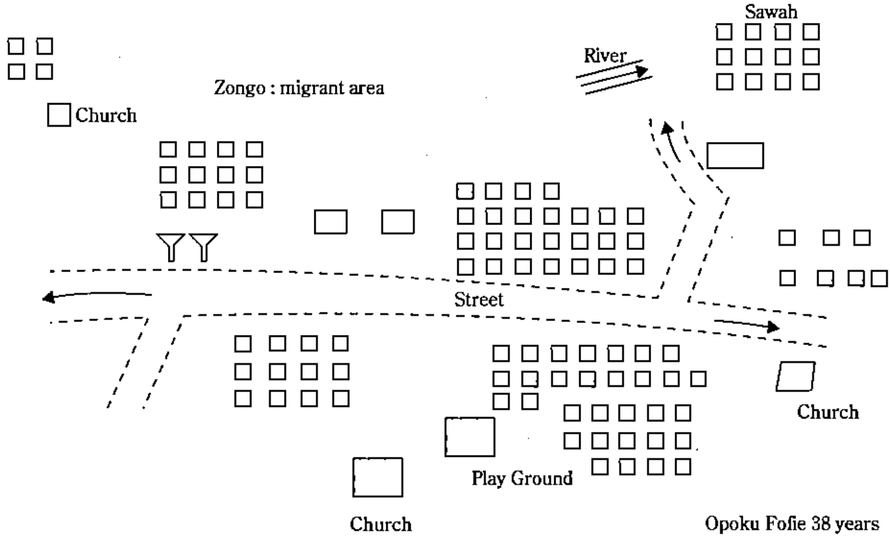


Fig.6-50 Example of the free drawing of the residents

roughly classified into three: those frequently mentioned, those mentioned infrequently, and those not mentioned. These three categories are here named recognized areas, latent areas and unrecognized areas. According to this criterion, the recognized areas of the subjects other than the sawah group are within roughly 500m from their houses, while those of the sawah group extend to the sawah fields and the irrigation dikes and then to a road to the town. The mention ratios of sawah fields are 67% for the non-sawah group and 100% for the sawah group. For the non-sawah group, the cocoa board building leads others (mention ratio : 100%), followed by the church, the market, and the water pumps (83%), and sawah fields rank fifth with a mention ratio of 67%. The cocoa board building is located just in front of the bus stop and is conspicuous. In the case of the sawah group, the cocoa board building and sawah fields have the highest mention ratios, accompanied by the schools, the churches and the market. The members of the sawah group draw sawah fields and their surrounding areas more frequently, suggesting that sawah fields are closer to their life. However the mention ratio of canal and dyke were low, showing poor understanding the whole sawah systems.

From the foregoing, it is found that while the cocoa board building, the market and the church are the community spaces affecting the non-sawah group more, sawah fields have an impact equivalent to or stronger than these on the

Table6-16 The spatial elements and mention ratios

Component elements	Mention ratio (%)	
	sawah members	Residents
Road	100	100
Cocoa board building	100	100
Church B	75	89
Market	75	89
Water pump A	25	89
Own farm	50	67
Shop	25	67
School B	80	56
Water pump B	50	56
Water pump C	50	56
House, next to the Cocobod	50	56
Church C	50	56
Palace of village chief	50	56
Play ground B	50	56
Sawah	100	37
Bar A	25	56
Bar B	25	56
Bridge	50	33
Zongo	50	33
River	50	33
Trees in front of Zongo	25	33
House on the other side of the bridge	25	33
Houses facing Zongo	50	11
Playground	25	11
Upland in front of sawah	50	0
Canal	50	0
Bamboo groves	50	0
Dike	50	0
Country road from the dyke to town	0	0

members of the sawah group. But the mention ratio of sawah fields is fairly high among the non-sawah group, too, which shows the strong effects of sawah fields on the space recognition of the subjects. The areas of daily activities are those within 500m of the subjects' houses and extend to their farms (or sawah fields). Sawah fields give a very strong impression on the residents and are recognized as special spaces. It was also found that sawah fields are being established as a spatial component element or a new scenery component in the subconscious awareness of the subjects and that they have a greater effect on the space recognition of those involved in the sawah field project.

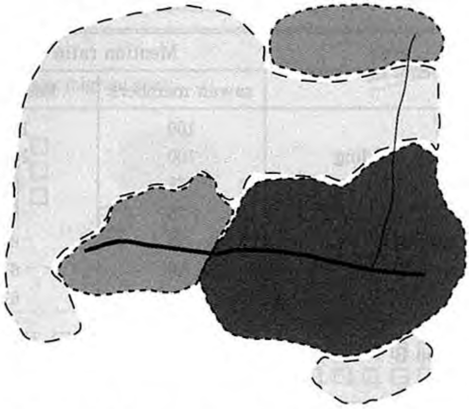


Fig.6-51 Living area of Non-sawah members

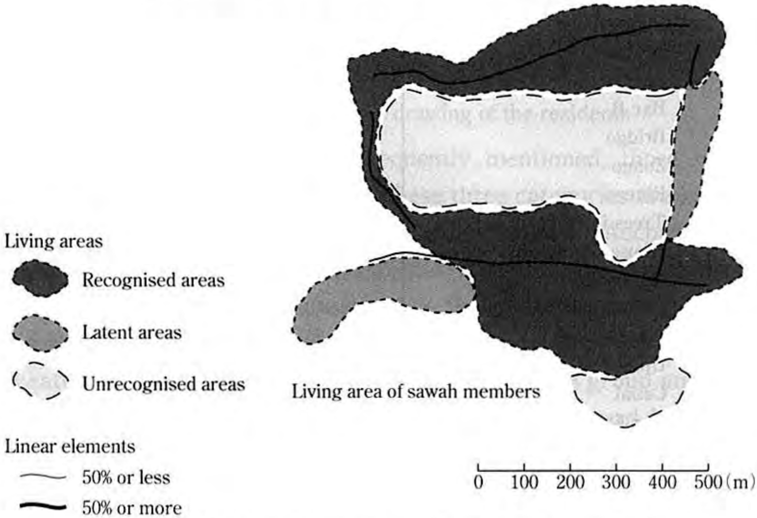


Fig.6-52 Living areas of sawah members and residents

(6) How do the participating farmers evaluate sawah field development?: future of sawah fields and a tentative proposal for sawah field development: ecotechnology approach

1) Purpose and method

This subsection summarizes the survey of the sawah group members from Biemso and Adugyama on the tentative proposal for the development of sawah fields at valley bottom by participatory ecotechnology approach which is described in the section 3-2 of this chapter. By investigating the participating farmers' views of the proposal, it attempts to get a grasp of the ideas of the members about sawah fields. For all of the participants in the project from Biemso and Adugyama (hereinafter referred to as the "participating farmers"), the following sessions were held: 1. Explanation of the tentative proposal; 2. Report of the situations of sawah fields in Biemso; 3. Questions from the sawah group; 4. Interviews using a questionnaire; and 5. Discussion.

2) Result and discussion

The discussion with the respondents can be summarized as follows: "The tentative proposal is a very attractive one especially to us, the members of the sawah group. In fact, those interested in sawah fields are rapidly increasing not only in Biemso but also in nearby areas. Everybody who has experienced traditional rice growing can see that sawah fields are better than the traditional cultivation system of rice. Another attraction of the proposal is the loan provided to purchase power tillers, water pumps, and other machines. Though we have to pay it back, it is very attractive because we will be able to own these machines in future when we finish repayment. In addition, the proposal will realize what has never been possible and allow us to change our lifestyle from a nearly self-sufficiency into one in which we will get something from the outside. In these respects, too, the proposal is a very interesting one.

However, we have taken part in the sawah field development project and consider that it will be impossible for us to construct dikes and canals and open up 1 to 1.5 ha of sawah fields in the first year without wages. We worked so hard, therefore we were able to develop even 1.5ha of sawah fields, but other people would find it difficult to achieve the goal at all. Another problem would arise if our power tillers break down. If they become out of order in the first year, we will be unable to continue the project. Moreover, what will happen if our crops fail even in one year during the 6-11 years repayment period? We are satisfied with the profit planned but we will not be able to agree entirely with the proposal considering the hard labor required. We have been able to continue working for the project because we have had financial aid from the Japanese staff. It would not be too much to say that it would be impossible without such assistance. The proposal we can offer is to reduce the area of sawah fields somewhat to be reclaimed in the first 5 years and to pay us wages, or at least allowance for food expenses. But we would like the Japanese side to remember that sawah field development is a very interesting proposal to us."

Table6-17 Answers to the questions (%)

	Question	Bl *1	Ad *2	Av *3	Np *4
1	Doyou think people in Biemso No. 1 and other areas are interested in this tentative proposal?	83	82	83	87
2	If you had not been a member of the sawah group, do you think you would have participated in this proposal?	80	63	72	93
3	Do you think the number of the group's members is appropriate?	91	27	59	37
4	Have you ever got a loan?	0	0	0	9
5	Do you agree about obtaining the proposed loan?	100	55	76	96
6	Do you think the amount of the proposed loan is appropriate?	66	45	56	-
7	Do you think you can continue to work for the project without any wages and allowance for food expenses?	0	27	14	90
8	Will it be possible to reclaim 1.5ha of sawah in the first year?	25	45	35	86
9	Do you think the five-year target of 5ha of sawah is appropriate?	50	100	75	70
10	Do you agree about repaying the loan in eight years?	16	55	36	94
11	In the tentative proposal, the target output is 3.5 tons/ha for the first five years and 4.5 tons/ha for subsequent years. Do you think it possible to increase the output in the sixth year and after as planned?	58	64	61	70
12	Are you satisfied with the proposed profit?	100	100	100	90
13	Are the labor required for the project and the profit earned from it well balanced with each other?	16	75	46	80
14	Do you think the tentative proposal estimates the profit accurately?	42	36	39	-
15	If you had not been a member of the sawah group, do you think you would have participated in this proposal?	80	45	23	93

Note: *1Sawah members from Biemso No. 1, No. 1,*2Sawah members from Adugyama, *3Average, *4Non-participates
*The interview survey on the opinions about sawah for a total of 220 residents in the two villages in the project sites. For the details of proposal, see p447.

As shown in Table 6-17, the tendency in answers of the three groups of participating farmers sometimes differ greatly from one another and this is probably because of differences in the composition of the groups and the background of farmers. In particular, many members of the Adugyama group who were in the third year of the project expressed a desire to take part in the sawah team continuously despite the strict conditions, such as repayment of loans and no wages. This attitude was not observed among the members of the Biemso group who were only in the first year of the project. It may reflect the attachment to sawah fields felt by the farmers in Adugyama who continued to work for the project for three years.

The same question (2 and 15) was given to the respondents twice : just after they got an explanation of the tentative proposal at the end. Great differences arose between the first and second times in the ratios of affirmative answers. There is the tendency as the respondents answer other questions one after another for their views of the proposal become gradually negative. Though this may be partly the result of the psychological action on the respondents produced by the way of the question asks the question, etc., its main reason will be that, as the questions continue, they come to see the proposal more theoretically and concretely and to take account of their experience. Because of this, their answers the second time of asking will be more reliable. As evident from Table 6-17, non participants tend to take a more optimistic view of sawah fields than participating farmers. If we are to propagate the concept of sawah fields further in the future, we will have to spend more time and have residents understand it better.

Since the proposal (p447) is a draft plan, we can improve the proposal based on further interaction with farmers' groups and more detailed economic analyses. The proposal for participatory ecotechnology approach has no insurance component to secure the farmer during the season of abnormal climate or disaster. This we also have to add.

(7) Summary

The residents in Biemso and Adugyama are well aware of the sawah field development study project and have a favorable image of sawah fields. They recognize sawah fields as profitable and intensive and have the impressions that they are more beautiful, newer, wetter and more intensive than other types of farmland (cocoa farms, mixed-cropping fields, and traditional upland rice fields). The degree of interest is affected more by experience in rice growing than by sex and birthplace, and the knowledge and awareness of sawah fields increase as more years have passed since the start of sawah field development. But established knowledge of sawah fields does not directly lead to people wanting desire to take part in the project ; rather, their interest in sawah fields is promoting the establishment of the knowledge. In general, non-participating residents tend to look on the bright side of sawah fields. Some of them may jump in just at the name of sawah field development and run away soon afterwards, finding that they have to do unexpected work and that the conditions are very strict. To avoid such a situation, there will be the need to give them opportunities to listen to the opinions of those with experience in sawah fields and to have them understand the proposal better.

Participating farmers also have a good image of sawah fields and evaluate their scenery and appearance better than non-participants. They believe sawah fields are more beautiful and intensive than other types of farmland and have some kind of pride in their sawah fields. While they understand the advantages and disadvantages of sawah fields concretely, they conclude that sawah fields are a good system and want to continue to use them for rice production.

Sawah fields, which are a newly added scenic element, leave very strong impressions on residents and are regarded by them as special spaces. This tendency is stronger among participating farmers than non-participating people. Sawah fields are being established in the subconscious of residents as a new scenic element.

Finally, it should be emphasized that these surveys aim at examining residents' opinions about sawah fields and the effects the fields have had on people. They do not attempt to study their evaluation and judgment of the fields. This is because at the present stage where no concrete figures are available for a comprehensive evaluation of sawah fields in long term socio-economic, crop scientific, and other related fields, it is impossible to ask residents to evaluate them. One of the future tasks is to examine the reasons why participating farmers continue (or discontinue) their participation, referring to the data obtained by the present surveys. This is an important problem in exploring the possibility of sawah field development in Africa in the future and we would like to lay emphasis on this major theme. (Midori Nawano)

3-4 Development intervention and incentive structure for residents : case study of traditional landownership system and small-scale sawah field development in Central Ghana

(1) Introduction

Many studies in recent years show that to increase the sustainability and efficiency of a rural development project and to encourage residents to take part in the project, the project team should take account of the institutions and socio cultural factors of the project site. But there are only a few cases where the outcome of these researches is fully reflected in the planning and implementation of development programs. One reason that the results of studies and lessons learned in this field have not been used efficiently in actual projects is that the regional diversity and characteristics of institutions and socio-cultural factors have made it hard to apply the lessons gained in one area to other areas. Because of this, lessons drawn from case studies have mostly been vague (e.g. "Factors peculiar to the area should be reflected adequately in the project") or have only resulted in so-called "shopping lists" that contain the matters to be checked at random. Thus, there have been not many proposals for methods that would extract regional features effectively and would be applicable to all districts and fields.

This paper attempts to present, as one of widely applicable methods, an approach that pays attention to the traditional land system and to the structure of incentives for residents found in the system and to apply this approach to a case of cash crop production in central Ghana. The author believes that this approach will have some important implications for many development projects not merely in Ghana and in cash crop production but in other regions and fields as well.

The investigation by this approach was conducted in the Ashanti Village B, in central Ghana in October and November 1999. The main cash crops grown in this village are cocoa (cacao bean) and rice. In central Ghana, rice is grown in inland valleys by the traditional method, depending on rainwater, and an irrigated system is only rarely introduced. But in the Ashanti area, attempts have been made since 1997 to develop small-scale sawah fields by residents' participation under the joint study project operated by JICA/CRI-CSIR. In Village B, also, the villagers' group opened up about 1.2 ha of sawah fields equipped with small irrigation facilities in mid-1999.

In the case study below, the author adopts the method of comparing the relations between land and farmers in the production of the three cash crops: cocoa production, rice growing by the traditional system, and sawah agriculture (Table 6-18). Sub-sections (2) and (3) deal with cocoa production and traditional rice growing and compare land lease contracts and incentive structures contained in the contractual relations in the two types of cash crop production. Then attention is paid to the newly introduced system–small-scale sawah field development project with farmer participation–and it is pointed out that the farmer-land relations in sawah agriculture are closer to those in cocoa production than to those in traditional rice growing. In conclusion, the importance of the traditional land system and the structure of incentives for farmers is summarized.

Table6-18 Comparison of cocoa production, traditional upland rice growing and sawah agriculture in central Ghana

	Cocoa production	Traditional upland rice growing	Sawah agriculture
Crop type/ farming method	Tree crop Harvestable period from the same cocoa tree: about 30 years	Annual crop Farms changed every year	Annual crop Same sawah fields used for a long time
Workload	Heavy in the first year (development of new cocoa farm), gradualy decreases in the second and subsequent years, weeding/harvesting work is main work in the fifth year and after	Same every year	Heavy in the first year (development of new sawah fields); decreases in the second year and subsequent years
Farmer-land relations	Continue long	Short (only one rice-cropping)	Continue long
Landlord-tenant contract	Share renting tenancy	Fixed rent tenancy	Fixed rent tenancy
Tenancy period	Continues as far as cocoa farms are well managed	Only one rice cropping period	Six years
Farmer's incentives	Cocoa production (profits) and acquisition of land rights (benefits from land)	Only rice production (profit)	Non-leader members of the farmer's group: only increased rice production (profits): leaders: profit from rice and future succession to sawah fields (benefits from land)

(2) Farmer-land relations in cocoa production

The residents of village B are composed of two main groups: native residents who have always lived in the village, Ashanti, and immigrants who came from northern parts of Ghana to work, Zongo, mainly as farm hands, and their descendants. Land in the Village B area is owned by indegenes and immigrants get arable land by land lease contracts with.

There are two types Cocoa growers: owner farmers who grow cocoa on their own land, and tenant farmers who have no land and produce cocoa on land leased by contracts with landlords. The tenancy contract used in cocoa production is of the share cropping system in which the harvest and other profits are divided between the landowner and the tenant. This share cropping contract has two kinds: one is the agreement under which the tenant does only weeding and harvesting work in the landlord's existing cocoa farm and they share profits with each other, and the other is the contract in which the tenant does all the work from the development of a cocoa farm to its management and harvesting (hereinafter referred to as "reclamation and sharing contract"). The characteristics of the reclamation and sharing contract, which is important in studying farmer-land relations in cocoa production, are discussed in detail below.

The reclamation and sharing contract has three variations of what is to be divided between the landowner and the tenant. First is the method of sharing the sales of cocoa (hereinafter referred to simply as "profits"). The second method is to partition the cocoa farm into two at a certain period after it had opened up, and to divide grown cocoa trees between the landlord and the tenant. Finally, there is the method of sharing the cocoa farm between them after it had been developed rather than the cocoa trees. In the second method, where the landowner and the tenant divide the cocoa trees between them, the land itself remains the landowner's asset. If the tenant can no longer harvest cocoa as a result of, for example, the withering of cocoa trees, in the future, he loses his usufructuary right to the land. By contrast, in the third method, in which the cocoa farm is divided between the landlord and the tenant, the ownership of part of the land is transferred to the tenant after a certain period of time. In these two contract systems, the landowner and the tenant share, at an agreed ratio, the profits earned from the cocoa farm by the time the cocoa trees or land is divided.

In the reclamation and sharing contract, the workload of the tenant is the heaviest in the first year and then gradually decreases every year, reaching a generally constant level at about the fifth year. The workload in the first year is very heavy because the development of a new cocoa farm requires hard labor for clearing undergrowth, cutting tree, burning weeds, planting cocoa trees, etc. As cocoa trees grow taller, weeding and harvesting become only the labor needed, thus reducing the total workload.

One important characteristic of the reclamation and sharing contract is that the tenant's usufructuary right is long and stable. According to the explanation of the contract made by its parties and the contents of its clauses, the landlord may cancel this agreement in only one of the following cases: (1) if all the cocoa trees planted die; (2) if the tenant leaves the village and abandons the cocoa farm ; (3) if the tenant steals harvested cocoa ; or (4) if it is found that the tenant practiced juju (evil magic). Thus, except in these special cases, the tenant who grows cocoa under this contract is guaranteed the right to continue cocoa production on the same land for a long time.

Another related feature of the reclamation and sharing contract is that the right acquired by the contract may be inherited. Even if the tenant dies, his wife, children, and relatives may take over the contract rights as a group and continue cultivation on the same land. In other cases, the tenant donates his usufructuary right to part of the contract land to his wife or children, or after the tenant dies, two or more of his relatives succeed to the land by dividing it among them and individually continue their own contractual relationship with the original landlord. In short, the usufructuary right to the land under the reclamation and sharing contract is not a right with a limited term and granted to one particular tenant ; instead, it has a value as an asset inheritable by the tenant's wife, children, and relatives.

As noted above, unlike the share renting contract that stipulates only the sharing ratio of profits, etc., the reclamation and sharing contract is strongly linked with the tenant's continual right to land. In other words, this contract guarantees the tenant a usufructuary right and the right to donate and inherit it as far as cocoa trees are productive. It also gives the tenant the chance to become a landed farmer because he can get part of the land from the landowner. Therefore, the tenants engaged in cocoa production by this contract have two incentives : the "profit" incentive (profits from cocoa) and the "land" incentive (guarantee of long-term and stable right to land).

Another important fact in considering farmers' incentives to grow cocoa trees is that the existence of cocoa trees helps strengthen their owner's right to the land. This greatly depends on the characteristic of cocoa trees : the harvest can be reaped from the trees for as long as 30 years or so. It is actually hard to divide the right to land from the right to cocoa trees planted on the land. Because of this, the good management of the trees by the tenant under a reclamation and sharing contract leads up to his guaranteed right to use the land for a long time. As stated so far, cocoa production in central Ghana is supported by a traditional institutional foundation that enables the tenant's labor expended on opening up and managing a cocoa farm to be rewarded by guaranteed benefits from long-term land use and continued profits from it.

(3) Farmer-land relations in traditional rice growing

By contrast with cocoa production in which there is a long-term connection between a particular piece of land and the farmer who cultivates it, the farmer-land relations are short in traditional rice growing. Traditional rice production is carried out in lowlands in the rainy season but it is rare for the same piece of land to be used continuously for more than one year. Instead, rice growers move their fields every year. But there are some cases where they plant vegetables and other crops in the land after they have harvested rice.

As already noted, in cocoa production, workload is the heaviest in the first year because a new farm needs to be developed and then it gradually decreases. But in the production of rice, an annual crop, by the traditional system, farm work is the same every year and workload per unit area does not change from year to year. In the Village B area, traditional rice growing is almost always carried out by tenants from northern Ghana, who have no land of their own. The tenancy contract is fixed rent tenancy in which the amount of money or product (polished rice) that the tenant pays to the landlord is fixed in advance, and is a short-term tenancy for only one rice crop. In almost all cases, tenants change land every year and seldom use a particular land lot for many years. They also change landowners with whom they sign a tenancy contract every year, which means that landlord-tenant contractual relations do not last long. There are not cases where the tenant's land right is long-term and stable and can be inherited, unlike in the reclamation and sharing contract in cocoa production. The landlord makes no transfer of land ownership to the tenant.

It is considered that the above-mentioned temporary farmer-land relations observed in traditional rice growing are the combined result of the characteristic of rice (only several months are needed for the whole process from land development to harvesting) and that of the traditional farming system (cropland is moved from place to place). In the case of rice, an annual crop, the labor of farmers is rewarded several months later in the form of harvested rice. Thus the work of the tenant engaged in traditional rice growing is supported only by the "profit" incentive–the crop reaped in a short time. On the other hand, since the period from field development to harvest is relatively short in rice growing, there is no need for any institutional support that would guarantee farmers the use of particular land for a long time. In addition, because fixed rent tenancy in traditional rice growing is short and the land being used changes frequently, there exists no "land" incentive, unlike in cocoa production, where farm development and management by tenants guarantee them a long-term land use. As described above, the farmer-land relations in traditional rice growing are in striking contrast to those in cocoa production.

(4) Farmer-land relations in a small-scale sawah field project

In Village B, a small-scale sawah field project has been continued since 1999 with residents' participation to examine the potential for rice growing in inland valleys. In this project, a group composing about 10 villagers was organized. They opened up sawah fields equipped with small-scale irrigation in the land they borrowed from two landlords and started sawah-based agriculture there.

Seen from angle of farmer-land relations and incentives for farmers engaged in rice growing activities, this newly introduced sawah agriculture resembles cocoa production more than traditional rice growing. First of all, in this sawah-based agriculture, the relations between farmers and particular land lots continue for a long time. In traditional rice growing, almost all farmers (tenants) change land and landowners every year. But in sawah agriculture, farmers continue to use the same land for a long time because they can expect a high yield from the sawah fields they have opened up. These long-term relations between farmers and particular land lots in the sawah agriculture are the same as those in cocoa production.

Sawa agriculture and cocoa production also resemble each other in the yearly change in workload and the pattern of profits–returns–for labor. In the former, creating sawah fields in the early years of development stage (land leveling, bund making, canal and dyke construction, etc.) requires great labor. But in the subsequent years after development, the tasks are mainly the maintenance of sawah fields and rice growing and the labor needs decrease. On the other hand, produce sawah fields, once completed a higher yield than traditional rice growing and the high yield continues for a long time. In the case of cocoa production, too, the work for developing a cocoa farm is heavy in the first year but the workload subsequently declines. The yield from developed cocoa farm gradually increases as the of tree grow, and this allows farmers to earn profits for a long time. The two types of agriculture have a common feature : initial labor input (initial investment) is large but profits (returns) last long.

This common characteristic observed in sawah agriculture and cocoa production–long-term farmer-land relations and a large initial investment rewarded by continued profits in subsequent years–leads to the following conclusion : to prevent any reduction in the incentive for farmers doing either of the two types of crop production some institutional backing is needed that would guarantee that the farmers could continue using the land for a long time and at the same time could surely gain profits from the land. As already noted in cocoa production, such an institutional guarantee system has been established by the reclamation and sharing contract that gives tenants a long-term land right.

In the newly introduced sawah agriculture, in a system for guaranteeing growers a long-term land-use right is not yet perfect. The sawah fields created exist in the land of the two owners and the group's members individually signed a six-year land lease contract with the landlords. The contracts with the two owners are almost the same as each other and the main clauses are : (1) the group gives a certain volume of rice to the landowners each year as rent for the land ; (2) the group never commits illegal acts ; and (3) unless the contract is renewed, the group returns the land to the owners six years afterwards. One problem relating to incentives for the farmers' group is the six-year land-use period in (3). While the reclamation and sharing contract in cocoa production guarantees tenants the right to continue using the cocoa farm as long as they manage it well, the period for land use is limited to six years in advance in the sawah agriculture in Village B. Therefore, whether or not the farmers' group would gain enough from great labor for sawah field development in the first year depends on whether or not the landlords would agree to extend the contracts six years afterwards.

A major factor that affects the possibility of long-term land use by tenants is the social relationship between the landlord and his tenants. One of the landowners who lend land to the group in village B is a maternal uncle of the group leader. The residents of the village adopt matriarchy and in most cases inherit land and other assets from the brothers of their mothers. This leader is also in a position to succeed to the land of this maternal uncle (where the sawah fields exist) in the future. Thus, the contract was concluded between the leader' s maternal uncle and the farmers' group but the leader is a "potential landlord" who will inherit the land in which the sawah fields are situated. When, as in this case, the farmer who created the sawah fields and the landowner who owns the land belong to the same family group, the possibility of the farmer being prevented from long-term land use diminishes greatly.

Since he is likely in future to inherit the land where the sawah fields exist from his maternal uncle, future, this group leader has a stronger incentive to contribute to the heavy initial investment in new sawah field development than the other members. This is because the leader has the "land" incentive-the hopeful prospect of inheriting the land with a value added of sawah fields-in addition to the "profit" incentive, that is, a higher yield of rice from sawah-based agriculture. On the other hand, the other members of the group have no family relationship with the landlord and have no "land" incentive of their labor being rewarded by any land right in the future. Their major incentive is thus the "profits" earned by increased rice output realized by sawah fields. As noted, differences are observed between the incentive of the group leader and that of the other members, who take part in the same project.

(5) Conclusion

This paper examines the impact of regional institutions and socio-cultural factors on a rural development project, taking the case of a small-scale sawah field project in central Ghana. The approach adopted here pays attention to the traditional land system, examining the relations between farmers and land and the crops grown on the land and analyzing the relations from the viewpoint of farmers' incentives. The analysis of the Ghanaian case by this approach revealed that farmers' incentives should be studied not merely in terms of the "profits" derived from crop production but also from the "land" aspect-stable land right.

The above-mentioned approach of attempting to examine what relations residents have with land and crops (or tree crops) in the context of the existing land system will be applicable to rural and agricultural development, forestry, environmental and other projects in many other countries as well as to central Ghana and small-scale sawah field development. Out of the rural residents who has land right, to which land do they have such right, and what kind of land right do they have? To whom do the crops and trees on land belong? What are the socio-economic relations between residents inherent in the traditional land system? These are the basic problems to be investigated before the implementation of rural area-related projects. This paper tries to show that these factors are inseparable from the incentives for residents who participate in the project and are likely to have considerable effects on the whole project.

Acknowledgements:
This paper is based on the "Study of Agro-pastoral Forestry Systems and Land Systems in West African-type Inland Valleys," a study project conducted with a Grant-in-Aid for Scientific Research of the Japanese Ministry of Education, Science, Culture and Sport (representative: Professor Toshiyuki Wakatsuki at

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(Tsutomu Takane)

4. Potential for agroforestry as a part of integrated watershed management

4-1 Constraints on the introduction of tree crops

(1) Arrangement of trees in agroforestry

Farmland and forestland have been categorized separately : while the former is to be used only for agricultural crop production, the latter has been the sites exclusively for forestry activities. But as degradation of both forest and soil became serious, especially in the tropics, it became commonly understood that conventional bureaucratic sectionalism could not settle these problems. In such circumstances, the concept of agroforestry was proposed as a new approach that would break down stereotypes and contribute to a more effective land use.

There have been various definitions and classifications of the concept of agroforestry but its basic idea is combining trees with other crops (Nair 1989). Agroforestry is not limited to the combination of two or more crops. Multipurpose trees (hereinafter referred to as "MPTs") are also included in this category, which supply various products such as wood, food and forage, or have soil improvement and other functions. The time arrangement of trees on farmland is divided into two types : coexistence of trees and agricultural crops on the same pieces of land at the same time, and alternate arrangement of trees and crops at different times. If trees and crops are allowed to coexist at the same time, the special arrangement can be divided into four : (1) surrounding farmland with trees (hedge-like arrangement) ; (2) planting crops and trees in alternate rows (row arrangement) ; (3) scattered arrangement of trees ; and (4) three-dimensional arrangement with a random combination of various species (e. g., *pekarangan* in Indonesia) (Vergara 1987).

On the other hand, attempts have also been made to introduce agricultural crops into forestland. Both of these methods are called agroforestry but have quite different backgrounds and purposes. While arrangement of trees on farmland aims at sustainable land use and at supplying forest products necessary for daily life in rural areas, the goal to introduce agricultural crops to forest land is the development of tree plantations. One widely known method for the latter is the *taungya* system devised in Burma under the British rule in the nineteeth century. According to Tani, the origin of this system was found in the work of colonial foresters when demarcating the land where local farmers had already practiced shifting cultivation. Instead of being excluded from the demarcated forest reserves, the farmers were encouraged to plant teak (*Tectona grandis*) before they abandoned the area and moved to new sites for cultivation (Tani, 1998).

Another example of the method for introducing crops into forestland is *yakihata ringyo* (forestry combined with slash-and-burn agriculture) practiced in many parts of Japan in prewar days. This method was to plant tree crops such as Japanese cedar (*Cryptmelia japonica*) after the harvest of agricultural crops in mountainous regions. This played an important role in developing forest plantations (Kitamura, 1996). The *taungya* system and *yakihata ringyo* were introduced in different institutional setlings but have some common characteristics from a technical viewpoint: initially crops and trees are planted on the same land, cropping is discontinued later when trees grow, and the land in the end is covered by forests.

(2) Offset mechanism of the taungya system

Though it achieved no great progress in reforestation in British Burma with a low population density (Tani 1998), the *taungya* system began to be employed in various regions of the world as a re/afforestation method, resulting in the production of many variations. But in general, this system is characterized by intercropping at the early stage.

Participants in a *taungya* site are allowed to grow annual agricultural crops for their own consumption between the rows of the trees that they plant for the owner or management body of the land, normally the forestry service. As a result, it contains an economic mechanism in which the wages to be paid by the forest service to the participants and the rent of the land for intercropping to be paid by the participants to the forest service are offset. This offset mechanism makes the re/afforestation cost lower than that of tree planting by directly hired workers (Fig. 6-53).

The rent to be paid to the land used for intercropping depends on whether some land usufruct market has been formed in the area concerned. The wages to be paid to participants in the *taungya* project also differ according to the location, but their differences are not as great as those in land rent. Thus, if no

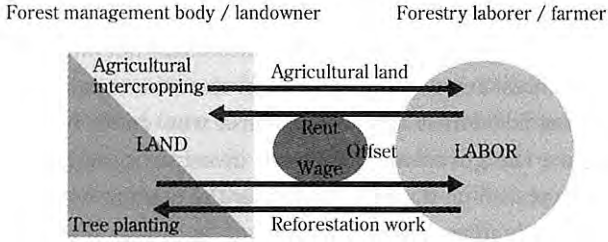


Fig.6-53 Offset mechanism of the *taungya* system

Note: Here the *taungya* system is defined as an contract basis afforestation method combined with agricultural intercropping

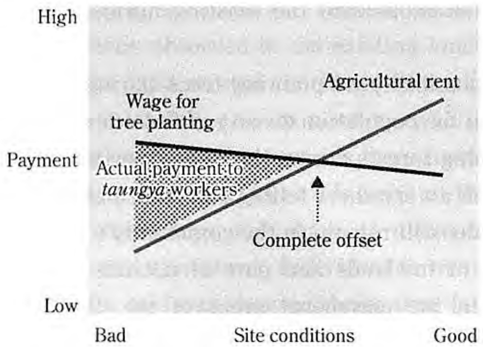


Fig.6-54 Advantage of the *taungya* system for the forest service

land usufruct market has been established, the offset mechanism of the *taungya* system does not work, this will make the forest service pay additional costs, such as the full amount of wages for tree planting works and for the provision of various social services (Fig. 6-54). But even in this case, the *taungya* system may offer some advantages to the forestry service as a countermeasure to control shifting cultivators as already mentioned, or to secure a labor force, especially in remote areas. By creating a subsistence economy involving whole families inside forests, the forestry service can save on transportation and family allowances.

It is necessary to emphasize that clear land demarcation is a prerequisite for the application of the *taungya* system. Without the boundary and certain powers to clear off people from forests, the *taungya* system does not function as an system advantageous to forestry services.

(3) Constraints due to the land system : an example of G settlement

As mentioned in Chapter 4, forest reserves including national parks make up only about 10% of the total land of Nigeria and there is little possibility of increasing these reserves. Consequently, it is necessary not only to conserve and improve existing forest reserves but also to protect the remaining trees and to develop forests outside forest reserves. Those who could work to solve the latter problem are the government, private investment, and farmers but not much hope can be placed on the first two under the context of Nigeria considering their financial situations.

Is there some possibility of tree planting projects by farmers, then? Based on the results of the investigation on land-use systems and the arrangement of trees conducted in G settlement (see Chapter 4, Section 1 and 2), the potentialities of introducing tree crops into the existing agricultural ecosystems are discussed below.

First of all, the possibility of planting trees during the fallow period is examined. Considering the population density of G settlement, it is obvious that the method of developing forests during the fallow period could not be applied unless tree species with a very short felling period are available. Despite this, some secondary growths still remain in the community's land. This is because the high productivity of lowlands and part of uplands allows longer fallow periods, particularly in the peripheral areas of the community. Stumps of various species surviving even after land clearance also facilitate the succession to secondary forests during the fallow period.

Can these secondary forests be turned into forests with a higher economic value? Existing secondary forests do have some economic function in supplying fuelwood and non-wood forest products but no positive steps are found in the customary system to conserve these forests. Demand for new farmland is satisfied by clearing these secondary forests, and in this respect, the secondary forests may be regarded only as reserves of land. Nomadic Fulani may use these forests as campsites, and forest fires occur annually. In addition to these uncertainties, there is no established land tenure system in this region. In light of these facts, it will be hard to secure land lots for permanent tree planting in uplands.

Another problem associated with conversion of secondary growth to a tree plantation is biodiversity. The forest reserves lying scattered in Niger State have mostly been turned into plantations of exotic species, such as teak (*Tectona grandis*) and *Gmelina arborea*. Sheanut discussed in 3-2 below and the materials used for traditional medicine stated in Chapter 4 are supplied from secondary growths left in outside forest reserves.

Next the method of combining agricultural crops and trees, rather than the developing of forests only, is examined as to the four types of spatial tree arrangement in agroforestry. A hedge-like arrangement is difficult to apply because no private land tenure has yet been established. Trees may be planted along roads and canals but roads are often abandoned and reconstructed. As for the row arrangement, there is the system known as alley cropping, which allows continuous cultivation without manuring. But this method is designed for humid and sub-humid climates so that it is hard to apply to a savanna zone where field fires often occur (Nair 1989).

As far as G Community is concerned, a scattered arrangement and *pekarangan*-type tree gardens have the highest possibilities, and these tree arrangements are already observed in the existing land use in the community. In particular, since the land around the house is traditionally allotted to its family members, it is relatively easy to plant trees in the land.

However, as mentioned in 4-2 below, the trees scattered in uplands are the naturally growing useful trees that were left uncut at the time of clearance. If farmers try to plant tree crops, they have to overcome the obstacle of the traditional system of land allocation. Individual farmers can have an exclusive control over a land lot so faras they cultivate that land. Under the present farming system, land fertility unavoidably decreases in uplands and degraded land is abandoned. As a result, farmland is re-allotted among the members of the community in an attempt to realize a fair land distribution. On the other hand, according to the customary system, all crops belong to those who planted them and trees are no exception. Thus, if a farmer plants trees on a farmland and then abandonesit, the chief of the community will take control over such a land, while the trees still belong to the farmer. This real right separated from the land will pose no serious problem while the land lies fallow, but might stir up a dispute if another farmer wants to cultivate the land.

These are the main constraints to the introduction of tree crops found in Nupeland. Moreover, there is another obstacle peculiar to the Cis-Kaduna as discussed in Chapter 4, the same land is under the dual control of Fulani absentee landlords and Nupe village heads. The latter have direct control over the land but are subordinate to the former, the descendants Fulani conquerors who have formed a socio-political stratum of absentee landlords. The introduction of trees, new crops, will contain various uncertain factors relating to the distribution and final ownership of harvests and to the landlord-farmer relationship. Thus, unless ownership to the trees planted is guaranteed by a modern legal system instead of local custom, there is not much hope of any large-scale introduction of tree crops that need a long period to grow. (Misa Masuda)

4-2 Sheanut : traditional agroforestry in savannas

(1) Sheanut as an export commodity

Sheanut or shea butter tree is a sapotaceous shrub widely distributed in the areas from the Guinea to Sudan savanna zones. This tree bears fruit around June, the early rainy season. The size of a small egg, its fruit has a light green skin and its thin yellow flesh is edible. Its brown stone contains about 50% of fat. As the name suggests, this fat remains solid at normal temperatures and is used as a substitute for cocoa butter in both food and cosmetics.

Mungo Park, a Scottish explorer in West Africa in the late eighteenth century, is believed to be the person who first introduced sheanut into Europe. In his report, Park wrote that this tree grew naturally all over the territory of Bambara. People cut all the trees when they cleared forests for cultivation but left sheanut trees unfelled. Park said that the butter tasted better than all the butter he had ever tried (Park, 1816). However, it has a problem of being easily oxidized, though it might be tasty so long as it was fresh.

In the 1880s, sheanut was just one of crops with the possibility of being used as a source of oil and fat for European countries. But in the early twentieth century when the region was colonized, this product began to be exported to Britain via the Niger River. Sheanut ranked second in main exports from northern Nigeria and 3,000-10,000 tons were exported annually until World War II. After the war, also, Bida and Zaria were the two main trading centers for the product, which ranked twelfth out of 20 top export products from Nigeria in terms of quantity. But when petroleum production started in the areas along the Gulf of Guinea, the position of sheanut in the country's exports sharply declined. Nigeria has continued to export about 10,000 tons of sheanut a year to Europe and Japan in the 1970s and afterwords, this is roughly on the same scale as in colonial days (Moloney, 1887 ; Dudgeon, 1911 ; Burns, 1917 ; Nigeria, 1947 ; Buchanan & Pugh, 1955 ; Federal Office of Statistics, 1971, 1979, 1983, 1987).

(2) Current situation of the domestic market

No perfect production statistics are available for the trends of the domestic market and conjecture is the only possible means. Shea butter was traditionally produced in villages in northern Nigeria and widely used as a source of food and light (Allen & Thomson, 1848). But when palm oil and groundnut oil from factories began to be brought to the market, shea butter gradually became less important in people's daily life. Moreover, since no domestic demand developed for this product as an industrial material, its domestic market shrunk considerably. As public interest in primary products generally diminished as a result of the petroleum boom, both the government and researchers no longer paid much attention to sheanut.

Sheanut is shipped to the international market as dried stones without any processing. Shea butter for the domestic market is still produced manually just as in the nineteenth century. According to the Rapid Rural Appraisal made in the Cis-Kaduna area, there are two types of communities : those where the women sell sheanut but never make shea butter, and those where all the women are engaged in making shea butter. In the former communities, women gather mature and fallen fruit during their daily activities, such as farm work and washing clothes at rivers, dry and pound it to remove the skin and flesh. In case of a large quantity the fruit is smoked and sold after the thin husk is removed from the stone. According to an interview with eight women engaged in sheanut collection at G Settlement, the study site mentioned in Chapter 4, they produced 73.5 kg of dried sheanut on average in one season. Six of them sold it to the middle women who visited the community to buy sheanut, and two sold to the middle women who purchased sheanut at the local market[1].

In Nupe's rural life, the gender division of work is clearly observed in general. The collection, processing, and distribution of sheanut are all performed by women. The author visited some communities where shea butter was produced but was unable to find out the reason why shea butter production was concentrated only in particular communities. The information obtained there was just that women in these communities had been engaged in making shea butter from around the time when the community was established or just for many years. As the domestic market shrinks, some communities have abandoned shea butter production but none have commenced production.[1]

The place for making shea butter is located inside the community where it is easy to get water and there are shady trees. Various tools, such as three-stone stoves, wooden mortars and pestles, and saddle stones for grinding, are provided there. The women in each family have their own tools, and the number of stakes to hold grinding stones shows the number of families engaged in shea butter production. The production process is as follows : firstly, the kernels of sheanut are put into an iron pan and shea butter is added to it and then the mixture is roasted until it begins to brown. This part of the work is sometimes done indoors. Then the stuff is moved to the mortar while hot and pounded well with a pestle. It is further grated on a grinding stone placed on three stakes. This work is the most laborious and, in recent years, is often subcontracted to the owner of a grinder mechine in the neighborhood. The well-grinded black thick liquid is then put into a mortar filled with water to cause oil to separate and the supernatant is boiled down in a pan. Finally the butter is separated.

The butter is either sold directly at the local market or to middle women. Its main use is frying oil and the end consumers are the roadside food sellers of fried yam, sweetpotato, or ground cowpea, who are also all women.

after finished sheanut gathering, women in the communities collect caterpillars (*manimani*). These rapidly increase around and after the fruiting period. They sell boiled caterpillars at the market and smoked caterpillars to the middle women from the South, just like sheanut. They are mostly the Yoruba and bring the caterpillars back to their home land in southern Nigeria. The yields of sheanut and caterpillars both fluctuate according to the year and the two products have roughly the same economic value to Nupe women.

(3) Distribution of sheanut in uplands

Though its domestic market has greatly shrunk, sheanut is still a very common species in the rural ecosystem of savanna zones. This tree is observed especially extensively in the areas from Mokwa to Bida and Wawa. It is also easily seen from the car in the suburbs of Zaria and Kano. The scattered arrangement of sheanut and various other useful trees can be found all over northern Nigeria. The species generally observed in the Guinea savanna include locust bean (*Parkia biglobosa*), tamarind (*Tamarindus indica*) and dry mahogany (*Khaya senegalensis*) in addition to sheanut. In a part in southern Zaria are scattered large kapok (*Ceiba pentandra*) trees. As the climate becomes drier, baobab (*Adansonia digitata*) and various leguminous species begin to appear. Among those, due to its unique characteristic (leaves sprout in the dry season and fall in the rainy season), *Faidherbia albida* has been paid much attention. Gum Arabic (*Acacia senegal*), which is distributed in the Sudan savanna zone and the Sahel, is comparable with sheanut in terms of export commodity.

To study to what extent sheanut is distributed, quadrats of 100 m x 100 m were established in four locations, according to land-use category, i.e., tree garden adjacent to the settlement farm land and fallow (two sites used for the surveys in 1993 and 1995) in Community G. The number of sheanut trees and their diameters at breast height were measured. Plots of 1 ha were also established in a forest reserve and in a National Park to study the distribution of sheanut in natural vegetation. These control plots should have been located as near as possible to Community G but the nearest forest reserve with natural vegetation was the Gunu Hills Forest Reserve about 50 km north and the nearest national park was the Zugurma Sector of the Kainji Lake National Park about 140 km northwest (Fig. 4-1). Since this forest reserve was composed of mesas, the plot had a size of 40 m x 250 m and lay from the foot to the top. In all of the quadrats and plots, only the trees with a diameter of 5 cm or more at breast height were counted (Table 6-19).

The tree garden is an artificial space where mango and other fruit trees and many kinds of annual crops are grown together (Fig. 4-6). Nevertheless sheanut is still grown and their average diameter at breast height is larger than that in the other three quadrats at G Settlement. Following the tree garden in diameter size are the trees in farmland. This is because the field was developed by felling down small-diameter trees as well as trees other than useful species. In the upland field quadrat, three locust beans had been left uncut and one mango and an oil palm had been planted between the rows of crops in addition to sheanut.

The two quadrats in the land under fallow show a difference in the total number of trees. There are about twice as many trees in the quadrat (Fallow 93) which is farther from the community. But the ratio of sheanut is roughly the same between Fallow 93 and Fallow 95 ; on average, this tree makes up 56% of the total number of trees and 62% in the total basal area at breast height.

Table6-19 Ratio of sheanut in each quadrat (DBH≧5 cm)

Land use	Total tree number	Sheanut				
		Number		Average DBH (cm)	Total basal area	
		Tatal	(%)		(cm^2)	(%)
Tree garden	37	6	16.2	45.4	11,332	7.8
Farmland	23	18	78.3	30.3	13,864	89.4
Fallow '93	134	78	58.2	14.1	14,483	61.1
Fallow 95	68	36	52.9	21.2	14,375	62.7
Forest reserve	811	59	7.3	10.5	8,121	10.3
National park	455	91	20.0	14.0	16,042	15.5

Then, what degree of dominance did sheanut have in the primary vegetation of the Guinea savanna? Here the forest reserve and the national park, where natural vegetation is conserved by the state and national government, are selected for comparison. But residents in nearby areas regularly enter the forest reserve to collect firewood, and fimber., and nomads burn the undergrowth. In the national park, where residents are strictly prohibited from entering, rangers periodically burn undergrowth every year to prevent uncontrolled field fires and conserve savanna-type vegetation.[3] Therefore, no primary forest environment is now left in savannas in Niger State.

From the fact observed in farmland that it survives clearing work for cultivation, it is evident that sheanut is highly resistant to fire. It can grow even from the stump after burning. This tree has a high ratio of 10-15% in basal area at breast height in these surveyed areas, but the possibility of burning at the forest reserve and national park increasing the sheanut density cannot be denied. A low ratio of 7.3% of tree numbers in the forest resreve is because the mountainside of the mesa is covered with small-diameter coppice. From these results, we found that sheanut trees, which are widely distributed in farmland in the Guinea savanna, were those which was already existing and were selectively left uncut rather than newly planted trees. (M. Masuda and S. Kudu)

4-3. Cacao : agroforestry in the forest zone

Traditional agroforestry is often arranged ingeniously at the point of contact between the natural environment and an artificially created environment. In the case of sheanut, agroforestry is used as the method for utilizing effectively a useful tree that has already grown. A similar situation is seen in rice-growing forests in northeastern Thailand. On the other hand, agroforestry using cacao, observed in the forest zone in West Africa, is an example where a newly introduced tree crop is well incorporated into the existing farming system.

(1) Introduction of cacao into Ghana

Land in Ghana can roughly be divided into two ecological zones: forests and savannas (Fig. 6-55). While it is not known when cacao planting was started in Ghana, there are several theories about its introduction. According to one of the theories, Tetteh Quarshie, a blacksmith belonging to the Ga, one of the ethnic groups in Ghana, took back a cacao tree from a small island in the Gulf of

Guinea in 1879. Thus, cacao growing befan in the country (Manu, 1995). It is not clear whether or not this theory is correct but Ghanaian farmers now call cacao tetteh quarshie.

The colonial government had placed great emphasis on the cultivation of new commodity crops in the British colonies in West Africa. In Ghana, after introduction of the crop, it distributed young cacao trees to farmers in 1887 to encourage them to grow this tree. Because the temperature and precipitation conditions of forests in southern Ghana resembled those of South America, the home of cacao, the land suitable for cacao growing in Ghana was almost all opened up and planted by about 1900. In 1970, the area planted to this tree reached about one half of the country's total acreage under cultivation. In 1947, to secure stable producers' prices, the country created the Cocoa Marketing

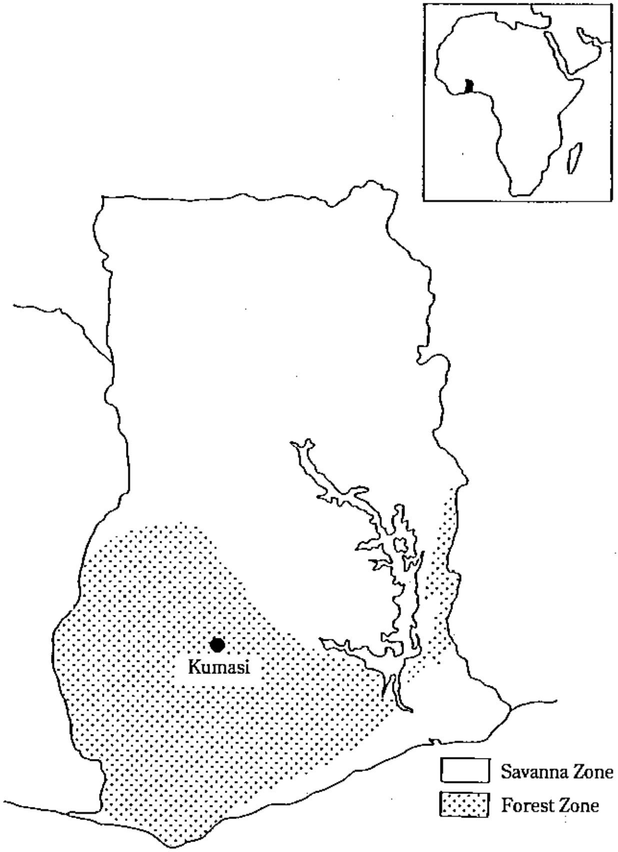


Fig.6-55 Republic of Ghana

Board (CMB) a government agency for cacao purchase. This agency helped small cacao farmers in the country to enlarge their farms further (Huq, 1989).

A variety of factors will lie behind the fact that no large cacao plantations were created in Ghana, but one important reason is probably that this crop was well built into the existing shifting cultivation system that farmers were already employing before the introduction of cacao. This is because small farmers carry out almost all the cacao production in Ghana. Unlike plantations operated by large companies, this cacao-growing system among small farmers does not try to maximize the yield, and uses profit of a single crop. Instead, it combines various strategies, such as crop arrangement for securing both the supply of materials for daily life and cash income, and uses such techniques and management scales as may be covered by family labor. As a result, a cacao agroforestry-like farming system was created.

The figures and tables shown below in this section are the results of the two surveys conducted in 1997 and 1998 in the Ashanti region, the capital is Kumasi, Ghana's second largest city. Three villages were selected according to the distance from Kumasi (location): Adugyama, a village about 40 km north-northwest of Kumasi facing a trunk road that was rapidly urbanized; Biemtetrete, about 4 km back from the section of a trunk road about 4 km north from Adugyama ; and Mmoroben about 20 km from a trunk road (Fig. 6-15).

(2) Characteristics of the farming system

How is cacao introduced into the traditional cycle of shifting cultivation? First of all, farmers clear a natural forest leaving trees too big to cut down and burn the undergrowth. After the burning, they plant such food crops as maize, cocoyam, cassava and plantain first and then young cacao trees in the spaces under these crops. As the cacao trees grow taller and begin to shade the land with branches and leaves, they stop growing food crops and the land gradually turns into cacao woods. Young cacao trees need shade in the early growth stage and this is provided by the trees left unfelled and the planted food crops that play the role of shelter woods (Fig. 6-56).

After cacao woods have been established, if new gaps are made as a result of, for example, the felling of big trees remaining in the woods by woodcutters or the withering of trees due to disease or aging, farmers grow food crops in the gaps again and plant young cacao trees between the rows of food crops. Finally, the cacao trees are renewed (Fig. 6-57). This process is repeated thereafter in newly made gaps (Ochiai /*et al.*, 1998).

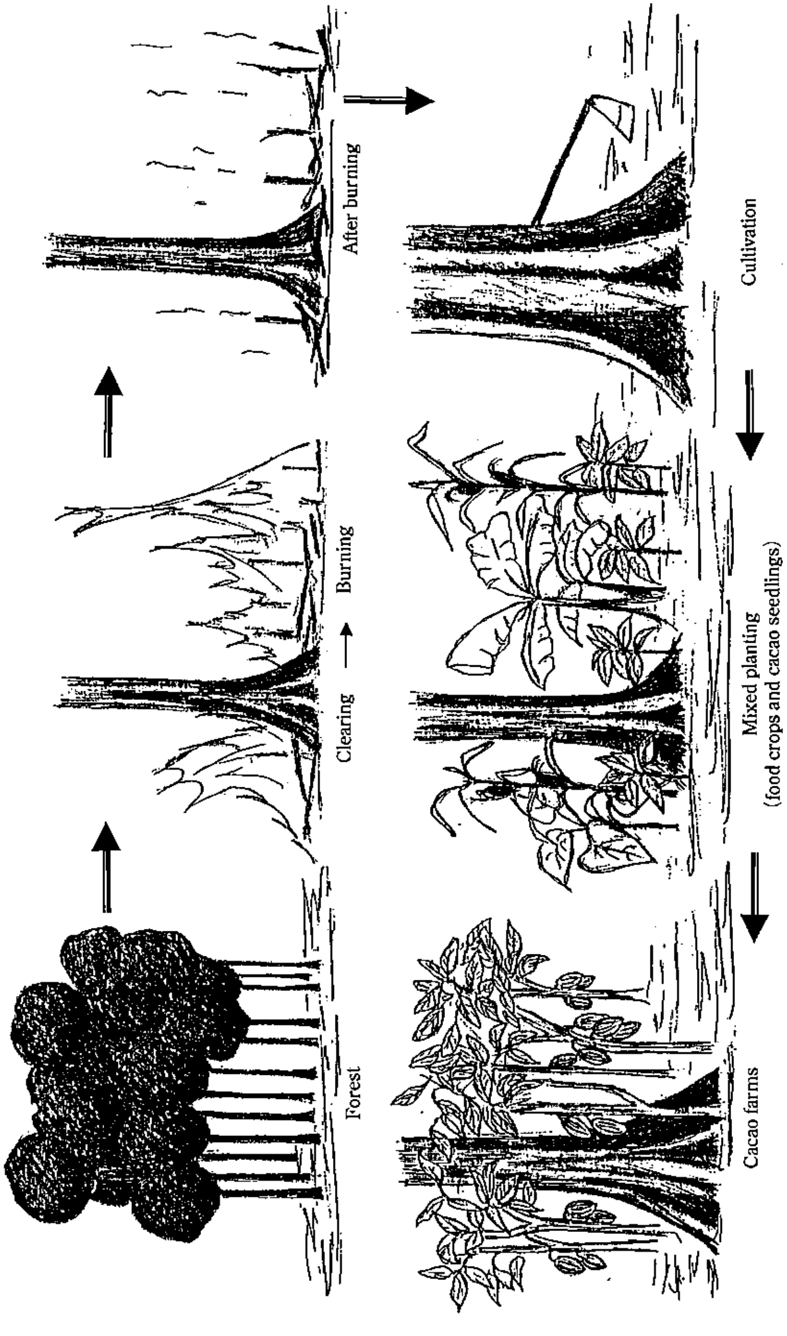


Fig.6-56 Formation process of cacao farms

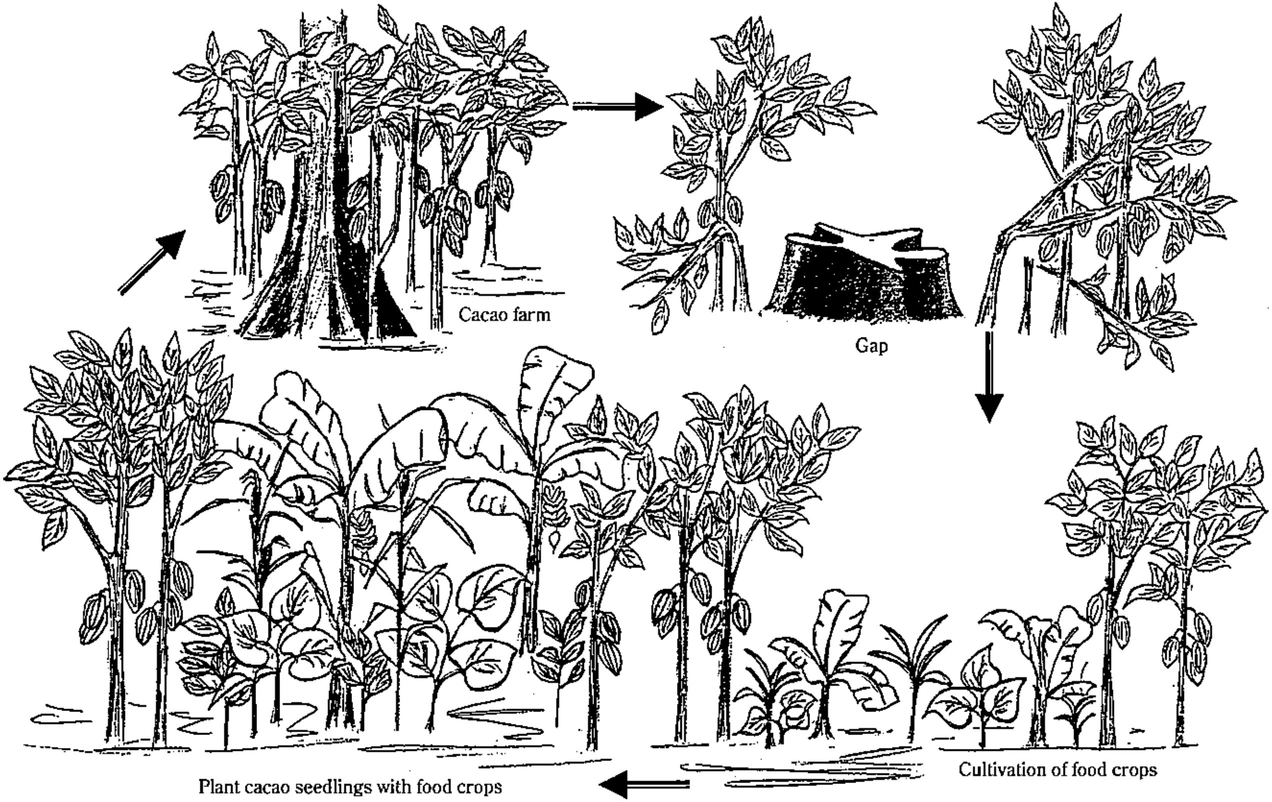


Fig.6-57 Renewal of cacao trees

(3) Multipurpose character of cacao agroforestry

1) Multipurpose use of cacao itself

Cacao seeds are dried and sold to the cacao-purchasing firm in each of the villages. They are mostly exported. The flesh around the seeds is sometimes eaten raw. Caustic potash is made by burning cacao shells ; together with palm oil lees this is used as the material of soap and is a valuable source of cash income for women in the villages.

It seems that tree crops such as cacao have been regarded as "crops" for seed production and that their role as firewood has been considered less important though they are "trees." But the function of cacao as fuelwood is very useful.

In 1997 and 1998, an investigation on household fuels was conducted in the three cacao-producing villages. Fig. 6-58 shows the ratio of cacao to the total firewood weight of the families in Biemtetrete. While some families had no stock of cacao, the percentage of cacao was 100% in two households. The ratio of cacao to the total firewood stock in weight of all households in the village was 42%. A similar tendency was also observed in Adujama and Mmoroben. Considering that the stock of fuelwood other than cacao is composed of multiple tree species, these figures suggest what an important part cacao plays as

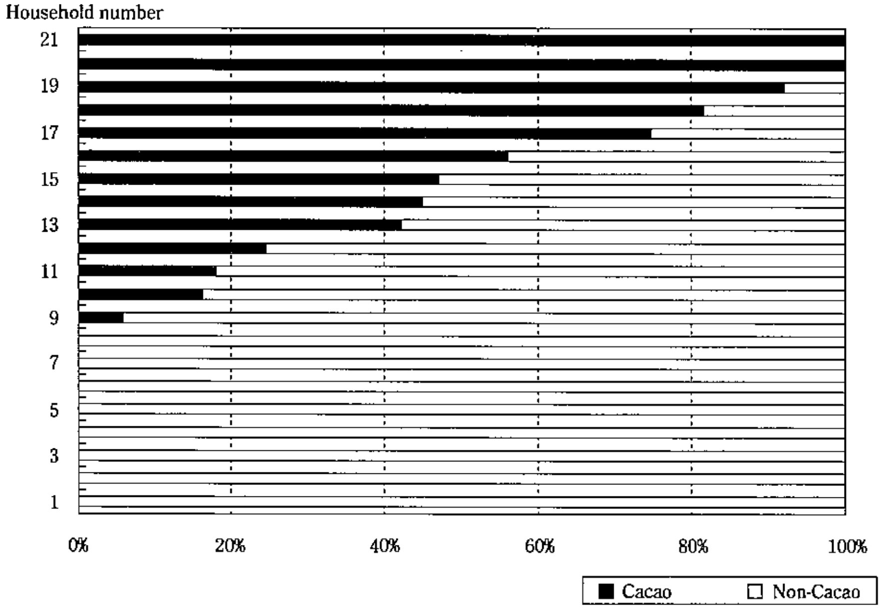


Fig.6-58 Ratio of cacao to fuel wood materials

Table6-20 Fuelwood[1] consumption[2] in Adujama (A) and Biemtetrete (B)(m^3)

	Family size (Persons)		Average no. of persons per meal (persons/meal)	Average no. of cooking per day (Times/day)	Fuel consumption (m^3/household/week)	Estimated yearly fuel consumption per person (m^3/person/year)
	Adults	Children			Firewood	firewood
B1	2	3	7	2	0.08	0.77
B2	3	5	11	2	0.10	0.60
A1	2	4	11	2	0.04	0.32
A2	2	3	7	3	0.08	0.77
Average	2	3	8	2	0.08	0.62

Notes: 1. Only cacao was used as firewood.
2. FAO's mass conversion equation (kg/cubic metre = 725) was used.

firewood.

It had been expected that residents in Mmoroben would use other trees more than cacao as firewood because the village is adjacent to a forest reserve and there are non-cacao forests where they could gather wood for fuel. But the survey revealed that they used cacao as much as residents in Biemtetrete and Adugyama, which are far away from the forest reserve.

Table 6-20 is the result of the investigation as to the consumption of fuelwood in which two households randomly selected from Biemtetrete (B) and Adugyama (A) were asked to use only cacao as fuel. As a result, it was found that each household used 0.08 m^3 per week on average. Based on this figure, the yearly fuel consumption is estimated at about 0.6 m^3 per person.

To estimate how much fuelwood is taken from cacao woods, six plots of 20 m x 20 m were established in the cacao woods of native and improved species and the number of cacao trees planted was counted in each of the plots. In addition, ten of the cacao trees that would be soon cut down as fuelwood (that is, those which were unwanted or stood dead) were felled and weighed (Table 6-21). The values obtained from the plots and weight measurement were averaged and figures per ha were estimated. The number of trees was 1,291 per ha and the volume of fuelwood materials that could be obtained from cacao trees was 0.08 m^3 per tree on average.

If cacao trees were renewed in a 30-year cycle and those reaching 30 years of age were consumed as firewood, about 233 cacao trees would be needed to meet rhe early demand for fuel per person. These cacao trees are equivalent to about 0.2 ha of cacao woods. This means that one cacao tree could supply fuel to one family of two adults and three children for a week and those cacao woods of 1 ha could meet one household's daily demand for fuel throughout the year.

Table 6-21 Volume of cacao fuelwood that could be obtained[1] (m³) and the area of cacao woods that could meet demand for fuel (ha)

Planting density[2]	Volume of fuelwood that could be obtained from one cacao tree[3]	Yearly fuelwood consumption[4]	No. of cacao trees that would meet fuelwood demand per person[5]	Area of cacao woods that would meet fuelwood demand per person
(No. of trees/ha)	(m^3)	(m^3/persons/year)	(No. of trees/person)	(ha/person)
1,291	0.08	0.62	232.5	0.18

Notes: 1. FAO's mass conversion equation (kg/cubic metre = 725) was used.
2. The average number of trees in the six plots of 20 m×20 m is converted into the figure for ha (no. of trees/ha)
3. Estimated based on the average weight (kg) of the ten trees to be used for firewood.
4. This is the figure estimated in Table 1.
5. It is supppsed that cacao trees were renewed in a 30-year cycle and those reaching 30 years would be used as firewood.

2) Food supply function

As already noted, young cacao trees need to be shaded at their early growth stage and because of this, they are planted in the shade of food crops. Thus it may be said that cacao trees have the function of food supply for a certain period of time. By the same method used in estimating the volume of firewood that cacao woods could supply, the quantity of food crops grown on the floor of cacao woods was measured. The crops investigated were cassava, cocoyam, and plantain that usually planted together with young cacao trees. These crops provide the main ingredients of *fufu* (prepared by steaming carbohydrates, making them into rice cake-like stuff which is eaten with soup). This is the main meal eaten almost every evening in Ashanti, the survey site.

In Table 6-21, it was estimated that in Ashanti, about 0.2 ha of cacao woods would satisfy the yearly demand for firewood per person. Thus it was supposed that each of the residents owned 0.2 ha of cacao woods. From these woods, they could reap about 56 kg of cassava, 63 kg of cocoyam, and 59 kg of plantain a year. Supposing these harvests were all used for *fufu*, they could eat about 178 kg of *fufu* a year. According to the survey conducted in this region in the same period, the yearly consumption of the three crops used for *fufu* is about 194 kg per person (estimated assuming that each person eats *fufu* once every day). This means that they can get about 90% of the three crops from their cacao woods. Of course, the harvest will change year after year owing to weather conditions, availability of farm hands, and other factors and it will be impossible to meet almost all of the demand with crops from cacao woods. But cacao woods can supply a considerable volume of crops and play a very important role in the supply of food crops.

(4) Considerations for gender and the existing systems

Worldwide, the preparation of meals, farm work for the cultivation and harvesting of crops needed for cooking, and the collection of firewood consumed in the kitchen are considered to be mainly the tasks of women. We have discussed the roles women play in cacao woods, and these functions have very good effects on women who take charge of these tasks.

Whether non-cacao forests where firewood can be gathered are near or far, the ratios of cacao trees to the total stock of fuelwood are roughly the same in the three villages surveyed (see (3) 1) above). This is partly because cacao is a suitable firewood material but also because cacao woods (that are both the sites for wood collection and those for food crop production) are scattered on a small scale within the sphere of women's activities. Cacao woods give them an important physical advantage : after doing farm work and gathering food crops for daily consumption, women can also collect firewood. This is very important factor in reducing women's working hours and workload.

While shortage of fuel materials is posing a serious issue in the savanna zone in general, it has not attracted much attention in the forest zone because it is usually considered that this zone has a sufficient stock of fuel wood. It may be true that the forest zone has more fuelwood resources than the savanna zone. But what is more important in considering the question of fuel materials, especially that of a lack of firewood for household use, is access to resources rather than the entire stock of resources existing in the area ; an increase in forest areas will be no solution to the problem of providing fuel materials. To overcome a shortage of fuelwood, emphasis should be placed not merely on measures to increase resources (development of new fuelwood forests, etc.) but also on how to reduce the labor and time of those engaged in the work of firewood collection work.

Ghanaian people succeeded in incorporating cacao, a newly introduced tree crop, into their traditional farming system and created, cacao agroforestry a new system that can be used for many purposes. Within only one century, a very short time compared with their long history, they adopted a new farming system as their own. Their ability to introduce what they needed into their environment in an appropriate form and the diverse and reasonable land-use methods they established as a result are really outstanding.

As seen from cacao agroforestry in Ghana, the "existing" system is not anything unchanged for a long time but the one established through adaptation to various circumstances. Ghanaian people have accepted new technology and knowledge and have used them to build up what is appropriate to their environment. It is no bad thing to introduce new techniques and tree species. But in development aid projects aiming at increasing fuel material production, consideration should be given not only to early-growing species from abroad but to the "selection of trees appropriate to the area," including native trees and tree crops, as well. Instead of just trying to increase woody resources by a large-scale project, the "selection of forest sizes" should be made properly and the project site should be chosen with gender considerations. What is more important will be the recognition that newly introduced elements are not separate and independent but are those to be built in the already existing system, to which adequate attention should also be paid. (A. Ochiai)

4-4 Introduction of tree crops into the Guinea savanna zone

The need to pay attention to the land system when introducing trees into areas outside the forest reserve has already been pointed out. Traditional societies do not always have a land tenure system that would be an obstacle to the introduction of tree crops as shown in the case of Cis-Kaduna in chapter 4. One example where a tree crop changed the traditional land system can be seen in Ghana as mentioned in 4-3 above. It is observed that the land partition by the traditional chieftaincy in the Ashanti region has been accelerated with the expansion of cacao production. By contrast, a case where change in the land system led to the widespread introduction of tree crops can be found in Tanzania. According to Yasu, as a result of the villagization project carried out by the socialist Tanzanian government, people have planted trees spontaneously around their farmhouse as well as distant farms allocated by the government to show their exclusive rights on the land (Yasu, 1998).

In savannas, which form the marginal areas of forests, a traditional agroforestry of crops and useful trees was established by imitating a combination of bushes and gramineous herbs in the natural ecosystem. But the trees arranged in these areas are those that grow naturally there. If, for example, plows or tractors begin to take the place of hoes and these randomly arranged trees hinder plowing work, the trees might be cut down immediately. Moreover, when women take charge of gathering crops from trees and men work on farmland, decisions will easily be made disregarding the various direct as well as in direct products of trees. Agroforestry in savannas, represented by sheanut, exists only on an unstable equilibrium of various conditions, including the land tenure system, farming system, and gender relations.

What kind of institutional supports could be created for conservation of trees outside forest reserves in savannas? Or if we consider introducing another tree crop as a replacement for the existing natural stands, what elements other than the land system mentioned first should we heed?

When farmers plant trees voluntarily, they have some explicit or implicit purpose. If the government, researchers, aid organizations, or other outsiders are involved in a tree planting program for rural areas, such a program must give incentives to individual farmers even though it aims at promoting the public interest. According to an investigation conducted by the Forest Research Institute of Nigeria in Community G mentioned in Chapter 4, indegenous tree species in savannas are, regarded as, free goods existing in a natural state, and so residents show no interest in taking the trouble to plant these trees (Igboanugo, 1996)..

On the other hand, farmers tend to display a high level of interest in exotic tree species. *Gmelina arborea*, the species the Nigerian government once encouraged people to plant, has no other effective uses than as a shelter tree but it can often be seen in rural communities. Therefore, if there are any exotic species bring some direct benefits, people are very likely to accept them. In addition, considering the constraints of water supply and risks of bush fires in the dry season, better survival ratio could be realized by screening and introducing MPTs with as many functions as possible. One of the roles of task managers of tree planting projects outside forest reserves is guaranteeing many alternative species, including fruit trees. There is the need not merely to provide technical supports but also to establish the supply system of seeds, seedlings, and mother tress to provide grafts and buds. In case of G Settlement, technological assistance of grafting and budding was favorably accepted by the people, but

Table6-22 Motivations for forest conservation and rehabilitation

Location	Approach	Species	Actors	Motivation			
				Timber	Fuelwood	NWFP	Environment
Inside forest reserve	Conservation of existing ecosystem		Forest service	−	−	−	+
	Plantation	Indegeneous		+	−	−	+
		Fast growing		+	−	−	−
Outside forest reserve	Conservation of existing trees		Local People ( ):women	−(−)	−(−)	−(+)	−(−)
	Plantation	Indegeneous		−(−)	−(−)	−(−)	−(−)
		Exotic		+(−)	−(−)	+(+)	−(−)

there was a problem of grafts supply. It is the people who make a final selection but in the decision-making process, attention should also be paid to the difference in interests between men and women, the availability of land, and other gaps among the social strata (Table 6-22). (M. Masuda and J. Aliu)

Chapter 7

Conclusion : Integrated watershed management by the ecotechnology approach

1. Historical and ecological background of non-sawah based rice cultivation in West Africa

The history of the cultivation of African rice in West Africa may be shorter than that of rice growing in Asia that is estimated to be 7,000 to 8,000 years ago. As of now, excavation shows that the oldest African rice cultivated in this region was the one grown in the area of Djenne, a city in an inland delta in Mali, about 2,000 years ago (Phillipson, 1985). Considering this, future excavation may reveal that West Africa has a longer history of rice cultivation.

Rice farming peoples in Asia invented sawah fields and strove to improve the growth conditions of rice plant. They have also selected better varieties and made ceaseless breeding efforts during the past several thousand years. In Asia, the breeding of rice and the development of sawah based agriculture occurred at the same time. On the other hand, in West Africa, rice growing was started but no sawah system was created.

What are the reasons that sawah systems were invented in Asia, but not in West Africa? The theory that Asian rice cultivation has its origins in the delta plains of the Chang Jiang (River) and in the areas along the Chang River is becoming the prevailing one (Sasaki and Morishima, 1993, Sato 1996). But from the viewpoint of sawah based rice farming systems, it has generally been assumed that the centers or origins of the early stage of sawah based rice planting in Asia were small mountainous valleys in the regions from Yunnan to Assam (Watabe, *et al.*, eds., 1987). It is believed that the first sawah fields were created in these small valleys. Since these small valleys have a small volume of river flow of several tons per second or less and moderate slopes, it was probably relatively easy for farmers to level the ground, make sawah fields encircled by bunds, and dam up a river to draw water through canals to the fields. Thus rice can grow in sawah systems by controlling water supply and drainage. With the progress of these environment-creating techniques, i.e., ecotechnology, the undifferentiated rice varieties in the early stage, which were neither adapted to sawah nor upland ones, must have been divided into lowland sawah and upland rice in the process of adapting to the environment (Watabe, *et al.*, eds., 1987). It is believed that those who migrated from Korea or China to western Japan brought the first sawah based agriculture to Japan in the Jomon (5000-300 B.C.) and Yayoi (300 B.C.-300 A.D.). Having neither very high mountains nor large rivers, the Izumo, Chugoku and Kinki districts in western Japan are what is called gently sloping, hilly and small mountainous areas where Japanese-type "peneplains" are prevalent. They are mostly those small lowlands where small rivers run through hilly areas like the Kyoto and the Nara Basin. In these small lowlands, it must have been easy to make sawah fields with relatively simple techniques.

On the other hand, it is considered that African rice was first grown mainly in the inland deltas in Mali (Carpenter, 1978). The deltas extend 100 km from north to south and 300 km from east to west and are formed where the Niger meets the Sahara. Thus both farmers and their rulers must have never dreamed of making any attempt to control water in such huge and unique inland deltas. We might compare this habitat environment with the floating rice belts in the Ayutthaya area along the Chao Phaya River in Thailand. Even in this country with a long tradition of sawah based agriculture, it was almost impossible until a few decades ago to develop any water-controlled sawah fields in this area. Only during thirty years were huge scale sawah systems with electrically controlled various draingae and irrigation facilities developed in this area.

The comparison between the growth environment of the habitats of African rice and that of its Asian counterpart leads us to another interesting fact: whereas the latter is the product of a humid tropical ecological environment, the former is evidently that of a savanna one. The wild species, the ancestors of cultivated ones, had adapted themselves to an ecological environment where the ground would be flooded during the rainy season but totally dried up in the dry season. It is considered that after its cultivation was started, African rice, born in a semi-arid environment, spread to southern equatorial forest zones with more rainfall (Cowan and Watson, 1992). One of the most important advantages of sawah systems is weed control, and damage from weeds might have not been so serious in a savanna environment as in the humid tropics of Asia.

2. Agronomic and engineering adaptation in rice cultivation

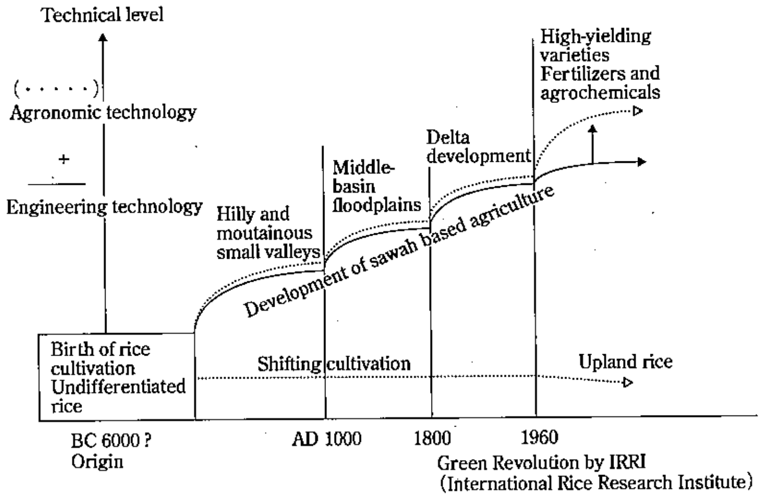
Fukui (1987) pointed out that the history of rice growing in Asia has two aspects in its development processes: agronomic and engineering adaptation, though their importance differs according to rice farming ecology and the historical developmental stage of technology in each area. The examples of agronomic adaptation include breeding, fertilizing, weeding, disease prevention and pest control, cropping systems and cultivation methods, and those of engineering adaptation are improvements in the environment of rice growing areas by constructing and improving weirs, small reservoirs, irrigation and drainage facilities and sawah fields.

When rice cultivation was started in Asia, undifferentiated rice varieties that were neither lowland sawah nor upland ones must have been grown in the farms that were neither sawah nor upland fields. Such a situation may be compared with rice growing now practiced in inland valleys in West Africa. WARDA (1988) named the rice grown in this type of cultivation environment hydromorphic rice or upland/inland swamp continuum rice and regarded the environment as having the highest potential for increased rice production in the future.

At its early stage, rice growing was divided into upland and sawah rice cultivation. As already noted, the first sawah fields were probably started in small inland valleys under gently sloping hills and small mountains. This is because, with the advent of a feudal society in the Middle Ages, there appeared advanced technology and strong political power to take flood control measures and perform irrigation and drainage work to develop sawah fields in middle-basin floodplains. To develop sawah fields in a delta in the most downstream area, it is essential to have a drainage system with electric pumps. Because of this, it was in the modern era that the development of large deltas was started in earnest.

As mentioned above, sawah field agriculture was basically established in Asia. The Green Revolution began in the 1960s triggered by the breeding of

A : History of rice cultivation in tropical Asia



B : History of rice cultivation in West Africa

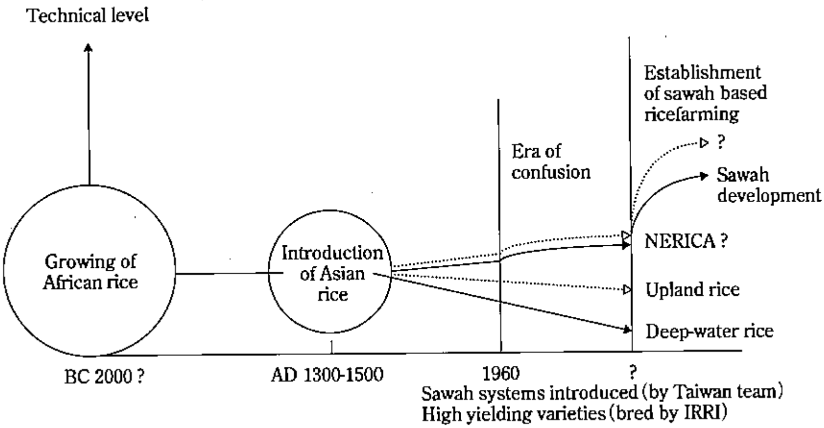


Fig.7-1 Schematic diagrams of the history of rice cultivation in monsoon Asia and monsoon West Africa

IR-8, IR-20 and other high-yielding varieties by IRRI (International Rice Research Institute) and achieved glittering successes in tropical Asia in a short period until the mid-1980s. Behind this was the existence of sawah based agriculture (the sawah hypotheses, Chapter 1). Fig. 7-1 shows the schematic diagrams of the history of rice cultivation in monsoon Asia and monsoon West Africa (Wakatsuki, 1990). Since no environment creation technique of sawah fields, i.e., ecotechnology, was applied to African rice traditionally, its selection and breeding did not make rapid progress. As a result, after 15th century when Asian rice was introduced into this region, the planting of low-yielding African varieties decreased. The growing of African rice has sharply declined since the 1960s and is estimated at 10% or less of the region's total rice production at present. Main cultivated areas of this rice are now only a few, such as Sokoto and Gashua, Nigeria, and some parts in inland deltas in Mali. In many cases, African rice is only regarded as a weed growing in the fields of Asian rice.

IITA (International Institute of Tropical Agriculture) and WARDA started development research in the early 1970s placing emphasis on breeding, with the aim of bringing about in Africa, a Green Revolution like the one IRRI carried out in Asia. However, as already stated, rice growing in tropical Africa and West Africa has since remained at a low level.

3. Road to sustainable rice cultivation in West Africa

Three strategies can be considered to cope with this situation. The first is to depend totally on biotechnology from the standpoint that new varieties will solve problems. Biotechnology, mainly gene recombination that has rapidly developed recently, has led many people to believe that we may solve the problems by breeding. The dreams of advanced technology, such as molecular and cell breeding, are much more attractive than traditional breeding methods. Needless to say, we should continue to promote studies in this direction.

Important technological innovations in this field have been reported. In a recent research project, WARDA (1995) succeeded in the interspecies crossing of African rice, which is resistant to weeds, tolerant to drought, and has genetic properties of surviving even in poor nutrient conditions, with Asian rice, which is high yielding. For 20 years, WARDA did not succeed in the attempt to crossbreed Asian rice with its African counterpart. Then Dr. Monty Jones, a breeding scientist at WARDA, found that the African rice collected in Guinea could be crossed with Asian rice and bear seeds well. This is a noteworthy and important breakthrough though some more time will be needed before it becomes possible to unify the good genetic properties of the two groups of rice and to create new useful varieties out of them. It is hoped that molecular genetic mechanisms will be discovered and totally new rice varieties will be developed. It may not just be a dream that some day the genes of African rice will contribute to rice growing in Asia. As described in the chapter 1 and the preface, by the continuing efforts of WARDA (1999) on inter-specific hybrid rice, NERICA, a new African rice between *Oyrza sativa* and *Oryza glaberrima*, is available for West African rice farmers. Present NERICA varieties are, however, still targeting the improvement of upland rice (Ishii 2001) at the moment (Fig 7-1B).

But it is also true that even the genetic characteristics of excellent species cannot show their potential fully unless fundamental environmental conditions are available. Will it be possible that a species with high drought and poor nutrient tolerance achieves a high yield in a non-sawah field having almost no water control or inefficient fertilizer application? Unless biotechnology turns into alchemy or unless technology can go beyond the rule of mass balance, it will be impossible to keep the productivity of rice at a high level. Under a poor environment, it will be hard to realize an average yield higher than 2.5 t/ha on a sustainable basis. Moreover, to depend on an approach devoid of an environmental conservation concept will not contribute to the prevention of desertification of both upland and lowland fields and is even likely to promote it. Therefore, the authors thinks the upland rice system, even with NERICA, will not be sustainable and will contribute to the degradation of environment in West Africa. As we described in this book, the first priority should be given to the R&D of lowland sawah based farming systems in West Africa. NERICA will be the most useful in sawah based systems. In this sense, although the author understands the stepwise target of WARDA(1999) to adopt NERICA in the stabilization of upland rice, then rainfed lowlands in inland valley bottoms, and, finally, irrigated systems, the first step of the stabilization of upland rice is questionable. Therefore, the author proposes the NERICA strategy of WARDA(1999, 2000) should integrate the eco-technology based sawah strategy described below as soon as possible.

The second approach, which is opposite to the one mentioned above, lays stress on engineering technology for a better environment, such as irrigation and the creation of sawah fields. It is clear that this type of engineering technology, like the one of sawah based agriculture where various measures are taken to control and conserve water and land, is important in tropical Africa. But because the projects for developing irrigated sawah fields have mostly been carried out by foreign aid, they tended to be large-scale disregarding the region's social, economic and technical situations. In many cases, the most advanced rice growing machines were also introduced. As already noted, high technology symbolized by these machines is not sustainable in this region and cannot exist without continuous assistance from abroad. Continued foreign aid increases the region's debt.

As described in chapter 1, small irrigation schemes are considered more suitable for development at present. However, with the present small irrigation schemes, the construction cost, 20,000-30,000 US$/ha, is comparable to large schemes as far as their development depends mainly on engineering work by experts. Therefore the project ownership still belongs to the government (engineers) rather than the farmers. The characteristics of the target technologies are similar to those of the big ones. However, because the scheme is small, technology transfer, i.e., high/medium input, 300-500US$/ha/y, irrigated rice based agronomy including machinery, will be relatively easy. The sustainable development of the present small scheme, however, is questionable, because of the high initial construction cost. The production level of rice farmers, 1,000-2,000US$/ha/y, could not compensate for the high construction cost.

The last ecotechnology strategy is to realize the importance of both agronomic and engineering adaptation technology to the development of rice growing in tropical Africa and to make sure that this technology is sustainable in rural communities as well as ecology in the region. We should understand the fact that sustainable efforts are needed to increase farming production while conserving soil and water resources in tropical Africa, where the total destruction of the agricultural environment is occurring. Therefore sawah based agriculture may be recognized as important and may be accepted in the climate of tropical Africa and established there. The development of sawah based agriculture by farmer participation in inland valleys may be a first step of such efforts. The ecotechnology strategy discussed here is based on the various on-farm trials described in chapter 6. It may only be small to begin but might become larger in the future.

4. Ecotechnology approach for sawah based agriculture in inland valleys and floodplains in West Africa

4-1. Japanese international contribution for sustainable development on sawah based agriculture in Africa

What is important is to establish a structure for building up and spreading sawah systems by the joint efforts of African farmers, extension workers, researchers and engineers of agriculture and policy-makers. Unlike the case for spreading newly bred varieties, demonstration only is insufficient for technical assistance projects concerning sawah systems. Technical cooperation in the past was mostly composed of guidance on the technology of rice growing and its management using irrigated sawah fields that were designed according to the survey of foreign consultants, such as those from Japan, and made by a construction company. Almost no efforts have been made to provide local farmers with practical education and technical guidance to help them create themselves a sawah system suited to their ecological environment and socioeconomic conditions. As we described in chapter 6, on-the-job training is the most effective in the ecotechnology approach.

If we liken the situation to the case of automobiles, our past strategy was just to bring new vehicles with various useful functions to the host country and teach people there how to use (drive) and maintain these cars. Because of this, if sawah fields become old, their quality deteriorates just like cars. Past technical assistance of irrigated rice development was the same as the export of new automobiles. How to maintain and use sawah fields will not be a major problem if local farmers can develop their own. What is really needed is to support local farmers' endeavors to realize sawah based agriculture suited to the African environment.

Sawah based agriculture in Asia has such breadth and depth that it may be considered a civilization. It is not limited to rice production only ; combined with forests in waterhseds, it forms an excellent agroforestry and environmental technology and its water distribution and irrigation system provides a basis for well-organized social systems. Therefore, Asia's sawah based agriculture needs cooperation among people from a wide range of areas. Recently, several international organizations, including IIMI (International Irrigation Management Institute ; headquarters in Colombo, Sri Lanka), which handles irrigation problems, ICRAF (International Center for Research in Agroforestry ; headquarters in Nairobi, Kenya), which is responsible for agroforestry, and CIFOR (Center for International Forestry Research ; headquarters in Bogor, Indonesia), which specializes in tropical forestry, were founded under the CGIAR (Consultative Group on International Agricultural Research) system. IITA (International Institute of Tropical Agriculture, headquarters in Ibadan, Nigeria), WARDA (West Africa Rice Development Association ; headquarters in Bouake, Côte d'Ivoire) and IRRI (International Rice Research Institute ; headquarters in Manila, the Philippines) also belong to the CGIAR. Considering that sawah based agriculture embraces all these fields, a new international organization that may be named "Center for Sawah Agriculture in Africa" could be founded in West Africa. Such an organization would agree with the policy of the CGIAR that places emphasis on environmental conservation and sustainable farming production. We might begin with special programs aiming to reinforce IITA or WARDA in this direction under the policy of TICAD-III, Tokyo International Conference on African Development.

When we try to make human and technical contributions from Japan to CG centers, especially to WARDA and IITA, we have to overcome two main barriers, which are the two sides of the same coin. One of them is the shortage of researchers and engineers ready to be involved in African agriculture. The other is the conflict of "interests" of Japanese ministries for the contribution of international development, such as the Ministry of Foreign Affairs, Japan (MOFA) and the Ministry of Agriculture, Forestry and Fisheries, Japan (MAFF). While we should support WARDA, IITA and other international organizations with "money" and "human resources", MOFA persisted in its view that Japan's assistance to such international bodies as IITA and WARDA should be "Gulf War-type" contributions, so-called "core contributions only", which were limited to financial support. "Special projects" through Japanese initiatives including human resources and ideas were not common in the CG centers in Africa. On the other hand, as a result of MAFF's past emphasis on technical assistance to Asian countries, there are not many people who can carry out technical cooperation projects for African agriculture. The non-governmental organizations (NGOs) that want to make positive contributions to African agriculture faces the customary rule that MAFF takes charge of all projects in agricultural areas, and the technical level of NGOs, etc. is not sufficiently high in some cases, especially in Africa. There are discrepancies among "funds," "human resources" and "institutions." There should be policies for increasing human contributions to international organizations in tropical

Africa because Japan has not much experience there, thereby building up the stock of Japanese researchers and engineers devoted to this region. The studies of sawah based agriculture are one of the important fields for this objective.

Sawah based agriculture may be, in a sense, a concept comparable with a Christian view of the world that Europeans have worked to disseminate since the age of Christopher Columbus (era of slave trade). But it may also be argued that it is "only a technology" for creating a desirable watershed environment and continuing intensive and sustainable food production. Since it allows us to remain neutral in spiritual culture and views of the world, sawah based agriculture would be an ideal form of Japanese international contribution. The export of Japanese culture characterized by sawah fields and forests is really suitable for Japan in an age when the global environment is threatened seriously as described in chapter 1 (AICAF, 1993 ; Umehara, 1991 ; Sumita, 1991, Wakatsuki, 1992 ; Takeda, 1992). We should add the sawah based agriculture in the forthcoming TICAD-III, Tokyo International Conference for African Development, in 2003. See Fig 1-4 (p7) and Fig 1-5 (p19) in chapter 1.

4-2. Strategies for developing African based sawah agriculture

①Development of Japanese-type sawah fields

The development projects of sawah fields on all scales in the past mainly aimed to demonstrate by models, so modern technology and equipment were needed. This means that the same level of sawah agricultural technology used in Japan is brought to the host country. Because of this, as we described, it is not unusual for the development cost of one hectare of sawah fields to reach as high as $30, 000. If the initial goal is to develop sawah fields in 2 million ha of inland valleys and floodplains in West Africa over the next 20years, 10% of their respective development potentials of 10 million ha, the total cost will be $60 billion or about ¥380 billion a year. As described in chapters 1 and 6, since a sustainable cost of sawah construction is estimated to be less than $4,000 per ha considering the present economic power of African countries, rice price and possible yield, this method will not be a sustainable one. Should no-army and wealthy (?) Japan offer financial support to such a strategy ? This will be the same as the donation of new cars, as mentioned already, and is most likely to result in the waste of huge amounts of money after using, making, and abandoning old, degraded sawah fields.

②Development of African-type sawah fields

When we try to make the most of locally available tools and farm labor for creating a sawah system, what is needed is only to provide extension workers and farmers with practical on the job training and to assist them in their own efforts. In this case, the cost will be mainly that for sending experts, NGO members and other personnel. Suppose the expense per person dispatched was $200,000 with about 1000 people annualy, (which is equal to the number of sawah experts Taiwan sent to Africa during 1965-1975 as described in chapter 1 year), the yearly cost would be about US$200 million. If this strategy of emphasizing practical on the job training and promoting the expansion of sawah fields and training at the same time (Wakatsuki, 1991, 1992) works continuously, it will be possible to introduce sawah field agriculture at very low cost.

The problem with this method is that Japan and relevant Asian countries do not have many people who can carry out the needed diverse activities. Such include design and layout of sawah systems adaptable to the local topographic and hydrologic features and soils in Africa. Development and management also need to be accommodated to African rural communities. The most important subject is to provide local farmers and extension staff with technical guidance on all related subjects, including surveying, construction of irrigation and drainage systems, leveling and bunding for sawah construction, water management and rice growing. These activities depend mainly on human power that require very hard work. If the supply of Japanese staff is insufficient, it would be possible to ask for cooperation from experts in Taiwan, Korea, Thailand, Indonesia, China, etc. But as noted in Chapters 3 and 6 it, will be not easy to carry out modern rice growing in sawah fields with the simple tools available in the area because these tools have been developed and improved for local traditional agriculture.

At the initial stage, there will be the need to send people from Japan and other Asian countries, but to localize sawah agriculture and make it possible for farmers to reproduce it themselves, there should be a system for those training extension workers. This would be the main role of a "Center for Sawah Agriculture in Africa".

③Ecotechnology approach for sustainable development of African based sawah agriculture(Wakatsuki *et al*. 2001 a and b).

The above two approaches are poles apart and a road to the introduction of sawah based agriculture using appropriate technology will be found between them as described in Chapter 1 and 6. Simple and sustainable small-sized power tillers and other small farm machines, such as water pumps applicable to the region's ecological environment should be developed and used positively. There is room for improvement in tools, too. Though there is an important difference between Asian and African rice growing systems moment as exchanges of experiences between African farmers and their counterparts, for example, in northeastern Thailand, Sri Lanka, India and other Asian countries, who have a rice growing ecology similar to West Africa, are also useful. Another important role of a "Center for Sawah Agriculture in Africa" would be to encourage technical exchange activities between the two regions. The form of appropriate technology will differ according to each rice cultivation ecology. It will also be discovered through grass roots joint work with African farmers. Needless to say, the task of establishing appropriate technology should be that of local researchers and extension workers and what Japan has to do will be to help develop such human resources.

5. Toward integrated development and management of inland valley watershed in West Africa

The ultimate goal will be to raise agricultural productivity and farmers' living standards through the protection and improvement of the entire environment of each district, including villages, with positive cooperation from families and rural communities. The inland valley watershed in Africa is still a frontier for future development. We do not see so many traces of environment-creation efforts, i.e., development, resulting from the accumulation of many years of farm work (e.g., lines drawn on the ground) like sawah field systems in Asia. Sawah systems are a kind of national infrastructure, such as road systems. Ecotechnologies play a major role in creating beautiful farming landscape. As far as farm work remains just the repetition of the consumption of resources as in shifting cultivation, there will be no ecotechnological creation of environment. The creation of environment is possible only when the outcome of farm work by families and communities for generations is stored on the land. As in the case of the accumulation of capital and assets, farm labor must be stored up to create beautiful rural scenery in inland valley watersheds. Adequate consideration should be given to comfortable rural structures and houses, rich homestead forests, well-marked and leveled farmland, conservation and accumulation of fertile soil, irrigation and drainage channels, roads, orchards, a good arrangement of reforested land and natural forests and so on, as described in Chapter 6.

Fig. 1-25 in chapter 1 is a schematic diagram of the images and development factors of inland valley watersheds (called "unit watershed") from forest to savanna zones in West Africa. The unit watershed is an unit of an environment of the earth. As biotechnology has been practiced as cell engineering, the ecotechnology to restore the global environment will be materialized as unit watershed ecotechnology. Agriculture in West Africa is now mostly carried out in the uplands, which are essentially disadvantageous in terms of intensive sustainability. Agriculture in the lowlands is far more advantageous for the sustainable and effective use of water, soil and forest resources. Sustainable productivity per unit area should be more than ten times as high as farming in the uplands (Sawah hypothesis as described in Chapter 1). Sawah based agriculture can be integrated with livestock raising and fish ponds in the lowlands, which can be further integrated into forestry, agroforestry, mixed farming, and livestock raising in uplands in an inland valley watershed. As described in Chapter 1, such integration increases intensive sustainability and creates beautiful views of inland valley watersheds.

Since the water control for sawah fields is basically the same as that for fish ponds, it may be effective, in the early days of sawah based agriculture, to build these ponds with the concerted efforts of rural communities. In this way it will be possible to develop sawah systems by farmer's participation in each unit of inland valley watershed of 1,000-10,000 ha. The minimum unit area may be different depending on the climate and topography of each agro-ecological zone in West Africa. Sustainable sawah development based on the ecotechnology approach will contribute to the establishment of environment-creating agriculture in West Africa. By the sustainable intensification of lowland sawah based agriculture, we will be able to conserve or restore forests in the upland areas in a unit watershed. We can encourage the planting of multipurpose tree species, fruit trees, soil improving leguminous trees and other useful trees. Thus sawah based agriculture can promote agroforestry and social forestry through a combination of forestry and agriculture or rural communities and realize mixed farming with livestock raising in upland areas. This integrated form of agriculture, forestry and fisheries in a unit watershed will be a way to restore African land now exposed to degradation and desertification.

Though they appear to be very complex and diverse, the above-mentioned factors are only part of the work in which a small group of farmers is involved in managing their farms in watersheds. But there is the possibility that these diverse elements of technology may be separately brought by engineers, volunteers and researchers. In this case, what is of vital importance in the short run is the viewpoint that such technology can harmonize with Africa's traditional farming systems and rural life. Therefore, development programs should lay stress on dialog and joint work with local farmers and communities and farmers' assessment. In other words, what we should choose is the promotion of "African based sawah agriculture" that would be adaptable to the region's traditional agriculture. We hope that the ecotechnology approach for sustainable sawah development described in this book will contribute to increased food production and restoration of the environment in the rural community of West Africa.

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