Table 2.5.1 Summary of Existing Projects (Aid Organizations)

Name of Organization	Project	Implementation Year	Area	Agricultural Finance	Organization	Literacy Education	Extension	Agricultural, Stock Raising and Sylvicultural Production	Environment	Agricultural Infrastructure	Health and Sanitation	Budget	Features	Issues/Lessons
International Fund for Agricultural Development (FIDA: French, IFAD: English)	Village Development Fund Program	1984-1992 (1st phase), 1992-1999 (2nd phase)	Ségou Region	○	○	○		○		○		IFAD, Mali government, etc.	Performs a wide range of activities focused on the poor.	Small-scale financing through the National Agricultural Development Bank was unsuccessful.
	Income Diversification Program in Mali Sud Area (PDR)	1996-2000 (planned)	Entire area of San and Tominian and part of Bla and Macina (Non-cotton rain-fed farming zone)	○	○	○	○	○	○	○	○	IFAD, West African Development Bank (BOAD), OPEC Fund, Mali government	Focused on the poor. Assigns technological extension activities to CMDT. Has established the "Saving and Loan Mutual Benefit Union (CMEC)" with support from BEAGGES.	
	Sahelian Areas Development Fund Program (FODESA)	Implemented from 1999 to 2010.	Ségou, Macina	○	○	○		○	○	○	○	IFAD, Mali government, etc.	Focused on the poor. Has constructed a saving and loan system that farmers can easily access and provides with it literacy education and technological support, including management training based on the experience of credit business through the National Agricultural Development Bank.	
African Development Bank (AfDB)	Program for Development of the Middle Bani River Basin (PMB)	1998～2007	Along the Bani in Bla, San and Ségou	○	○			○ Rice	○	○		Government of Mali, AfDB and OPEC funds	Assigns the extension activities to the extension organizations of CMDT in the same way as PDR.	
German Technical Cooperation Corporation (GTZ)	Support for the *National Plan for* Environmental Action	1995 – *Present*	(Ministry of *Environment*)						○			Germany	GTZ performs various activities in more than 800 villages in Mali.	As a result of small-scale financial support project, GTZ has established nine credit unions in San. Although the debt collection ratio was more than 90%, how the sustainability can be assured for these financial institutes remains an issue.
	Small-scale financial support project	1995～1998	San	○	○							German Development Bank, etc.		
German Development Service (DED)	Project for Agricultural Ecology (PAE)	-2000	Bla, Tominian (CMDT)				○	○	○			German Development Bank, etc.	In cooperation with CMDT and NGOs, DED runs a business through conversations with farmers. In this business, a villager education method for environmental conservation was developed and a sustainable natural resource management method was extended. DED staff is permanently stationed at CMDT in Bla and Tominian.	

Table 2.5.2 Summary of Existing Projects (NGO)

Name of Organization	Project	Implementation Year	Area	Agricultural Finance	Organization	Literacy Education	Extension	Agricultural, Stock Raising and Sylvicultural Production	Environment	Agricultural Infrastructure	Health and Sanitation	Budget	Features	Issues/Lessons
World Vision	(World Vision is implementing five agricultural development projects in San)	20 years ago – Present	Bla, San		○	○	○	○	○	○	○	Canada, U.S., Switzerland, etc. (Budget for San and Bla accounts for 54% of the entire budget for Mali.)	Activities with emphasis on education of farmers. Puts great emphasis on literacy education. Still performs rural village financing in the Yanagasso district in Bla but supplies farmers with funds in the form of subsidy in the San office district because of shortage of debt collectors and a low collection ratio.	While the yearly budget for the San Cercle is U.S.$1.15 million, the issue of limited funds and personnel must be overcome. The Bla Cercle is in the same situation.
Sasakawa Africa Association, the Global 2000 Program of the Carter Center	Sasakawa Global 2000	1986 – Present	50 villages in Ségou Region	○			○	○	○			Sasakawa Foundation, Carter Center	Performs extension activities through DRAMR as the follow-up of PNVA. SG2000 occupies a large position in the activities of DRAMR. Actively works on small-scale financing by introducing saving and financing systems. The activity areas include Zambougou in the Cinzana Cercle.	
CARE		– Present	Macina	○	○	○		○Rice		○	○	CARE, USAID	Gives priority to women in small-scale financing. Only five out of the current 42 credit unions loan to both men and women. The financing method is determined according to the actual situation of a village.	Joint activity with PDR implemented by IFAD is carried out, but problem is communications and coordination.
YEREDON	Consulting on organization and operation of firewood collection and sales system.	– Present	5 villages in Ségou Cercle					○ Woods	○			Government of Mali	Activity under the National Plan of Mali.	
ACD	Vegetable Fields, Cultivation, Youth Health and Sanitation	1996～1998	Sarro (Macina)					○ Vegetables	○	○	○	CCA-ONG	Steady activities are focused on women, children and poor.	Activity funds are limited.
	Family, Maternity and Children Health and Sanitation	– Present	Say (Macina)								○			
SOS-Sahel	Tominian Commune Environment Project (PECT)	1996～1998	Tominian	○	○	○	○	○	○		○	Sos-Sahel (GB)	Natural resource management services requiring residents' participation.	

(2) Trends in Aid Organizations

1) IFAD

For many years, IFAD has been undertaking activities in the rain-fed farming zone of the study area, such as diversifying income sources and providing rural village financing with focus on the poor. IFAD is working on the construction of sustainable rural village financing systems, currently in progress, in both the projects of FODESA and PDR.

IFAD, undertaking wide-ranging activities in the study area, is already doing so in some of the villages under the verification study. We are attempting to define the relationship between IFAD and this study project. In particular, to avoid confusions on the part of farmers, it is important to avoid overlapping activities in the verification study and coordinate the burden share of farmers to implement the project.

2) GTZ

GTZ has been providing support for the National for Environmental Action Plan (NEAP/NAP-CCD) since 1995 and they are also involved in natural resource management, rural development, improvement of the status of women, and small-scale financing in more than 800 villages.

3) DED

DED is undertaking activities to organize farmers and promote social development to prevent desertification and establish sustainable agriculture in 4 Régions in Mali including Kayes, Koulikoro, Ségou and Mopti. However, the activities in the Ségou Région were completed in 2000.

4) Future Issues

In the existing projects, there already exist many of the technologies and methods used to prevent desertification, with some successful cases. However, these successful cases have not gained spatial expansion mainly because of lack of interest by villagers in desertification prevention measures and existence of little information exchanged among villagers and villages. Additionally, the cooperation is not so strong among administrative organizations, international organizations, and NGOs although they are implementing similar types of projects.

(3) Activities of NGOs

In various projects aimed at preventing desertification, many efforts are currently required including education and information supply to villagers, technical guidance, and coordination among those concerned to have beneficiaries themselves participate both in planning and implementation. NGOs occupy important positions to provide such efforts.

The activities of NGOs are coordinated by the Ségou Région Coordination Committee (CR-ONG-Ségou). CR-ONG is a coordination organization (NGO) founded in 1995 to "enhance the cooperation between administration and NGOs", "improve the institutional conditions", "enhance the organizations", and "enhance the relationship with financing organizations". Currently, 43 or about 60% of NGOs in Ségou are members of this organization. Table 2.5.3 shows the characteristics of NGO activities.

Table 2.5.3 Characteristics of NGO Activities

Advantages and successful cases	Unsuccessful cases and issues
• An NGO person in charge of a district is stationed on site and contacts local farmers from day to day. • An activity item is basically determined according to the intentions of local farmers and through discussions with them. • Beneficiary farmers are required to shoulder their share of both economical and labor burdens. • Through steady local activities, spontaneous education of the local community by farmers has occurred, such as the establishment of a farmers' bank by farmers and resolution of a dispute among villages.	• The activity item and the specialty field of an NGO delegate do not match, resulting in idle statuses of wells or nursery. • Part of a plan ends in a failure because of financial problems or an insufficient number of personnel or insufficient information exchanged. • Farmers, having learnt handicraft skills through the guidance of an NGO, desert their villages because of the skills.

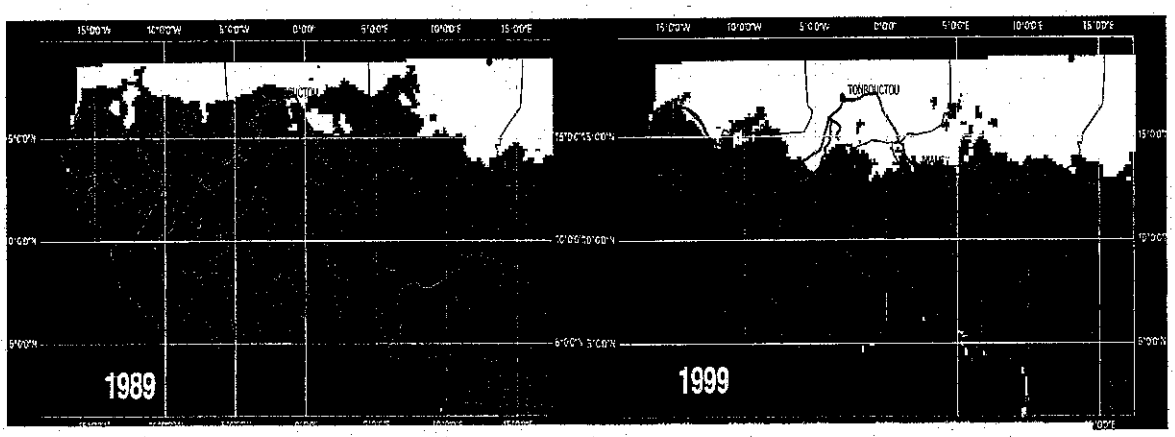
Although their fragility as organizations is undeniable, the NGOs in Mali are expected to carry out sufficient activities and can flexibly respond to changes in situations as long as they have a high performance and are supplied with necessary expenses, equipment, and information (and training if necessary). When cooperation with a NGO is required for the sake of researches or projects, however, it is necessary to sufficiently evaluate the NGO's performance, which varies greatly among different NGOs.

2.6 Present Status of Desertification

(1) Definition of Sahel Region

The UN Convention on Desertification adopted in 1994 defines desertification as "deterioration of land caused by various factors (including climatic change and human activity) in arid, semi-arid and arid semi-moist areas". Figure 2.6.1 shows the results of an analysis of the movement of vegetation in West Africa in 1989 and 1999.

Figure 2.6.1 Dynamic Analysis of Plants in West Africa



Source: NOAA Satellite Image Analysis (JGRC Project Result)

These diagrams show the distribution of the areas of vegetation and poor vegetation, by calculating the primary production quantity of plants using an experiential formula obtained from the rainfall data of

the previous year in the Sahel region, and categorizing them based on NOAA vegetation indexes. As can be seen from the diagrams, the poor vegetation area has expanded in the 10 years from 1989 to 1999. Therefore, it is presumed that long-term deterioration of vegetation, namely desertification, is expanding to a broad extent in West Africa.

(2) Desertification in Mali

The major causes of desertification in West Africa are:

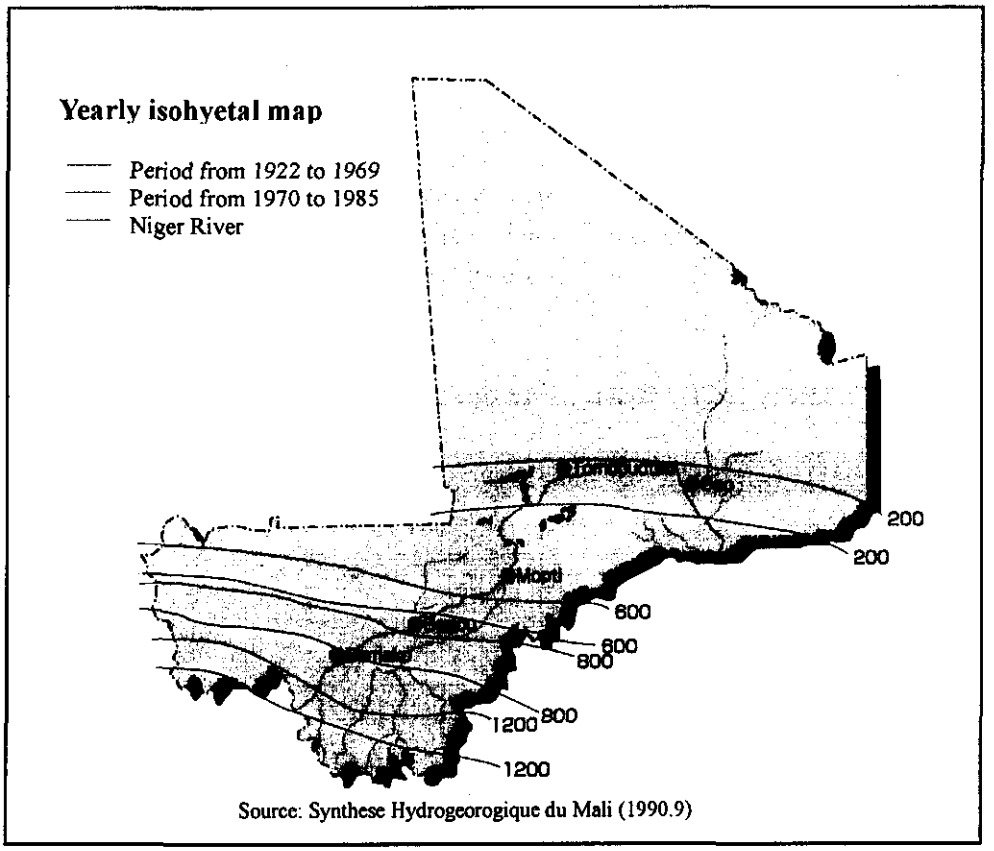
① Reduced rainfall
② Decline in fertility of cultivated land due to farmland expansion and shorter fallow periods;
③ Decline of forests due to increased consumption of firewood materials;
④ Excessive grazing, etc.

With regard to these causes, the present status of Mali is described as follows:

1) Reduction in rainfall

Figure 2.6.2 shows the transition in yearly average isohyetal lines for the years 1922 to 1969 and 1970 to 1985. As the isohyetal lines have moved south by about 200km, it can be presumed that the climate in Mali is becoming dry.

Figure 2.6.2 Transition in Yearly Average Isohyetal Lines

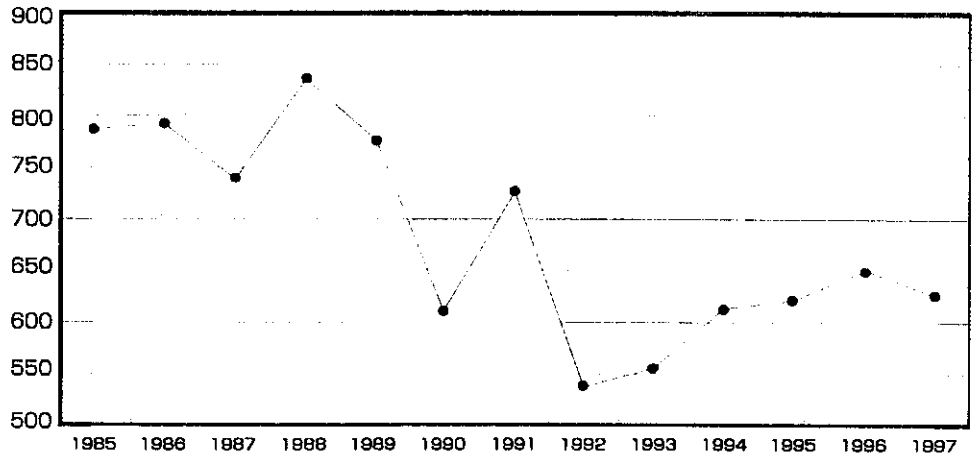


2) Decline in fertility of cultivated land

Figure 2.6.3 shows the trends in millet yield in Mali. The yearly fluctuation is very large, but the unit yield tends to decrease. From this fact, it is presumed that the fertility of the farmland in Mali is

declining year by year.

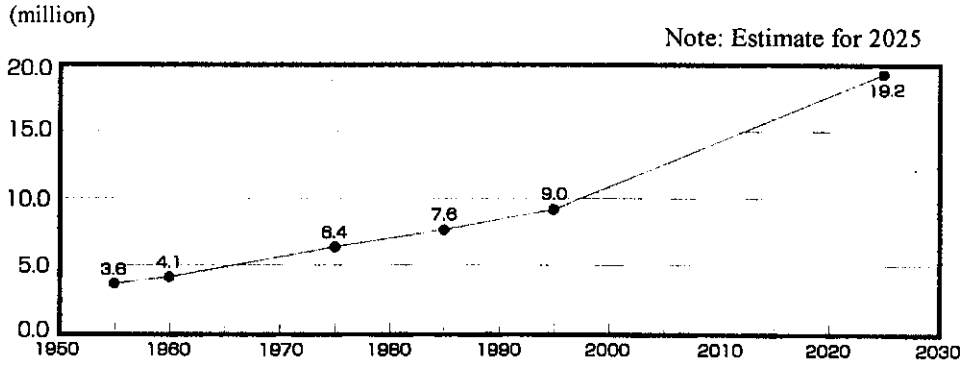
Figure 2.6.3 Transition in Unit Yield of Millet in Mali



3) Decrease of forests

Figure 2.6.4 shows the increase of population in Mali. The population, which stood at about 3.6 million in 1955, increased 2.5 times over 40 years to about 9 million in 1995.

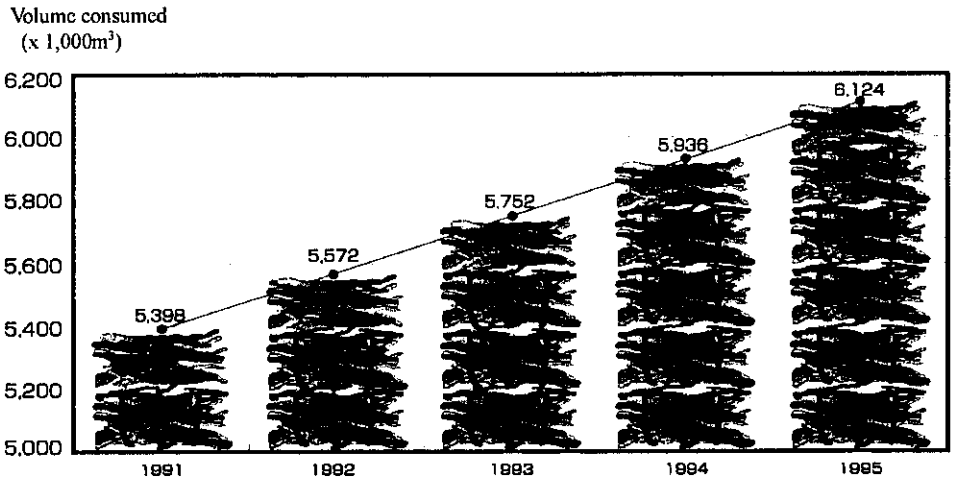
Figure 2.6.4 Transition in Population in Mali



Source: Etude Nationale Prospective Mali 2025,
President's Office of Mali, June 1999

Figure 2.6.5 shows the trend in consumption of firewood materials, which is increasing year by year.

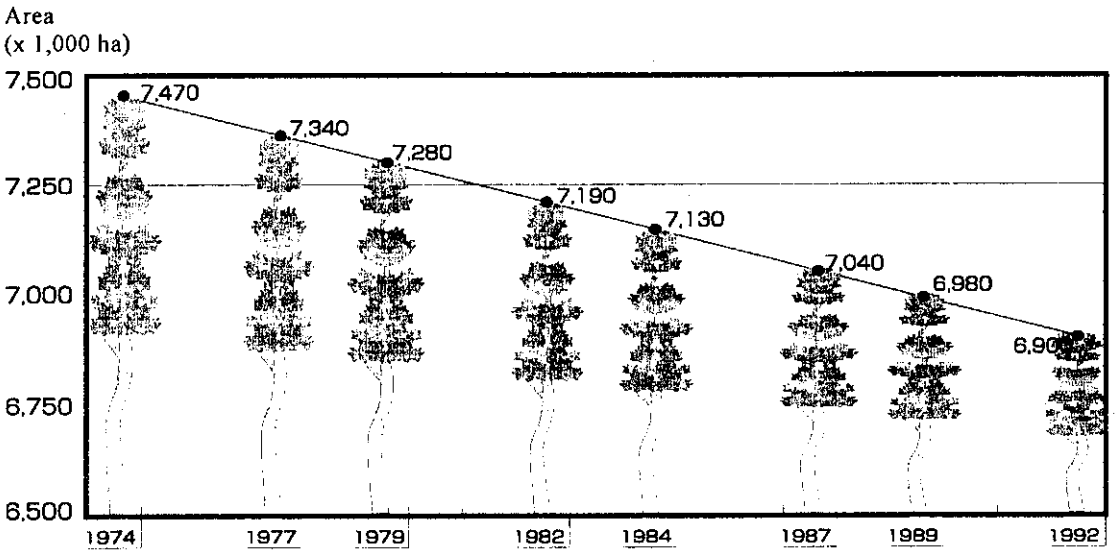
Figure 2.6.5 Transition in Firewood Consumption in Mali



Source: FAO Forest Products Yearbook 1991 – 1995

Figure 2.6.6 shows the transition in the area of forests in Mali, which decreased 7.1% over the 17 years from 1974 to 1992.

Figure 2.6.6 Transition in Area of Forests in Mali



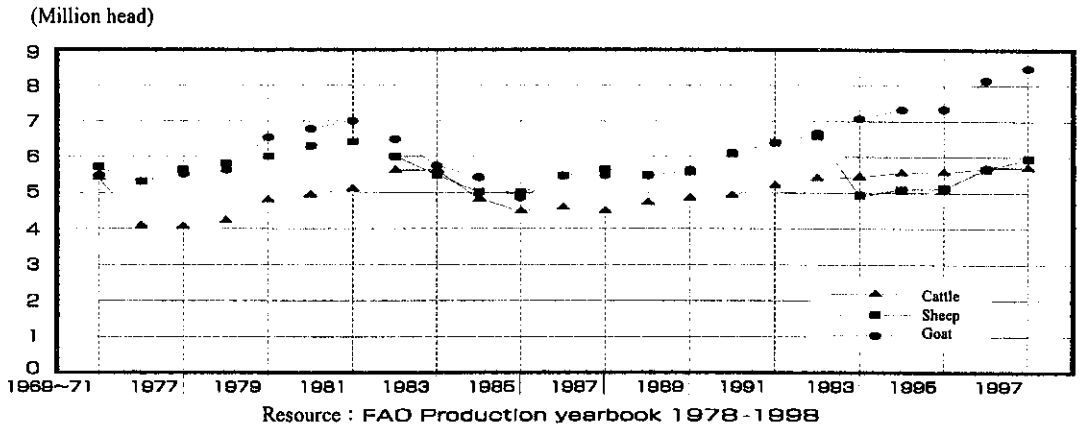
Source: FAO Production Yearbook, 1990 1995

The volume of firewood consumption is increasing as the population increases in Mali. It is expected that the population will drastically increase in future. Accordingly, the forests will drastically decrease unless effective countermeasures are taken.

4) Excessive livestock grazing

Figure 2.6.7 shows the transition in the number of head of livestock raised in Mali.

Figure 2.6.7 Transition in the Number of Head of Livestock Raised in Mali



Resource : FAO Production yearbook 1978-1998

Because of the effects of the drought from 1983 to 1985, the number of head of livestock raised fell temporarily, but the trend is a gradual increase. Feed resources in Mali, dependant on natural grasslands, are fragile. With this trend towards an increase in the numbers of livestock, there is a growing trend towards excessive livestock grazing, leading to fears of greater instability in the productivity of the natural grasslands.

As mentioned above, in addition to the drop in precipitation and against the background of an increase in population, there is continued expansion of farmland, reduction of forests and excessive livestock grazing in Mali. As it is expected that the population will continue to increase in the future also, there is a strong possibility that widespread desertification will advance.

(3) Efforts to counter Desertification in Mali

1) Efforts at government level

The Government of Mali has engaged in activities to promote natural resource management and prevention of desertification since an early stage. In 1985, the National Desertification Control Plan (NDCP) was formulated and independent activities were developed at national and local level. However, no satisfactory results were attained because the transmission of information and residents' participation were insufficient, and also because of excessive centralization of policy-deciding authority.

After that, the Government of Mali ratified the United Nations Convention to combat Desertification in 1995 and in accordance with the provisions of the Convention, formulated the National Environmental Action Plan and National Action Plans designed for the implementation of the United Nations Convention to Combat Desertification (NEAP/NAP-CCD).

The Plan provides for NGOs and villagers (both men and women, especially farmers, herders and resource users including organizations of farmers and herders) to participate effectively in the planning, decision making, implementation and review of the Plan and programs as stipulated therein. The Plan consists of the following 9 programs. For implementation of these programs, sufficient support and assistance by donors are indispensable.

① National land development

② Natural resource management
③ Water resource development
④ Improvement of life quality
⑤ New and renewable energy source development
⑥ Environmental information management
⑦ Environmental information, education and communication
⑧ Follow up of conventions
⑨ Research on desertification control and environmental protection.

2) Efforts at regional level

In response to the above NEAP/NAP-CCD, the action plan "Program of Recovery and Renewal of Natural Resources in the 4th Region" was also formulated in May 1997 in Ségou Region. In the program, the present environmental conditions of the Ségou region, the action plan and the budget necessary for the plan are described. The action plan also analyzes the problems in Ségou Region as follows:

① Lack of campaigns against deterioration of natural resources
② Ignorance of the effects of using wood as fuel
③ Ignorance of the adequate technology for rational development of natural resources
④ Insufficient experience in intensive agriculture and stock raising
⑤ Insufficient participation of residents in reforestation
⑥ Weak organization with regard to forest development and training of foresters
⑦ Low rate of adoption of alternative energy sources
⑧ Small area of forest protection districts
⑨ Low rate of adoption of improved ovens

To solve the above problems and enable villagers to execute rational management of natural resources, it is necessary to promote activities through the residents' participation in the following 4 points:

① Improvement in villagers' ability to manage land
② Promotion of rational management of natural resources, and agriculture and stock raising
③ Promotion of rational forest management and forest utilization
④ Efficient execution of M&E in this program.

A budget of 3,048,674,000 Fcfa for 5 years is required to implement these activities, and the allocation of costs is planned according to the following breakdown:

①	Villagers:	850,000,000 Fcfa (27.9%)
②	Government:	340,000,000 Fcfa (11.2%)
③	Development agency:	887,800,000 Fcfa (29.1%)
④	NGOs	970,874,000 Fcfa (31.8%)

In reality, it is very difficult to procure such a budget amount, and it is difficult to say that these activities have been carried out in a satisfactory way.

2.7 Characteristics of Cercles

The characteristics of individual cercles are summarized in Table 2.7.1.

Table 2.7.1 Characteristics of Cercles

Cercle	Characteristics of Location	Characteristics of Production
Baraouéli	Located along the Niger River and first-class national highway, with favorable transport and market conditions.	Cultivation of vegetables is popular using riverbed water and shallow wells. Diverse produce such as cassava and fruit. Paddy farming in parts. Livestock is mainly sheep.
Bla	Relatively steep slopes account for just less than half of the cercle. Relatively high rainfall. Access to markets is inferior to Baraouéli.	System of cultivation of cotton and peanuts combined with millet. Almost no horticultural products such as vegetables. Raising of cows and donkeys is relatively popular.
Macina	Located along the Niger River with relatively favorable transport conditions. Flooding in many villages in the rainy season and poor drainage conditions. Farmland area per capita is very small.	High dependence on paddy farming (largest area of cultivation in the study area). Many kinds of horticultural products such as shallots and melons. Unit yield of millet is the lowest in the study area.
San	Located about 2 hours from Ségou and good access to the central region, but transport between villages is very difficult in the rainy season.	Main products are cereals such as millet. Cotton and peanut cultivation in parts in the south. High dependence on stock raising with many kinds and head of livestock .
Ségou	Located in the center of the study area along the Niger River. Transport and market conditions are good, including national highways.	Diverse agriculture, including cereals such as rice, and horticultural products including vegetables and fruit. Stock raising involves the highest number of head in the study area.
Tominian	Furthest away from Ségou. Diverse topological features with high percent of slopes. Access in the rainy season is very bad.	Rain-fed farm products such as millet. Cotton and peanuts are cultivated in parts. As for livestock, many head of goats.

In May 2000, the hearing and questionnaire research from the chief of each cercle was made to confirm the understanding of the actual conditions on the administrative side and the proposals for prevention of desertification. The questionnaire was made on the following 10 items:

① Organization, budget, etc.
② Area and population
③ Actual conditions and issues of agriculture, stock raising and sylviculture
④ Comments on progress of desertification
⑤ Livelihood of villagers
⑥ Women's activities
⑦ Agricultural and rural infrastructure
⑧ Distribution of agricultural, pastoral and sylvicultural products
⑨ Education
⑩ Medical care

Outline of the study results is shown in Table 2.7.2. All Cercles highly recognized the progress of desertification. However the actual measures depended on the improvement of the infrastructure for BHN by the central government and NGO activities. The measures were handled insufficiently due to lack of local budgets and staff.

Table 2.7.2 Results of Study by Questionnaire to Chief of Cercle

No.1

Cercle	Area, Population, Villages, etc.	Agro-sylvo-pastoral Issues	Comments on Progress of Desertification	Living States of Villagers
BARAOUÉLI	① Area: 446,508 ha ② Population: 128,861 ③ Number of villages: 239 ④ Population density (persons/km^2): 28.9	① Problem of striga (harmful weeds) in millet fields ② Problem of diseases in watermelon and calabash ③ Shortage of well and irrigation facilities ④ Aggravation of soil erosion due to water and winds ⑤ Excessive grazing of livestock	① It is recognized that natural resources are decreasing due to cutting of trees. ② By the decentralization, the cercle is obligated to formulate the reforestation and other plans.	① The rate of poverty of villagers is 40% and the rate of those working away from home has reached 30%. ② There is a problem of children who have abandoned their villages because of no chance of employment.
SEGOU	① Area: 1,614,504 ha ② Population: 421,374 ③ Number of villages: 239 ④ Population density (persons/km^2): 26.1	① Expanded farmlands due to increase of population ② Aggravation of soil erosion due to decrease of woodlands and fallow fields ③ Agro-pastoral production not freed from traditional techniques ④ Water resources not used effectively	① Villagers are aware of the progress of desertification because of difficulty in gathering firewood. ② For prevention of desertification, it is necessary to educate villagers. ③ It is a problem that the cercle has no budget to cope with prevention of desertification. ④ Soil erosion is in progress in the hilly land in the south.	① Overpopulation of Ségou Commune because of immigration of villagers from the environs of Ségou. ② High rate of infant infection due to insufficient health and sanitary management ③ Lack of chance of employment
BLA	① Area: 556,114 ha ② Population: 151,976 ③ Number of villages: 223 ④ Population density (persons/km^2): 27.3	① Most serious decline of profitability of agro-pastoral production due to soil deterioration ② Excessive grazing of livestock ③ Aggravation of soil erosion due to excessive cutting of trees in forests ④ Poor agricultural finance	① The progress of desertification is recognized from decrease of grasslands and forests and long-time dry weathers. ② It is necessary to cope with prevention of desertification based on NEAP/NAP-CCO and RAP in order to improve the poor consciousness of villagers.	① 85% of villagers are living on agriculture, stock raising and fishery. These villagers will be subject to foods crisis due to desertification. ② There is a mutual aid system to support the households having difficulty in livelihood.
MACINA	① Area: 633,565 ha ② Population: 143,291 ③ Number of villages: 247 ④ Population density (persons/km^2): 22.6	① Decrease of woodlands due to spread of illegal cultivation ② Degeneration of vegetation due to excessive grazing ③ No concern of villagers for reforestation ④ Lack of agro-pastoral infrastructure ⑤ Low-hovering prices of products ⑥ Disputes on land use between farmers and herders	① Villagers are aware of the accelerating desertification. ② The cercle has no budget to prevent the desertification, and efforts of national level are required. ③ The activity against desertification should be made by residents' participation.	① Farmers in the rice-farming zone have relatively stable livelihood. However, many villagers in the rain-fed farming zone belong to the poor class. ② Many are working away from home because of lack of employment.
SAN	① Area: 639,642 ha ② Population: 203,142 ③ Number of villages: 420 ④ Population density (persons/km^2): 31.8	① Environmental pollution due to use of agricultural chemicals in cotton cultivation area ② Aggravation of soil erosion in fields and woodlands ③ Villagers not fully organized. ④ Shortage of equipment and materials for agricultural production	① The recent decline of productivity in agriculture, stock raising and sylviculture proves that desertification is in progress. ② The progress of desertification is made clear from the fact that the aspects of forests and animals have become poor.	① The villagers make up for the shortage of income by working away from home. ② There are some villages that many villagers have abandoned.
TOMINIAN	① Area: 681,960 ha ② Population: 129,246 ③ Number of villages: 313 ④ Population density (persons/km^2): 19.0	① Decrease of area of forests due to expansion of farmlands ② Pastures made bare due to excessive grazing ③ Struggle on land management between farmers and herders ④ Lack of agro-pastoral infrastructure ⑤ Retarded development of water resources	① Withering of trees for reforestation due to hot and dry weathers ② Villagers are aware of the fact that the progress of desertification is due to bad management of natural resources.	① The incomes of villagers have decreased due to drain of natural resources caused by excessive cutting of trees in forests. ② High percentage of disease contraction due to poor balance of nutrition.

Cercle	Women's Activity	Improvement of Agriculture and Rural Infrastructure	Distribution of Agricultural, Pastoral and Sylvicultural Products	Education and Medical Care
BARAOUÉLI	① There are activity groups of vegetable cultivation, small-scale trade and sale of cereals and handicraft. ② The cercle is taking the measures for supporting women in health, education and elimination of discrimination.	① Construction/improvement of roads for mutual access to villages ② Installation of equipment for well and irrigation facilities ③ The agricultural infrastructure should be managed by villagers themselves. ④ Improvement of conserved woods in Koulala districts	① The means of transportation of products is carts, which are very inefficient. ② The production equipment and materials must be transported based on economic values. ③ Construction/improvement of roads to connect villages to arterial highways	① The rate of attendance to elementary schools is about 40%, and the low rate is due to lack of schoolrooms. ② Systematic efforts are made for vaccination. It is also necessary to make systematic efforts for sanitary education. ③ The medical infrastructure is insufficient in all villages.
SEGOU	① Women participate in the activities such as vegetable production and sheep fattening. ② Transportation and sale of vegetables in Ségou market. ③ There are literacy centers for women groups.	① Reinforcement of production by expanded seedling growing facilities ② Measures for soil conservation in the hilly land in the south. ③ Water resources development and construction/improvement of water service facilities in villages ④ Extension of production technology to farmers by providing model exhibit fields	① This cercle is a large site of consumption, but the distribution and processing infrastructures are insufficient. ② This cercle is a relay base to transport products to Bamako and equipment and materials for Mopti, but it is poor in distribution facilities.	① Schoolrooms are insufficient. ② There are not so many graduates from elementary education. ③ The medical care centers are insufficient in each village. The pharmacies are also insufficient.
BLA	① The cercle is retarded in organizing women. ② Agricultural women are forced to do heavy labor. Their activities are limited to small-scale trade and vegetable cultivation. ③ It is necessary to install milling machines. ④ There are literacy education centers for women.	① Development of water resources including improvement of traditional wells and construction/improvement of irrigation ponds ② Construction/improvement of roads to interconnect villages ③ Restoration of vegetation in bare pastures ④ Promotion of measures for soil conservation ⑤ Reinforcement of agricultural finance	① It is possible to make shipments to Sikasso, but the infrastructure for collection, storage and transportation of goods is insufficient. ② It is retarded to organize the distribution-related groups.	① Villagers should make natural resources management by themselves to prevent desertification. For this purpose, education is necessary, but schoolrooms and teachers are insufficient. ② There is a literacy center in each village, but teachers are insufficient.
MACINA	① Women's groups are active in vegetable cultivation, dying, basket making, small-scale financing and brick manufacture. ② There is no plan of supporting women's groups in the cercle level.	① Improvement of drinking water facilities for livestock and grasslands ② Rehabilitation of irrigation facilities ③ Introduction of low-interest financing system for farmers ④ Establishment of agro-sylvo-pastoral production technologies among farmers with support from foreign countries	① The destination of agricultural products is Mopti and Mauritania, and construction/improvement of roads is an urgent issue. ② The equipment and materials for agricultural production are transported from Bamako and Ségou, and it is necessary to pave the unimproved sections of national highways.	① The school attendance rate is low due to lack of classrooms. ② Children have to walk a long distance to attend schools. ③ The clinics, hospital and pharmacies are insufficient.
SAN	① The work shares of women and men in the agricultural production are definite. ② The movement of elimination of discrimination is promoted in the national level, but retards in the cercle level.	① Construction of seedling production facilities ② Infrastructure construction/improvement by residents' participation with the support from CMDT, PDR and World Vision. ③ Construction/improvement of roads to interconnect villages ④ Execution of measures for soil conservation	① The distribution facilities in the cotton cultivation zone are fully provided, but the rain-fed farming zone is not provided with sufficient infrastructure. ② The transportation and storage infrastructures are poor.	① Schoolrooms are insufficient. ② Especially, pediatric and gynecologic doctors and hospitals are insufficient. ③ Practical education is required for prevention of desertification.
TOMINIAN	① There are women's activities such as small-scale sale of handicraft and vegetable cultivation. ② There are not many activities of organized groups.	① It is an urgent issue to take the measures for soil conservation because the productivity of the agricultural production infrastructure has declined remarkably. ② It is urgent to construction of the agricultural roads. ③ Development of water resources by construction/improvement of wells and irrigation ponds. ④ Restoration of forest resources by reforestation	① The village roads for transportation of products are incompletely provided. ② The means of transportation are carts, donkeys and bicycles, which are inefficient. ③ The distribution costs are high because the production systems are not organized.	① The school attendance rate is very low due to lack of schoolrooms. ② The distances to schools are too far for some children to attend those. ③ Clinics and pharmacies are insufficient.

Master Plan

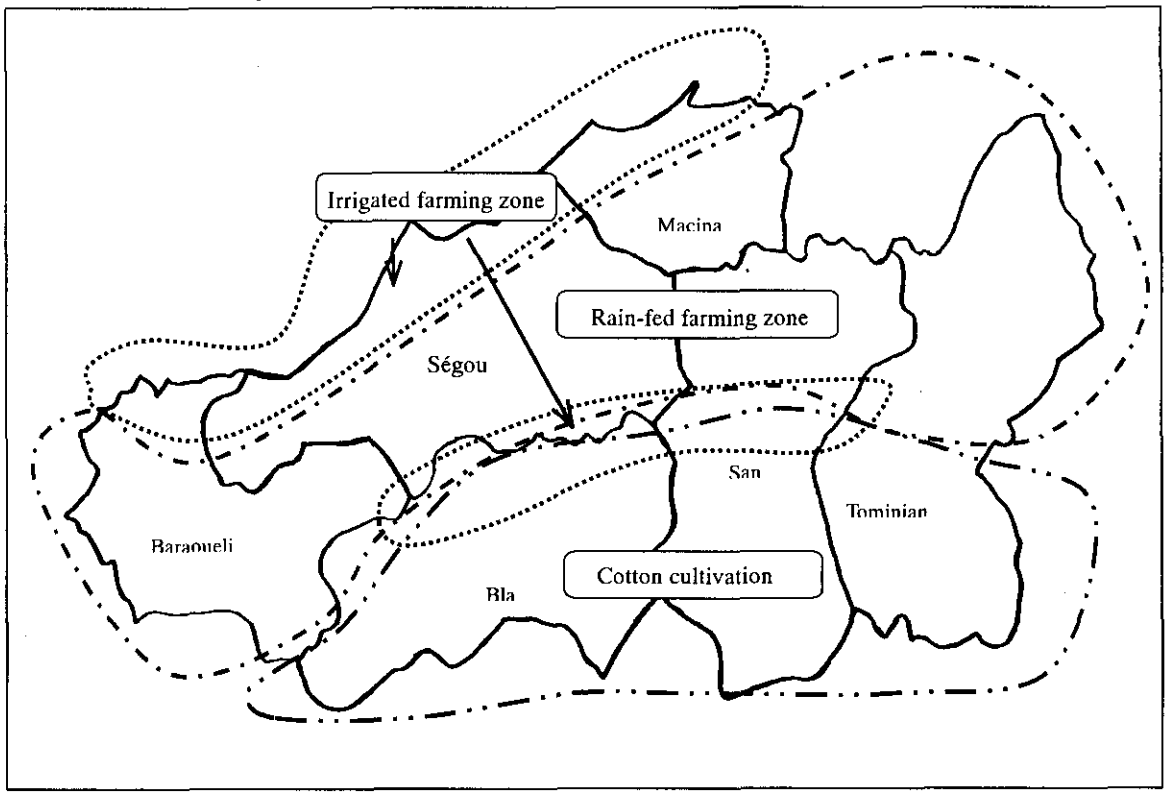
CHAPTER 3 PRESENT STATUS OF AGRICULTURE, STOCK RAISING AND SYLVICULTURE IN STUDY AREA

3.1 Classification of Agricultural Area

The study area is major agricultural area. The agriculture produces mainly cereals such as millet, sorghum and niébé (*Vigna unguiculata*). However, the local production seems to be specified by the rainfall, topology and water conditions. In view of this fact, the study area is categorized into the following three agricultural districts.

① Irrigated farming zone in the basin of the Niger River (including part of the basin of the Bani River);
② Rain-fed farming zone occupying most of the central part of the study area;
③ Rain-fed cotton cultivation zone in the southern part of the study area.

Figure 3.1.1 Agricultural Classification in Study Area



Tables 3.1.1 to 3 show the indices for the three zones acquired from the result of the survey on the production of village cadastres.

Table 3.1.1 Estimated Values of Major Indices by Zones

Zone name	Estimated value for the entire study area				Share of villages
	Number of communes	Number of villages	Area (thousand hectare)	Planted area (thousand hectare)	
Rain-fed farming zone	58	1,159	2,255	779	68.4%
Irrigated farming zone	10	197	384	133	11.6%
Cotton cultivation zone	23	339	660	228	20.0%
Total	91	1,695	3,298	1,139	100.0%

Source: Survey on the production of village cadastres (November 2000).
The same source is used for the following two tables.

Table 3.1.2 Estimated Values of Planted Areas by Crops

	Crop	Irrigated farming	Rain-fed farming	Cotton cultivation	Total
Result of village cadastres survey	Paddy rice	4,027	2,385	464	6,876
	Cereal	18,379	104,345	25,023	147,746
	Garden crop	413	1,284	876	2,573
	Vegetable	57	141	97	295
	Industrial crop	1,110	17,674	8,688	27,472
	Total	23,948	125,777	35,036	184,760
Total estimated value		132,514	778,522	227,759	1,138,796

Table 3.1.3 Coefficient of Specialization by Crops

Crop	Coefficient of specialization		
	Irrigated farming	Rain-fed farming	Cotton cultivation
Paddy rice	4.518	0.509	0.356
Cereal	0.960	1.037	0.893
Garden crop	1.238	0.733	1.794
Vegetable	1.493	0.703	1.728
Industrial crop	0.312	0.945	1.668

A coefficient of specialization is a value obtained by dividing a crop share for a zone by a crop share for all the zones. If a crop has an index larger than 1, the local agriculture is assumed to specialize in that crop.
Irrigated farming and cotton cultivation zones tend to specialize in various crops while a rain-fed farming zone significantly depends on cereals.

3.2 Land Use

(1) Land System

In the past, the land system of Mali, like that of other West African countries, had no policy of private land ownership. The CDF acknowledges that the right of land use and the right of land management at Commune level are divided into traditional and modern rights.

Traditional rights permit the village chief to grant the right of land use and the right of land management to people using the land. Modern rights, on the other hand, state that a person who wants to use the land must register with the Commune. In such case, the right to land use for ninety-nine years is recognized. However, most land users have in fact not registered even though there is a land registration application system. Recently, some people have started to realize that some traditionally-recognized rights of land use, albeit only a very small number, can be sold and/or bought.

① Farmland Distribution System

A chief of UPA that desires to settle on certain land submits an application to the actual owner of the desired land (village chief) before settling there. The village chief consults with the senior council and reaches a decision. The land ownership of the UPA is authorized by the village chief and the senior council, and an area of land is distributed to the UPA so as to correspond to the manpower of the agricultural production unit.

② Limitation on use of farmland

A family can lend farmland to another family, but the borrowed farmland may not be used for any economic investment such as erecting a building.

③ Use of land other than farmland

Forests, rivers and ponds are the common possession of the village.

(2) Land Use Conditions

1) General conditions

With regard to the land use conditions in the entire study area, the LANDSAT satellite images photographed on April 12 and 19, 1994 were analyzed, and a topographical map and a vegetation and land use distribution map were prepared (Figure 3.2.1). The areas by land type in the study area are as listed in Table 3.2.1.

Table 3.2.1 Estimated Areas by Land Type Based on Satellite Image Analysis and Reference Indices **(Unit: ha)**

Land type	BARAOUÉLI	BLA	MACINA	SAN	SEGOU	TOMINIAN	Total	Percentage
Woodland	207,627	203,393	92	124,048	67,777	92,372	695,309	21.1%
Grassland	65,789	155,330	129	154,270	152,487	74,227	602,232	18.3%
Bare land	25,442	37,082	208,532	78,502	263,811	117,000	730,369	22.1%
Farmland	147,248	222,264	5,297	250,110	131,041	382,692	1,138,652	34.5%
City area	2,751	2,132	470	2,141	4,556	507	12,557	0.4%
Water area	4,481	1,706	1,228	2,137	9,815	2,556	21,923	0.7%
Others	0	0	70,104	0	26,682	0	96,786	2.9%
Total	**453,338**	**621,907**	**285,852**	**611,208**	**656,169**	**669,354**	**3,297,828**	**100.0%**
Area percentage by Cercle	13.7%	18.9%	8.7%	18.5%	19.9%	20.3%	100.0%	

[Explanatory Note: Land Type]

Woodland	:	Land covered by a certain number of trees
Grassland	:	Grassy pastures
Bare land	:	Areas covered by fewer trees than certain amount and dune areas (classified as dune areas because of image analysis in the dry season when they are not covered with vegetation, although a half of them are estimated to be fallow fields where cultivation is possible), riverbeds, flood plains and exposed platforms.
Farmland	:	Rain-fed agricultural land used for rain-fed agriculture (ex: millet fields) and irrigated farmland, as well as afforested land for coconut palms, eucalyptus, etc.
City area	:	Hamlets and urban areas
Water area	:	Rivers, lakes and swamps
Other	:	Areas whose data could not be read in the satellite image analysis. Because of image analysis in the dry season, these areas are estimated to be bare land or farmland with poor vegetation.

The major features of the land use are as follows:

① Several percent of the woodlands in the study area are designated as conserved and protected

districts and their use is prohibited or limited. In rain-fed agriculture, a system of allowing a fallow period of about 7-15 years is adopted for farmland, except for paddy fields, vegetable fields and orchards equipped with irrigation facilities. It is estimated that the area of land where farm products are actually planted is approximately 20% of the cultivable land. Therefore, there is usually no definite boundary between farmland (rain-fed fields) and grassland.

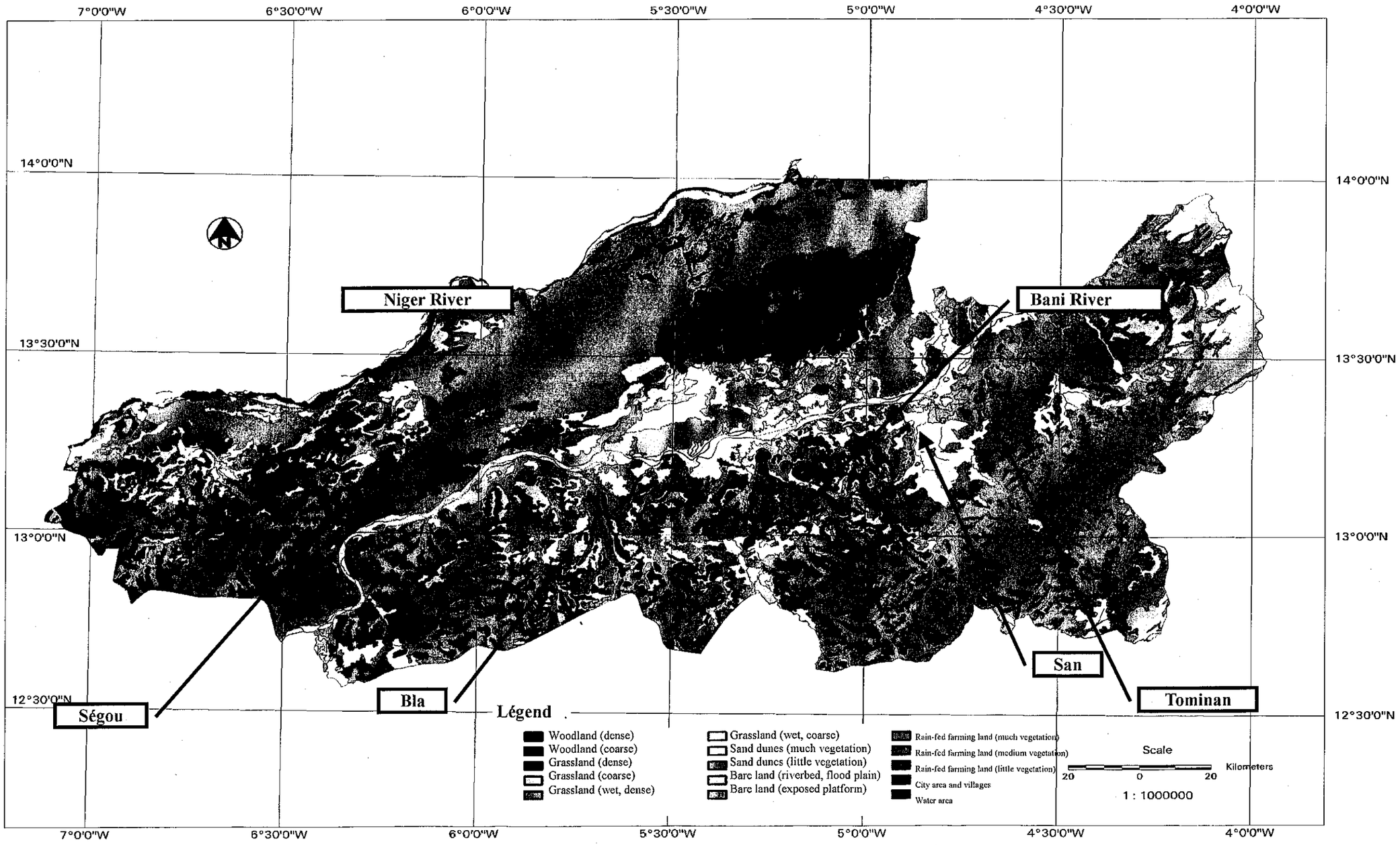
② Not only grassland, but also fallow and cultivated land provides fodder resources for livestock, and part of the woodlands is also used for fodder resources.

③ The flood plains of rivers and the swamps and marshes that appear only in the rainy season are used for cultivation of farm products such as rice and vegetables as the water recedes when the dry season begins.

④ One of the local features is that many areas north of the Bani River and the San and Tominian cercles are rain-fed agricultural land with only scattered woodlands. In particular, in the Tominian cercle in the northeastern part of the study area, there are many rain-fed cultivated areas with a little vegetation. It seems that the scarcity of rainfall has an influence on these areas.

⑤ There are many bare lands thought to be due to bare rocks in the boundary area northeast of the Tominian cercle. Other bare lands are distributed around the Bani River, the Niger River and other large-scale wadis.

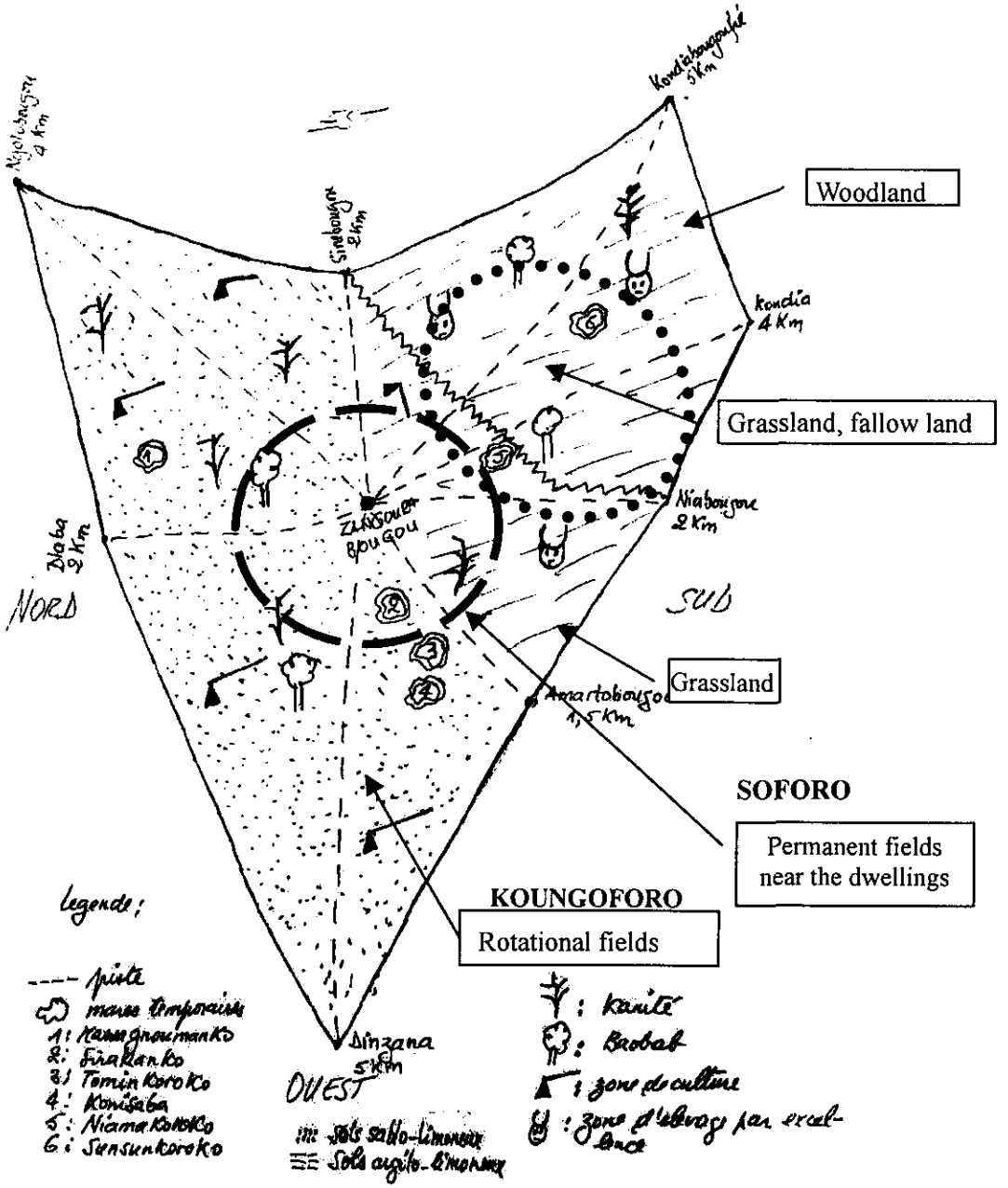
Figure 3.2.1 Land Use Overview Map



2) Land use at village level

The land use in the villages is such that the dwelling area is in the center of the village. The farmland near the dwelling area is permanent fields that do not lie fallow but are used repeatedly. The boundaries with the adjacent villages are defined by intersections, a big tree such as a baobab, or a grove of trees. According to the resource management sketch of the results of the Participatory Rural Appraisal (PRA), a typical example is shown in Figure 3.2.2.

Figure 3.2.2 Land Use Overview at Village Level (Example of Zangourabougou II Village)



Source: Resource management map as the result of PRA.

(3) Factors impeding the development

The factors impeding the development in land use are as follows.

① Organization and system to use and manage lands according to the plan established at village level.

② Although farmers were approved to use lands, they do not have legal right to own lands. A concept to consider the land use on long-term basis as individual assets remains hardly ingrained in the mind of farmers. For this purpose, the real improvement of land use does not proceed as expected.

3.3 Use of Water Resources

3.3.1 Surface Water

The surface water in the study area is found in the Niger and Bani Rivers as well as their branches or wadis, lakes and marshes. Surface water is found at all times throughout the year in the Niger and Bani Rivers and large lakes and marshes. Surface water is found only in a limited period of the year, from the rainy season to the first half of the dry season, in wadis and small marshes.

In the areas along big rivers, where surface water can be observed all the time, river water is used for living and irrigation as the main water source. However, improved water source facilities are limited to those improved by the Ségou Rice Office (ORS) and Development Program of Middle Basin of Bani River (PMB: Program de mise en valeur des plaines du Moyen-Bani). Most of the other facilities use portable pumps or the water pumped by manpower. In "wadis" and small marshes, water is reserved from May to December. During that time, they are used as the main water source such as the drinking water of livestock and water for living. With the period to use water being limited, there are not many improved facilities.

3.3.2 Groundwater

Groundwater in the study area occurs in the Quaternary layer, the Continental terminal (CT) layer, and the basement rocks consisting of Infracambrian system and others. The Quaternary layer, consisting of unconsolidated clay, sand, and conglomerate, is distributed relatively thickly in the plain area (inland delta) that extends from the central to northeastern areas of the study area. It is also distributed in the shallow valleys and depressions in the hilly area located in the southern to western parts of the study area.

The CT layer mainly consists of sandstone and mudstone layers that accumulated from the middle to late tertiary period. The laterite layer is developed in some areas. The CT layer is often distributed under the Quaternary layer in the plain area but is sometimes exposed on the ground surface. In the Quaternary and CT layers, groundwater mainly refers to a form of stratum water occurring in the pore space of layers. Basement rocks are distributed under the Quaternary or CT layer or in the hilly areas. They consist of sandstone, jasper, etc. which are highly consolidated. Thus, groundwater mainly occurs in the fissures.

The groundwater level in the study area is high along the Niger River, where there is a concentration of wells with a groundwater level of GL.-10m or shallower. The groundwater level is relatively high

near the Bani River. The groundwater level falls at places far from the Niger River. The groundwater level is the lowest at the center of the area between the Niger and the Bani Rivers, where there are lots of wells with a groundwater level of Gl.-30 m or deeper. Groundwater level is affected by fluctuations in precipitation or fluctuations in the flow of the Niger River. When low precipitation continues for a number of years, the groundwater level tends to drop.

Groundwater, used for drinking and household use, domestic animals, and farming, is a precious source of water in areas where rivers and marshes are far or surface water dries up in the dry season. In such an area, groundwater is used for drinking throughout the year. For domestic animals and farming, surface water is used in the rainy season and groundwater is used when surface water dries up in the dry season.

A well is a facility for using groundwater. Wells in the study area can be classified into traditional wells (Puits Traditionnels), modern large-diameter wells, and boreholes.

(1) Traditional Well

A traditional well is dug and constructed by villagers or well sinkers. With a diameter of around 1 m, a traditional well is a simply bored well, not lined on the hole wall. In many of such wells, the hole mouth is protected with a wooden or concrete tube installed in it. Generally, people draw water using a rubber bag, etc. with a rope by pulling up the rubber bag either directly or with the rope hung over a pulley installed on a wooden support. Water is drawn manually in many cases but may be drawn by domestic animals if the groundwater level is deep. A traditional well may be buried when the hole wall, not protected, collapses. Thus, villagers must frequently clean out a well. A well may be abandoned if the hole wall collapses significantly. The water quality is frequently problematic, as described later.

(2) Modern large-diameter well

A modern large-diameter well is constructed by well specialists. With a diameter of around 1.0 to 1.8 m, a modern large-diameter well is lined with reinforced concrete casing on the hole wall. Water is drawn in the same way as for a traditional well. The construction costs are the highest among the three well types. Depending on how hard or soft the soil to be dug is, 7 million to 8 million FCAF is required to construct a modern large-diameter well around 30 m deep. It also takes a long time to construct this kind of well. A modern large-diameter well is superior in durability. When the aquifer is made up of non-solidified sand, with the pumping and flowing of groundwater the sand and other sediments may flow into the well and accumulate at the bottom of the well. Therefore, well management, such as regular cleanups, is necessary.

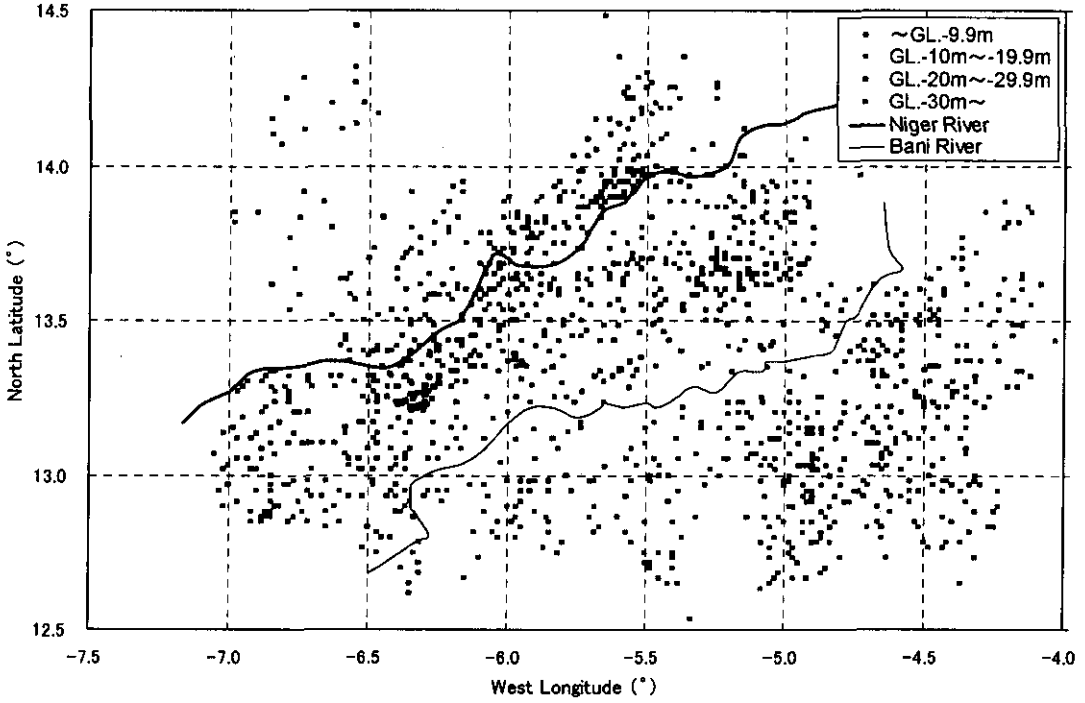
(3) Borehole

A borehole is a small-diameter well to be dug with special boring machines. A borehole is lined with a vinyl chloride or steel tube on the hole wall. A borehole is generally deeper than a traditional or modern large-diameter well; there is a borehole deeper than 100 m in the study area. Water is drawn by a pump using human or some other power. The costs of digging and constructing a borehole are lower than a modern large-diameter well but tend to be higher if a deeper well is dug. Around 7 million FCAF is required to construct a standard borehole with a 126 mm diameter and a 60 m depth. Time of constructing a well is relatively short; only a few days are required to dig a well around 60 m deep. In the case of a borehole, maintenance of the pump is necessary.

Available materials relating to the number of wells in the study area include the well database made by the Water Bureau of Mali, the statistic data on wells by the UNICEF, and the surveys on production of village cadastres conducted in this Study. From these materials, it is estimated that the number of modern wells in the study area is 2,500 to 3,000, and that of traditional wells approximately 30,000. Modern wells are not installed in all villages and only traditional wells are used in many villages.

Figure 3.3.1 shows the distribution of the amount of groundwater generated per well, using the data on borehole and modern large-diameter wells registered in the well database of the Water Bureau of Mali. The average amount of groundwater generated by the 2,591 borehole wells registered in the well database is 6.3 m^3/h. However, in places where the groundwater level is relatively low the pump discharge drawing rate using a manual pump is 1 to 2 m^3/h. According to the Mali Water Resource Development Plan (1991), of the areas where the aquifer is in the quaternary and CT strata, in the area along the Niger River an average of 15 to 20 mm^3/h of groundwater production can be expected from one borehole. In the quaternary and CT strata aquifer and areas of aquifers in base rock further away from the Niger River, the average groundwater production is 5 to 10 m^3/h. In almost all the areas where there is a distribution of the aquifer in base rock, the average groundwater production is 1 to 3 m^3/h.

Figure 3.3.1 Distribution of Groundwater Production from One Well



(4) Factors impeding the development

The factors impeding the development of water resources are as follows.

① Modern wells, which are the main water source, are extremely small in number in terms of improved wells.

② Traditional wells have poor water quality and insufficient volume, need enormous maintenance work, and are not considered the stable water source.

③ Facilities have short life because of insufficient maintenance such as the repair of the pump of deep well or the clearing of the bottom of traditional well.
④ There is no residents' organization that can maintain wells.

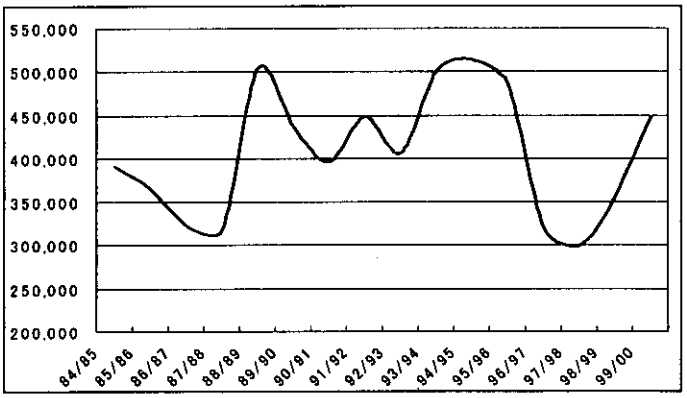
3.4 Agriculture

Major characteristics of each agricultural zone in the study area are described below.

(1) Rain-fed farming zone

Ségou Région is the largest cereal production zone of the 8 Régions in the country. For instance, it has a share of about 40% of the total production of millet in Mali. In this farming zone, millet, sorghum, niébé, peanuts, maize and fonio are cultivated.

Figure 3.4.1 Shifts in Millet Harvested Area in the Study Area



Source: Calculated from the agricultural statistics of Mali

However, the annual fluctuation in production is dramatic. Figure 3.4.1 shows the shifts in the harvested area in the last 15 years. The shifts are in the range of 500,000 ha to 300,000 ha (coefficient of variation[1]: 17.8%). This variation is large in terms of production volume and yield per unit. (Their coefficients of variation are 24.7% and 25.6% respectively.) The fundamental causes are the annual fluctuation in rainfall and unequal rainfall distribution in this area.

In addition, the variation is also spurred by the poor extension of drought resistance varieties and measures against damage by pests and diseases, the thick growth of harmful weeds, the shortening of fallow periods and soil deterioration. In the period from 1996 to 1998, the harvested area fell sharply due to scarce rainfall of about 500 mm a year, but it later returned to the average level due to increased rainfall.

[1] Fluctuation coefficient is obtained by dividing the standard deviation by the mean value. It is used as the scale to measure the degree of deviation of a value.

(2) Irrigated farming zone

Traditional paddy rice cultivation in the high-water period is common, but there are paddy fields developed earlier with French assistance and modern paddy rice cultivation is carried out there. The current area of paddy rice cultivation is estimated to be about 7,000 hectares. In the future, more paddy fields are planned to be developed by ORS or PMB (Program for Development of the Middle Bani River Basin).

Recently, small-scale irrigated vegetable cultivation and fruit production have been increasing in Ségou and neighboring Baraouéli and Macina. The main horticultural products are vegetables such as watermelons, shallots, tomatoes, melons and green peppers, and fruit such as mangos and citrus fruits. Recently, papayas and bananas have also been introduced in this area. The production of these horticultural products will increase in future because the consumption of perishable foods is increasing as the population of Ségou Région continues to increase at a considerable rate. Recently CMDT recommends producing sesame.

(3) Cotton cultivation zone

Cotton is produced mainly in Bla cercle and in part of San and Tominian cercles. In these farming zones, millet and sorghum are also produced, but cotton is mostly cultivated in combination with peanuts. The cultivating area for peanuts is larger than that for each cereal item. Cotton is an important product for earning foreign currency in Mali because its quality is highly evaluated on international markets. Therefore, CMDT has provided cultivation technology, funds, production materials, and detailed guidance and training in this area. The combined cultivation of cotton with peanuts has been achieved under these circumstances. Recently CMDT recommends farmers to grow sesame.

On the other hand, the self-supply rate of cereals is low, about 50 to 80% (estimated in this study) because the shift to cotton production has been accelerated. In addition, the quantities of chemical fertilizers are relatively high, so there is fear of soil deterioration.

(4) Production System and Cultivating Technology

Millet and sorghum are basically produced by the same system and with the same technology. Seeding of both cereals is carried out in June and harvesting in October. These cereals are cultivated in a single crop or in combination with beans such as niébé. Most vegetables are cultivated in the dry season, from November, when the rainy season ends, to May or June.

Paddy rice cultivation can be carried out by double cropping in modern paddy fields provided with irrigation facilities, but double cropping is rarely seen in the study area, and rice cultivation is only carried out in the rainy season. The paddy rice cultivation dominating in the study area is traditional paddy farming carried out in the flood plains of the Niger River in the period from June to November.

The study area has flat terrain except in the southern part. The millet and sorghum fields are virtually flat and there are a few traces of gully or rill erosion. There are also a few fields where soil erosion prevention or water reserve measures using zai[2] or stone lines have been implemented, except in some districts where special aid projects or other projects have been carried out. The main work involved in cultivating millet, which is a typical product in the study area, is shown in Table 3.4.1 The present cultivation system for the main agricultural products in the study area is illustrated in Figure 3.4.2.

[2] Holes with a diameter of approximately 30 cm are arranged in a check pattern with intervals of 30 to 100 cm. Processing is placed at the center and crops are cultivated. This method is used as the multi-purpose measure to prevent soil erosion, acquisition of surface water (reserve of water), or increase of the yield of products.

Figure 3.4.2 Present Cultivation System for Main Agricultural Products

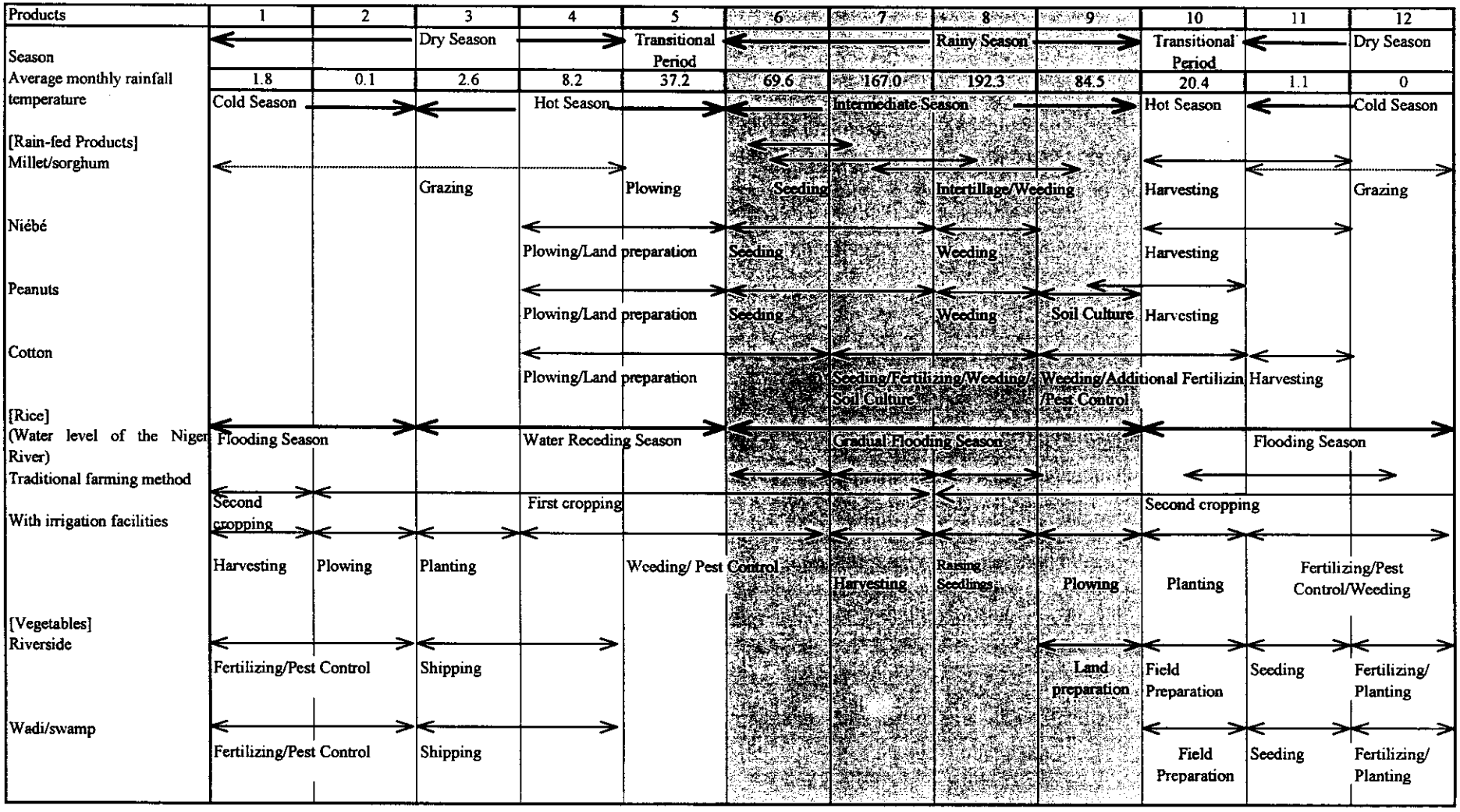


Table 3.4.1 Main Work for Cultivating Millet

Work	Period	Description
Land preparation	End of April to early May	• Dry soil is plowed with a plow drawn by a cow.
Fertilizing (organic fertilizers))	Mid-June to mid-July	• 6 tons/ha of organic fertilizer (cattle manure, compost, peanut shells and food waste) are plowed into the soil.
Seeding	Mid-June to mid-August	• When the first effective rainfall is 10 to 15 mm. The quantity of seed per ha is 4 kg. The seeding density is 10,000 holes/ha. Seeding is in holes at intervals of 40 cm x 60 cm to 1 m x 1m. Soil is plowed to make ditches. Manual seeding is common.
Thinning	End of June to end of August	• Shoots are divided from 10 days to 35 days after germination. The stocks per hole are thinned to about 3 stocks per hole about 21 days after germination.
Intertillage/ weeding	Early July to mid-September	• The first intertillage is carried out 8 days after seeding and the second intertillage is carried out 15 days after the first. After that, intertillage is performed as necessary.
Harvesting	Mid-October to end of December	• The crop grains that are ripe and firm are gathered. After harvesting, the grains are dried naturally in the fields.

In the study area, compost fertilization and cultivation using cows is popular. There are some compost reserve tanks here and there in the hamlets. The manure is transported to the fields in April through June and mixed into the soil during plowing and seeding in June. Phosphate rock powder is mixed with compost in some fields. Cultivation using cows involves the use of two head of cattle which are controlled by one boy of about 10 or a youth. In Bougan Village, a verification study zone, two people work in each half of a 50m x 100m field. The fields are usually rectangular to enable cultivation using cows.

Many UPAs have cows and plows for cultivation. A UPA that has no cows or plows borrows them from an association or individual within the village. A UPA that has a large field area but insufficient labor utilizes this system. Cows and plows are also lent between villages. For transportation of materials and products, donkey carts are often used.

After harvesting the millet, goats, sheep and cows are put into fields to feed on the crop residue, and the dung from the livestock is recycled as manure for the fields.

With vegetable cultivation, relatively many vegetable fields are concentrated in the alluvial area along the Niger River, and cultivation is carried out by irrigation using shallow wells or underflow water from rivers. Irrigation is carried out with sprinkling cans, buckets or bottle gourds.

Recently, vegetable cultivation has also been carried out in the rain-fed farming zone. Small fields of several square meters are made in the vicinity of a well and fenced with thorny bushes. Gourd is a major crop there.

(5) Supply and Demand for Cereals

The supply and demand were estimated for cereals in 1998 (Table 3.4.2). The cereal production in Mali is slightly lower than the demand. In the 8 Régions that constitute the country, Ségou and Sikasso have reserves in supply, while Koulikoro is just at the self-supply level. All the other Régions lack adequate supplies. Ségou has the highest supply reserves with a self-supply rate of 180%. It is clear that cereal production in this region has a major influence on food

self-sustainability in Mali.

Table 3.4.2 Supply and Demand for Cereals in Mali (Estimate)

Index	Kayes	Kkoro	Sikasso	Ségou	Mopti	Tbctou	Gao	Kidal	Bamako	National total
Population in 1998	1,372,019	1,565,838	1,780,042	1,679,201	1,475,274	461,956	397,516	42,479	1,016,167	9,790,492
Demand for cereals	307,332	350,748	398,729	376,141	330,461	103,478	89,044	9,515	227,621	2,193,070
Cereal production	159,931	373,448	563,286	690,055	263,308	51,946	21,840	0	0	2,123,814
Self-supply rate	52.0%	106.5%	141.3%	183.5%	79.7%	50.2%	24.5%	0.0%	0.0%	96.8%

In a comparison of the 7 cercles within Ségou Région, the self-supply rate of 3 cercles in the cotton zone does not reach the 100% level (Table 3.4.3). If the imbalance in self-supply within the Région is eliminated and the capacity to supply cereals to other Régions that lack them is improved in each Région, it will contribute to improving the supply of food not only to local residents but in the entire country.

Table 3.4.3 Supply and Demand for Cereals by Cercle in Ségou Région

Cercle	Population in 1998	Gross Demand (t)	1997/98 Production	Self-supply Rate
Baraouéli	166,413	37,277	58,288	156.4%
Bla	208,480	46,700	27,856	59.6%
Macina	169,025	37,862	72,330	191.0%
Niono	227,669	50,998	243,372	477.2%
San	252,113	56,473	46,631	82.6%
Ségou	489,733	109,700	201,603	183.8%
Tominian	165,768	37,132	18,380	49.5%
Total	1,679,201	376,141	668,460	177.7%

Note: The cereal demand per capita (224kg per person/year) is estimated as follows:

$Q = 365DG/(1 - L)/C$
Necessary calorie intake per person/day (D): 2,450 cal (FAO Guidelines)
Cereal calorie intake rate (G): 70% of gross calories
Refined cereal calorie supply: (C): 3,720 cal/kg
Loss rate due to processing and storage (L): α (0.25)

(6) Recognition of Food Self-sufficiency in Villages (Consideration Based on the Survey on village cadastres Results)

Table 3.4.4 shows the food self-sufficiency status learned through interviews with village chiefs which implemented through survey on the production of village cadastres. The number of villages with food self-sufficiency on the average in the study area is a little over 50%, considerably different from the macroscopic analysis results described in the above sections. This is mainly caused by the disparity of production capacities between UPAs in a village. Large UPAs, specifically, have a considerable production surplus while UPAs not reaching the self-sufficiency level exist in a village. Although the

production in an entire village meets the self-sufficiency level for villagers, the self-sufficiency for the entire village is not attained according to the number of UPAs.

Table 3.4.4 Food Self-sufficiency Status in Villages Selected for Village Cadastres

Agricultural zone classification	Number of villages that replied	Number of self-sufficient villages	Ratio of self-sufficient villages	Number of months in which shortage villages can be supplied
Rain-fed farming	186	93	50.0%	8.0
Irrigated farming	27	19	70.4%	6.8
Cotton cultivation	52	29	55.8%	8.9
Total	265	141	53.2%	7.9

Source: Result of survey on the production of village cadastres.

(5) Main issues

① Due to the increase of population and the increasing demand for cash incomes, the expansion of farmland by cultivating new land and the shortening of fallow periods that have been longer so far to restore the land fertility naturally and the permanent use of fields without fallow are progressing.
② These problems cause soil deterioration and a decline in soil fertility, resulting in weakened erosion resistance of the soil.
③ Production is extremely unstable due to large yearly and seasonal fluctuations in rainfall, poor extension of soil fertility improvement technology, poor technology and lack of materials for preventing damage by pests and diseases, and poor extension of drought-resistant varieties that grow in a short time.
④ The conditions of access to markets are poor, limiting the diversification of products such as vegetables which could lead to increased income.
⑤ Although cultivation management with new varieties and chemical fertilizers is examined and researched, it has not reached enough level to introduce it to UPAs.

3.5 Stock Raising

(1) Overview of Stock Raising

The stock-raising sector in Mali accounted for 12.8% of total exports in 1996. The herbivorous livestock decreased due to droughts that occurred twice in the 1970s and 1980s, but the number of head has been steadily increasing since 1986. In Mali, livestock are raised as live savings for emergency expenditure. Farmers increase their head of livestock if they have money to spare.

In Ségou Région, there are 1,017,000 head of cows, 1,053,000 head of sheep, 1,382,000 head of goats, 20,000 head of horses, 104,000 head of donkey and 2,759,000 fowls. This is calculated as 1,227,000 UBT in tropical livestock unit [1)] (UBT: Unité du Bétail Tropical), accounting for 17.4% of all livestock in the whole of Mali. Ségou Région is an important production base for the stock-raising business in Mali. (See Table 3.5.1.)

[1)] Tropical livestock unit (UBT: Unite de Betail Tropical): Unit determined by the fodder intake of livestock. A horse or camel is represented by 1 UBT, a cow 0.8 UBT, a donkey 0.5 UBT, and a sheep or goat 0.14 UBT.

Table 3.5.1 Head of Livestock in Ségou Région

Type of Livestock Category	Cows (Head)	Sheep (Head)	Goats (Head)	Horses (Head)	Donkeys (Head)	UBT Total	Poultry (Fowl)
Total in Mali	5,725,000	5,950,000	8,550,000	135,000	650,000		24,000
Calculated in UBT	4,580,000	833,000	1,197,000	135,000	325,000	7,070,000	Thousand fowls
Ségou Région							Thousand fowls
Baraouéli	91,800	87,088	174,175	1,308	7,596		550
Bla	104,000	185,500	123,000	155	9,500		399
Macina	126,040	117,435	191,200	1,040	10,350		353
Niono	183,250	49,152	80,167	534	18,365		76
San	202,943	258,863	381,744	9,706	21,372		608
Ségou	236,945	316,575	374,450	3,740	32,326		635
Tominian	72,306	37,990	56,980	3,343	4,897		139
Total	1,017,284	1,052,603	1,381,716	19,826	104,406		2,760
Calculated in UBT	813,827	147,365	193,440	19,826	52,203	1,226,661	
Share of Ségou Région of the total in Mali (%)	17.8	17.7	16.2	14.7	16.1	17.4	11.5

Source: For the whole of Mali, FAO Production Yearbook 1978-1998. For Ségou Région, Rapport annuel 1999 de la DRE Ségou

The stock-raising system in Mali is shown in Table 3.5.2. Stock raising in the study area adopts the form of grazing in natural grassland, fallow fields and forests. As the production of millet, sorghum and niébé as well as rice is thriving in the study area, the remains of these products are used as fodder for livestock. Stock raising is operated in close combination with agriculture in the following points:

① Reuse of remains of agricultural products;
② Recycling of dung to agricultural sector;
③ Use of cows as draft animals that are indispensable for agricultural tasks such as plowing and weeding in the three farming zones (cotton cultivation in the south, rice farming zone along the Bani River and rain-fed farming zone in the central).

In part of the study area, transhumance is carried out. In the rainy season, transhumance is made from the cotton zone in the south to Sikasso Région and Burkina Faso, and from Ségou cercle to Baraouéli cercle.

Table 3.5.2 Stock Raising System in Mali

Category	System	Features	Remarks
Traditional system	Nomadic system	Transhumant stock-raising system exercised by nomads in the Sahelian climatic zone where agriculture is impossible. They feed livestock on natural grassland and travel seeking grass and water, season by season, carrying their tents with them.	
Agricultural-stock raising system	Stock-raising system combined with rain-fed agriculture	Livestock are fed in the transhumant way. This is a stock-raising system combined with the agriculture that is available in an area with a yearly rainfall of 350 mm or more. Transhumance is carried out by regularly moving only the livestock, without moving the dwellings.	Adopted in the study area.
	Stock-raising system combined with agriculture using flood water	This system is operated in the flood area in the delta zone of the Niger River. Cows are mainly bred for supplying milk and making money.	
	Stock-raising system in farming areas including the rice-farming zone in the Niger River basin and the cotton cultivation zone in the south	Usually the livestock are settled, but transhumance is carried out for protection of agricultural products and optimum use of farmland during the rainy season in arid areas such as Ségou Région	Adopted in the study area.
Modern system	Intensive settled system	Livestock are bred in barns or paddocks. This system is used in the fattening and dairy production operated in the suburbs of cities.	Partly adopted in the environs of Ségou cercle in the study area

Source: "Agriculture in Mali", Association for International Cooperation of Agriculture and Forestry (AICAF), March 1986

In the dry season, transhumance is carried out to seek the residue of farm produce from Niono cercle in the north, outside the study area. The transhumant routes in the dry and rainy seasons are illustrated in Figure 3.5.1. The Bambara tribe entrusts its large livestock to the Peul tribe at the time of the seasonal migration. The fees for this are paid in money or food, such as millet. However, nowadays even the Puel tribe is tending to settle down and engage in agriculture, and transhumance is decreasing. Except for farmers with a large number of livestock, the trend is toward raising livestock in common pastures within Terroir even in the rainy season. Watch of grazing in the Terroir is sometimes entrusted to the sedentary Peul tribe. Competition for the feed resources in the Terroir occurs with regard to seasonal migrations or grazing. The reason for this lies in the fact that regulations on land use and management in the Terroir are not clear. In particular, competition occurs over grazing on the common pasture used by a number of villages, or when moving over land where there is no migration route.

A general cow grazing control calendar in the study area is shown in Figure 3.5.2. The cultivation period of farm products in the management site corresponds to the transhumant period of livestock. Delivery is carried out before the rainy season begins, and the period of lactation corresponds to the period when fodder is supplied amply. Vaccination is made against cowpox and peripneumonia in the cold dry season, and against anthrax, symptomatic anthrax and pasteurellosis at the beginning of the rainy season.

Figure 3.5.1 Transhumant Routes in Dry and Rainy Seasons

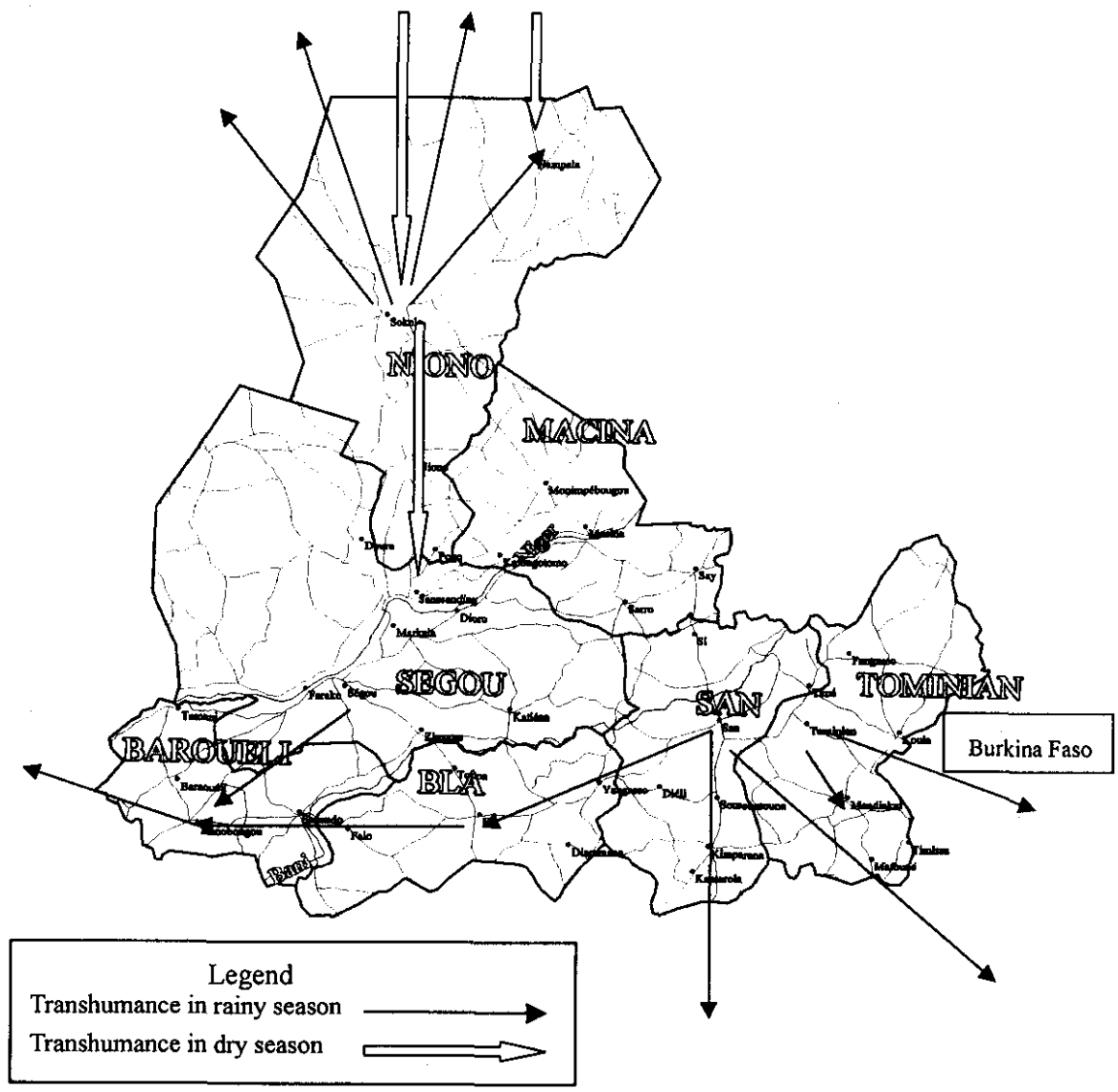


Figure 3.5.2 Grazing Control Calendar

Item	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Transhumance						←	—	—	—	→		
Raising at management site	←	—	—	—	—	→				←	—	→
Delivery				←	—	→						
Mating						←	—	→				
Vaccination	←	—	→		←	→					←	→
Insecticide		←	—	→								
Draft cow (cow ploughing and weeding)					←	—	—	→				

(2) Fodder Production Base

One of the primary factors in increasing desertification is grazing of excessive numbers of livestock. The number of head of livestock is higher than the fodder supply capacity level, resulting in unbalanced supply and demand for fodder.

The present fodder supply and demand balance can be estimated from the fodder supply and demand for livestock. Fodder resources consist basically of pasture from grasslands and the residues of agricultural produce (although a small volume of auxiliary fodder is supplied for breeding of draft animals and fattening of livestock). The fodder demand is estimated as 5.5 kg of the required quantity of dry matter per UBT. It is difficult to estimate the utilization rate of individual crops that can be expected from agricultural products because some are used as raw materials for compost and the rate varies. In this study, the following utilization rates were used to estimate the by-products of agricultural produce on the basis of the field survey: 50% for rice straws and 35% for other crops such as millet and sorghum.

The results of estimation of the fodder supply and demand balance are shown in Table 3.5.3 (estimation base:Annexe M3.5.1-2). As far as the fodder supply and demand throughout one year is concerned, the fodder supply satisfies the demand except in San cercle. In San cercle, large-scale transhumance takes place during the cultivation period in the rainy season. Therefore, the supply quantity is negative. In the study area, the biomass supply varies greatly in the dry and rainy seasons, causing a seasonal unbalance in supply and demand. Since fodder preparation by hay storage and silage is scarce, it seems that livestock can barely maintain their sustainable energy in the final period of the dry season.

Table 3.5.3 Estimation of Feed Supply and Demand (Rough Estimate)

Unit (t)

Cercle	Tropical livestock unit (UBT)	Required dry matter	Fodder supply capacity			Supply and demand balance
			Grassland, woodland, etc.	Residues of farm produce	Total	
Baraouéli	115,123	231,109	270,643	121,886	392,529	161,420
Bla	131,295	263,575	377,183	58,578	435,761	172,186
Macina	150,256	301,639	287,303	92,021	379,324	77,685
Niono	174,421	350,150	527,753	146,047	673,800	323,650
San	272,431	546,906	351,494	50,897	402,391	-144,515
Ségou	306,203	614,702	745,608	232,772	978,380	363,678
Tominian	76,932	154,441	363,216	33,305	396,521	242,080
Total	1,226,661	2,462,522	2,914,199	735,505	3,658,706	1,196,184

(3) Livestock Productivity

1) Cows

In the study area, Peul and Maure breeds of cow are mainly raised. The N'Dama breed is also raised in some parts. The Peul breed is hardy in dry climates and though small, is ideal for plowing work. In Ségou Région, the number of this breed is the highest of all. The Maure breed is suited to dry climates, like the Peul breed, and the number of head of this breed is the second highest. Many mixed breed cows of the two breeds are also raised. The livestock productivity of the Peul and Maure breeds is almost the same.

But the milk productivity of the Maure breed is a little higher than that of the Peul breed. The N'Dama breed has a low physique, making it suitable for hauling and plowing work, and it is used for

agricultural work. This breed is raised in part of the cotton cultivation zone in the south of the study area. The N'Dama breed is resistant to trypanosomiasis and is a valuable genetic resource in West Africa. As these cows are traditional breeds and no improvement by interbreeding with foreign breeds is planned, their milk and meat productivity is low. Cow productivity is shown in Table 3.5.4.

Table 3.5.4 Productivity of Cows

Technical Index	Present Condition	Remarks
① Bio-weight (female)	250～300 kg	Peul and Maure breeds
② Interval between births	18 months or more	
③ Breeding rate	55%	
④ Durable years	12 years	
⑤ Months to first birth	48 months	
⑥ Number of head delivered during life	5 head	
⑦ Calf weight	12～14 kg	
⑧ Casualty rate of calf	14% or more	
⑨ Yearly milk production	400～500 kg	

Source: Institute of Rural Economics (IER), interviews at Niono Cercle Center.

2) Sheep

The main breed of sheep raised is Djalonké. Other breeds are Sahel and Bali-Bali. Djalonké is small in physique and poor in meat productivity, but is resistant to disease and is highly adaptable to environmental changes. The Sahel breed has high milk and meat productivity and is hardy in dry climates. The Bali-Bali is large in physique and has long ears. Its milk production is low, but its meat productivity is high. Lack of fodder during the delivery period of adult sheep, disease, and infection by internal and external parasitic insects cause large losses among the young. The livestock productivity of sheep is shown in Table 3.5.5.

Table 3.5.5 Productivity of Sheep

Technical Index	Present Condition	Remarks
① Bio-weight	♂40 kg ♀30 kg	Djalonké: ♂35 kg ♀25 kg, Sahel: ♂50 kg ♀40 kg, Bali-Bali: ♂60 kg ♀55 kg
② Interval between births	12 months	
③ Months to start of breeding	23 months	
④ Durable years	♂6 years, ♀8 years	
⑤ Number of head delivered during life	6 head	
⑥ Weight of young	♂3.5 kg ♀3 kg	
⑦ Casualty rate of young	20% or more	
⑧ Yearly milk production	40～50 kg	

Source: Institute of Rural Economy (IER), interviews at Niono Cercle Center

3) Goats

Neen and Sahel breeds of goat are raised. The number of head of the Sahel breed is not very large. The Neen breed is small in physique, resistant to disease and highly prolific. The Sahel breed is raised on arid land and is large in physique. Goats are adaptable to desertification and can survive even in the event of drought. However, there is the problem of nutritive control for the young. Their loss due to disease and infection by internal and external parasitic insects is large. The livestock productivity of goats is shown in Table 3.5.6.

Table 3.5.6 Productivity of Goats

Technical Index	Present Condition	Present Condition
① Bio-weight	♂40kg ♀30kg	Sahel breed: ♂40kg ♀35kg, Neen breed: ♂30kg ♀25kg
② Interval between births	6.5 months	
③ Months to start breeding	10 months	
④ Durable years	♂5 years, ♀6 years	
⑤ Number of deliveries during life	11 times	
⑥ Weight of young	♂3.5kg ♀3kg	
⑦ Casualty rate of young	10～20%	
⑧ Yearly milk production	50～60kg	

Source: Institute of Rural Economy (IER), interviews at Niono Cercle Center

4) Poultry

The poultry in the study area include hens and guinea fowl. In the suburbs of the cities in Ségou cercle, there are enterprise-like poultry farms that are raising 3,000 to 5,000 fowls. On these farms, chickens of the Rhodel Island Red and Rhodel Island White breeds are regularly introduced from Bamako, and the feed is a self-prepared mixture of maize, fishmeal, bran and minerals. However, poultry farming at village level is usually by grazing at large. Productivity is low due to grazing at large, lack of vaccination and breeding of traditional breeds, but not improved breeds. Poultry productivity is shown in Table 3.5.7.

Table 3.5.7 Productivity of Fowls

Technical Index	Present Condition	Remarks
①Bio-weight	♂2.5kg ♀2.0kg	Traditional breeds: ♂2kg ♀1.5 - 2kg, Improved breeds ♂3.0kg～3.5 ♀2～2.5kg
②Months to start of egg-laying	6 months	
③Quantity of eggs	48 to 180 pcs	Traditional breeds: 4 eggs/month x 12 months = 48 eggs
④Weight of eggs	35g～50g	Improved breeds:15 eggs/month x 12 months = 180 eggs

Source: Interviews at Pelingana Poultry Farm, Ségou

(4) Livestock Production and Consumption

The official figures for cows, sheep and goats slaughtered in controlled slaughterhouses are shown in Table 3.5.8. However, it is presumed that the actual figures of slaughtered livestock are higher. The dressed carcass weight of a cow is about 100kg on average because most cows are traditional breeds for which no improvements have been made. The yield rate of a carcass is about 40%.

Table 3.5.8 Head of Slaughtered Livestock

Kind of Livestock (unit)	Cows			Sheep			Goats		
	Head	Weight (t)	Carcass (kg)	Head	Weight (t)	Carcass (kg)	Head	Weight (t)	Carcass (kg)
Baraouéli	1,196	109.5	91.6	975	10.1	10.4	6,155	57.5	9.3
Bla	435	46.0	105.7	1,956	28.7	14.7	5,530	70.4	12.7
Macina	113	11.9	105.0	1,013	13.2	13.0	3,855	46.2	12.0
Niono	1,407	152.3	108.2	909	17.1	18.8	5,558	70.4	12.7
San	2,193	193.7	88.3	1,954	20.2	10.3	8,622	87.9	10.2
Ségou	6,977	662.8	95.0	14,247	213.7	15.0	10,704	139.2	13.0
Tominian	176	15.8	90.0	423	4.2	10.0	3,526	35.3	10.0
Total	12,497	1,620	100.8	21,477	307.2	14.3	43,950	506.8	11.5

Source: Rapport annuel 1997 de la DRE Ségou

Fresh milk production is estimated at 25,800 t per year assuming that the number of milking cows in Ségou Region is 15% of the total number of cows, that is, approximately 157,000 head. Assuming that the milking period is 240 days, the milk production per day is estimated to be 0.5 to 1 liter.

In Ségou cercle, there is a suburban-style fattening operation that carries out the fattening of 3,000 head a year. In Tominian cercle, sheep fattening is also carried out although the quantity is 640 head or so a year.

There are no accurate data indicating livestock consumption in the study area. According to the FAO Production Yearbook 1978-1998, the yearly livestock consumption per capita in the entire country of Mali is broken down as follows: 13.1 liters of cow milk, 15.7 liters of goat milk, 9.3 liters of sheep milk, 8.4kg of beef, 5.1kg of mutton and goat meat, 2.6kg of fowl meat and 1.1kg of eggs. In the study area, cow milk consumption per capita based on the available livestock consumption data is 19 liters/capita, 45% higher than the national consumption per capita. The Puel tribe of herders has a high livestock consumption, but the Bambara and Malinke tribes of agricultural people have lower livestock consumption.

According to the Human Development Report 1999 by the United Nations Development Plan (UNDP), the calorie intake per capita in Mali in 1996 was 2,027kcal, protein 60.8g and fat 42.3g. Compared with the average data values in developing countries, the calorie intake rate in Mali was 77.1%, protein 91.6% and fat 73.3%. These figures demonstrate that livestock consumption in Mali is still low.

(5) Stock-Raising Infrastructure

Livestock control facilities include water supply facilities for livestock, animal corridors and pasture land barriers. As the water supply facilities, swamps, river water and wells are used. In the rain-fed farming zone, there is a lack of water supply facilities and some of the facilities are aged and dilapidated. The livestock that drink swamp and river water have a high percentage of contraction of diseases and parasitism.

Immunization yards for vaccination and livestock pharmacies are provided as livestock sanitation facilities. One immunization yard is required for each village, but the present level has not achieved this requirement. The distribution of facilities within the study area is shown in Table 3.5.9.

Table 3.5.9 Distribution of Livestock Sanitation Facilities

Facilities	Livestock Pharmacy	Immunization Yard
Baraouéli	2	34
Bla	3	159
Macina	0	12
San	9	106
Ségou	3	19
Tominian	1	68
Total	18	398

Source: Cartographie de la Repaublique du Mali

(6) Factors Impeding the Development

① The raising of livestock, especially large livestock (cows), is also intended as savings in case of emergency. As the livestock is not renewed at an economically appropriate time, the breeding period is usually long, resulting in low production efficiency.

② The livestock mainly belong to traditional breeds, for which no systematic improvement is planned, resulting in low livestock productivity.

③ The production structure is such that fodder resources depend upon the weather. Poor fodder storage techniques and an insufficient supply of supplementary fodder do not ensure a stable fodder supply throughout the whole year, resulting in low livestock productivity.

④ The lack of livestock sanitation facilities and low awareness of herders regarding vaccination measures cause a large loss of livestock due to disease and internal and external parasitic infections.

⑤ The number of livestock water facilities is insufficient and some do not function due to aging and dilapidation.

⑥ The productivity of poultry farming is low because of rough raising methods, failure to carry out vaccinations, and the use of traditional breeds instead of improved breeds.

3.6 Forestry

(1) Overview of Forests

The Sahel-Sudanian Région in West Africa has a yearly rainfall of 200 to 800mm. Thick woods or forests are locally distributed as vegetation zones, but sparse woods where the tree crowns are isolated from each other are combined with grasslands, and savanna and low gramineous herbaceous plants are intermingled with sparse shrubs.

It is assumed that the study area was covered with ample arid evergreen woods, little of which remain today due to strong influence of human activities.[1)] The area and cumulative volume of forests by cercle in the study area are described in Table 3.6.1 below.

Table 3.6.1 Area and Cumulative Volume of Woods by Cercle

Cercle	Area of Woods (ha)	Gross Cumulative Volume (m^3)	Cumulative Volume (m^3/ha)
Baraouéli	288,000	4,501,000	15.63
Tominian	448,000	5,454,500	12.18
Ségou	1,107,500	15,736,500	14.21
Bla	393,200	5,789,150	14.72
San	425,800	5,356,000	12.58
Macina	414,100	5,102,000	12.32
Total	3,076,600	41,939,150	12.37

Source: Projet Inventaire des Ressources Ligneuses et Occupation Agricole de Terres au Mali (Mars, 1989)

Notes: 1. The Ségou and Macina cercles include the left bank of the Niger River.

2. The area of woods includes the area of farmland, grassland, and fallow fields where trees grow. Thus, these figures do not match the figures used in the land use projects.

The average cumulative volume of forests is 12 to 16m^3/ha, so that forests of mainly tall trees can rarely be seen from the arterial highways. Most of the forests are sparse woods of mainly low trees.

1) Source: JOFCA (Japan Overseas Forestry Consultants Association) Report (1997/3)

The average yearly growth of the trees is restricted by the yearly rainfall, as explained by the formula below.[1] According to the formula, the average yearly growth in the study area is 1m^3/ha/year or less. Growth is extremely slow due to the adverse natural environment.

$$I = 0.3699E^{3.1652PR2}$$

I: Average growth (m^3/ha/year)
E: Natural logarithm base (2.718……)
P: Precipitation (m/year)
R: Coverage rate (%)
PR2: Square of Precipitation x Coverage Rate

The idea of integrating trees into the cultivation system (water evaporation control, nitrogen supply, etc.) is implemented in the farming districts. The main trees planted are karite (*Butyrospermum parkii)*, baobab (*Adansonia digitata*), *Acacia senegal* and *Acacia albida*, though the density per hectare differs greatly from district to district. It is estimated that there are 100 trees/ha in well-managed farm fields, but only 5 trees/ha in poor fields. The tree density per hectare tends to be lower the further you go from the Niger River and its tributary, the Bani River.

Forestry protection districts of 78,860 ha, equivalent to about 2.6% of the total forest area, are provided to protect these valuable trees. These forestry protection districts were specified from 1948 to 1954 and forestry maintenance plans were established according to the specifications for each protection district, which have not yet been implemented for reasons such as securing financial resources.

Thus, DRCN, in charge of control over the forestry protection districts, has a plan of implementing a management system requiring people's participation. However, these districts are freely used by the villagers as firewood collection sites at present and the resources keep on being deteriorated. The number of forestry protection districts and their area by cercles are shown in Table 3.6.2.

Table 3.6.2 List of Forestry Protection Districts

Cercle	Number of Districts (inc. planned districts)	Area (ha)
Baraouéli	2	16,500
Tominian	0	0
Ségou	6	2,440
Bla	0	0
San	0	0
Macina	8	32,960
Total	11	78,860

Source: DRCN (Direction Régionale de la Conservation de la Nature)
The Ségou and Macina cercles include the left bank of the Niger River.

(2) Forest Use

1) Law concerning forestry management in Mali

The basic requirements for forestry management in Mali are stipulated in the Act Determining the

[1] Schema directeur d'approvisonnement en bios energie de la ville Ségou (1988/7)

Conditions for Forest Resource Management (Fixant Les Conditions de Getion des Ressources Forestrieres LOI N°. 95-004 (hereinafter called the "Forestry Act").

The object of the Forestry Act is to lay down the terms for the conservation and protection and the terms and conditions for use and development of domestic forest resources. Forest Act widely stipulates the definition of forest products, the locations of protected forests, suitable and unsuitable land for cultivation, protected species, right of use and burning of undergrowth, and the definitions of ownership categories of national and private forests. However, the Forest Act is not followed actually because of lack of supervising system.

The tree varieties that are specially protected under the Forestry Act for economic, sociocultural and scientific reasons are listed below. Some of the varieties grow naturally in the study area. (The underlined trees are observed in the study area.)

	Scientific Name	Local Name
1.	*Elaesi guineensis*	Palmier a huile
2.	*Borassus aethiopium*	Ronier
3.	*Pterocarpus erinaceus*	Vene
4.	*Afzelia africana Smith*	Lenge
5.	*Acacia senegal willd*	Gommiei
6.	*Parkia biglobosa Benth*	Nere
7.	*Butyrospermum Parkii*	Karite
8.	*Bombax costatum Pallegre Veiller*	Kapokiei
9.	*Kaya senegalensis Juss*	Cailcedrat
10.	*Acacia albida*	Balansan
11.	*Anogeisus leiocarpus*	Ngalama

2) Status of forest use in villages

Under common ownership by custom, the villagers consider that forests in the village are used as firewood collection sites. In general, the sites where trees have been collected are not afforested, and the forests are used only for gathering wood. Therefore, the entire forest resources are decreasing and bare land is appearing in places in a mosaic pattern. The diameter of the trees used for firewood is, at most, the size of a human arm (about 10cm or so). The tool used for cutting trees is usually a hatchet. No cutting by handsaw was seen in the area.

On the other hand, the main protected trees seen on the farmlands include Karite, Kapokiei, and Baobab. In particular, the oil and fat components found in the endosperm of the sarcocarp of Karite are used for food (shea butter), soaps, and production of cosmetics.

(3) Villagers' Recognition of Reduced Forest Area

1) Changes of forest area

In the "survey on the production of village cadastres", we examined the changes, causes, and influences of the forest area in the past ten years (from 1991 to 2000; the same period is used hereafter). The result of the study on the villagers' recognition of changes of the forest area is shown in Table 3.6.3. The forest area is decreasing in most (88%) of the 275 villages under the study.

Table 3.6.3 Recognition of Changes of Forest Area in the Past Ten Years

Cercle name	Increase		No change		Decrease		Total	%
	Number of villages	%	Number of villages	%	Number of villages	%	Number of villages	%
Baraouéli	1	3	0	0	37	97	38	100
Bla	1	3	1	3	32	94	34	100
Macina	0	0	0	0	19	100	19	100
San	0	0	10	15	57	85	67	100
Ségou	0	0	14	21	52	79	66	100
Tominian	0	0	7	14	44	86	51	100
Total	2	1	32	11	241	88	275	100

Source: Survey on the production of village cadastres

2) Reasons for decrease of forest area

The forest area decreased mainly because of ① increase of cropping acreage, ② occurrence of droughts, and ③ excessive cutting of trees. In Ségou Région especially, villagers recognize that the forest area decreased because the cropping acreage increased. Table 3.6.4 shows the details.

Table 3.6.4 Reasons for Decrease of Forest

Reason for decrease	Baraouéli		Bla		Macina		San		Ségou		Tominian		Total	
	Number of villages	%	Number of villages	%	Number of villages	%	Number of villages	%	Number of villages	%	Number of villages	%	Number of villages	%
Increase of planted area	16	29	6	8	1	4	44	35	43	94	25	41	135	35
Drought	3	5	17	42	21	88	45	36	1	2	20	33	120	31
Excessive cutting of trees	37	66	30	24	2	8	33	26	2	4	16	26	107	28
Excessive grazing of livestock	0	0	18	26	0	0	3	3	0	0	0	0	21	6
Total	56	100	71	100	24	100	125	100	46	100	61	100	383	100

Source: Survey on the production of village cadastres

3) Villagers' recognition of how decrease of forest influences villagers' life

As the survey items, we provided ① high price of firewood, ② remoteness of firewood collection sites, and ③ competition in firewood collection and combinations of these three items. Table 3.6.5 shows the survey results.

Table 3.6.5 Villagers' Recognition of How Decrease of Forest Influences Villagers' Life

Villagers' recognition	Baraouéli		Bla		Macina		San		Ségou		Tominian		Total	
	Number of villages	%	Number of villages	%	Number of villages	%	Number of villages	%	Number of villages	%	Number of villages	%	Number of villages	%
1. High price of firewood	2	5	0	0	0	0	7	11	0	0	1	2	10	4
2. Remoteness of firewood collection sites	4	11	5	15	19	100	15	25	22	48	39	89	104	43
3. Competition in firewood collection	0	0	3	9	0	0	1	2	0	0	0	0	4	2
4. Combination of 1 and 2	0	0	0	0	0	0	2	3	11	24	3	7	16	7
5. Combination of 2 and 3	30	81	24	70	0	0	3	5	6	13	0	0	63	26
6. Combination of 1, 2, and 3	1	3	2	6	0	0	33	54	7	15	1	2	44	18
Total	37	100	34	100	19	100	61	100	46	100	44	100	241	100

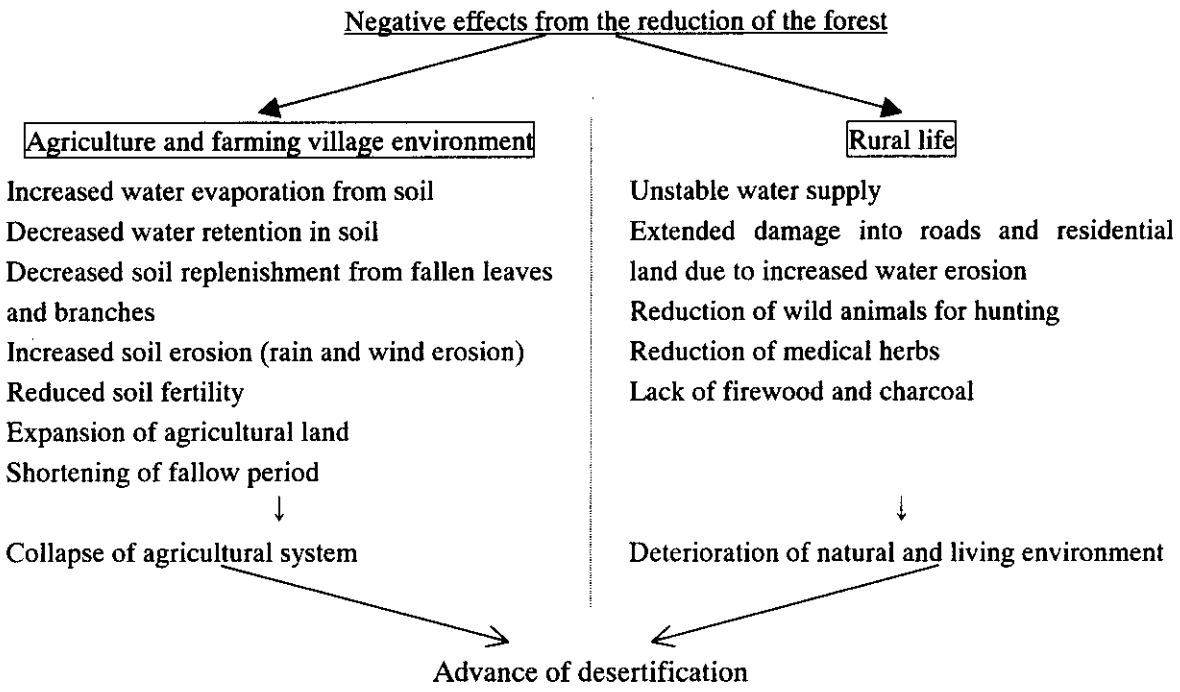
Source: Survey on the production of village cadastres

The influences of decrease of the forest area are not uniformly recognized; various reactions exist depending on the natural resource occurrence status of each village. It has been found that that the influence of forest decrease is directly recognized as difficulties in obtaining an energy source (remoteness and competition).

On the other hand, according to the PRA (Participatory Rural Appraisal) undertaken separately from the study of the formulation of village ledger, it was observed that the residents could not realize the decline of forests as a serious problem though they felt the inconveniences in procuring firewood caused by their decrease.

As shown in Figure 3.6.1, the decline of forests was one of the direct and significant causes of the progress of desertification. However, the residents did not understand that the decline of forests affected severely the rural living and they naturally have not started the proper activities independently to stop the said decline.

Figure 3.6.1 Process of Advance of Desertification Caused by the Reduction of Forest



(4) Demand and Supply of Wood

With regard to wood consumption (especially firewood), the Report "Schema Directeur d'Appovisionnement en Bois Energie de la Ville de Segou" issued in 1996 with the financial and technical assistance of the World Bank, the Netherlands, GEF and the International Development Association (IDA) states: "In the area of 120 km radius of Ségou, approximately 101,000 tons of firewood and 4,700 tons of charcoal (equivalent to a total of 133,000 tons of wood) are collected every year. The acquisition of energy sources for domestic regional cities is the most important economic activity. Total sales of firewood in Ségou City alone are approximately 1.5 billion FCFA. The business is a source of high employment and an indispensable source of income for the villages in the suburbs of the city and their residents.

Since the 1970s, demand for wood fuel has been controlled and many measures have been taken to increase the supply. An example of the success of such measures is the conspicuous promotion of improved ovens. However, the expected results have not been attained despite great efforts especially in the area of reforestation."

According to the above report, 92% of the households in Ségou used firewood as the main source of fuel in 1995 and 8% used charcoal. When this consumption is converted into money, it is evaluated at 14 FCFA/per person/per day. In addition, wood fuel consumption is increasing in pace with the dramatic increase in the population growth rate.[1] Wood consumption per capita is 1 kg/day.

Therefore, large quantities of firewood are collected in Ségou City from the neighboring regions and distributed to Ségou and the capital city of Bamako. The report also states that in recent years there has been a shift in consumption from firewood to charcoal due to its convenience. The balance of

[1] Schema Directeur d'Approvisionnement en Bois Energie de la Ville de Ségou

production/consumption is shown in Table 3.6.6.

Table 3.6.6 Wood Production/Consumption Balance within a 120km Radius of Ségou

(Unit: ton)

Wood Production	1,500,000
Amount taken to Ségou	-134,000
Amount taken to Bamako	-50,000
Consumption in rural area	-1,100,000
Balance	215,000

A balance of 215,000 tons is barely maintained in 1996, but a shortfall of 550,000 tons is forecast by 2010. Furthermore, if the tree cutting continues at the present speed of firewood consumption with the increase of the population, the sylvicultural resources in the study area would be exhausted before Year 2020. (Bases for estimation are listed in attached ARREXEM3.6.)

(5) Factors impeding the development

As the factors impeding the development in sylvicultural sector, the following can be considered.

① Damage of vegetation eaten by livestock or igniting of wild shrub zone is large.
② Increase of pressure to the decline of forests caused by the cutting of trees for firewood
③ Stagnation of afforestation backed by the neglect of residents towards tree planting

3.7 Marketing

(1) Marketing of Agricultural Products

Cereals such as millet are basically self-supplied farm products, of which the surplus is sold to earn cash to purchase daily necessities. Sales take two forms: one is sale to brokers from Bamako and Ségou. In this case, the brokers spend two days, the first day for negotiations to determine the price and the second day for collecting the shipments.

The second form is where the products are transported to the market in Ségou and sold to brokers, or are sold directly in the weekly market. In the study area, roughly one weekly market is held for 6 villages. In this case, the farm products are transported to the marketplace by donkey or hose carts, or on foot. Access between villages is poor and transportation usually takes half a day.

Transactions by brokers account for most of the distribution of cereals. The brokers buy large quantities of cereals mainly at harvesting time, transport them to large consumer cities such as Bamako and sell them throughout the year.

Looking at the trends in millet prices in the Ségou market since 1998, the short-term price from December to April after the 1998 harvest fell in January (to 70 FCFA/kg), but normally the price was stable at 80 to 85 FCFA/kg. In the rainy season in June, the price rose temporarily to 90 FCFA/kg.

However, the price of the 1999 crop fell in September because the farmers delivered their stocks in expectation of an increase in millet yields due to much rainfall. In addition, when an excellent crop became certain, new millet was shipped to the market, resulting in a sharp fall in price during November and December. The millet price declined from 60 FCFA/kg at the beginning of December

to 40 FCFA/kg in January. The price of sorghum started falling from the peak of 65 FCFA/kg in October down to 50 FCFA/kg in January. As for cereal, price fluctuates sharply as shown above. (Refer to Table 3.7.1.) Regarding other agricultural products, prices fluctuate in the same manner according to the planting state.

Table 3.7.1 Shifts in the Price of Farm Products on the Ségou Market (1999)

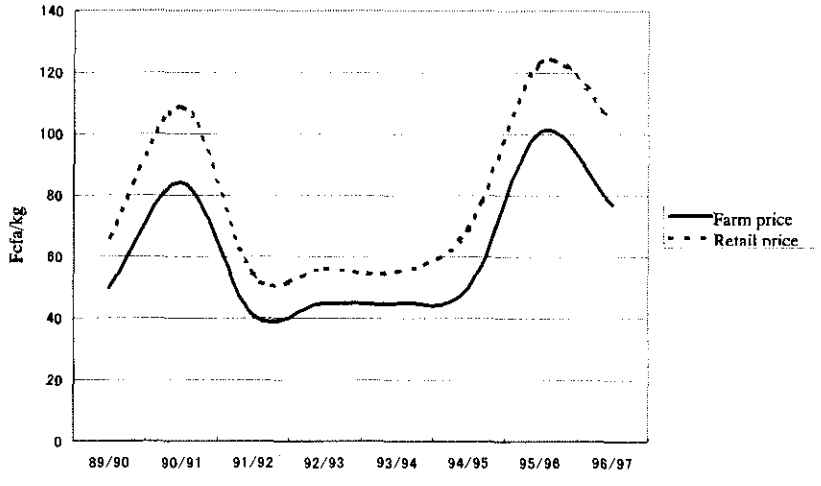
Unit: FCFA/kg

Product	After Harvest (Cool Season)			After Harvest (Hot Season)			Rainy Season			Harvest Period		
	January	February	March	April	May	June	July	August	September	October	November	December
Millet	70	85	85	85	85	90	90	80	55	70	65	60
Sorghum	70	85	115	115	110	115	115	105	70	90	65	55
Peanuts	185	-	240	250	240	240	240	215	-	125	120	120
Niébé	175	210	250	250	250	-	250	200	-	125	125	130

Source: JGRC Study

At harvest time, farmers sell both millet and sorghum to earn money, even if the prices are beaten down. In the off-crop season, farmers lack millet due to hunger sales. As a result, a contradictory situation arises in which the farmers have to buy back millet at a higher price. The Administrator of a certain cercle has pointed out that one of the causes of poverty in villages is such problem of distribution. The difference between the farm price and the retail price of farm produce (millet) is 20 to 40%. (See Figure 3.7.1.)

Figure 3.7.1 Differences in Millet Price on the Ségou Market



Source: SIM, Enquêtes sur marches, campagne de commercialisation 1989/1999 a 96/97

Vegetables, honey, shea butter and folk crafts (gourd-processed goods, millet mats, peanuts, etc.) are taken directly to the market by the farmers in many cases.

(2) Distribution of Livestock Products

Livestock products in the study area, after self-consumption, are transported to Ségou City and the capital, Bamako. The permitted export of live animals includes 27,125 cows, 49,829 sheep and 31,720 goats. Livestock traders collect livestock in Bla, San and Ségou cercles and export them,

especially to the Côte d'Ivoire. Livestock transactions are handled through brokers on livestock markets. Livestock destined for the slaughterhouse are bought and transported by the traders (butchers) to the slaughterhouses.

The dissected carcasses are sold wholesale at meat markets in the cities. Retailers from the towns come to the markets to purchase the meat. The brokers, livestock traders and retailers act in groups, but are not organized. They act in groups of several members or individually. Therefore, the intermediate distribution margin is high, resulting in higher retail prices. The brokers beat down the prices of the farmers, whose incomes are reduced accordingly. There is also no administrative service to convey the price trends in the consumer areas, including export markets, to the producing areas.

In the study area, the facilities related to livestock product distribution include livestock markets, slaughterhouses and milk processing plants. (See Table 3.7.2.) The percentage of transactions in livestock transported to livestock markets is shown in Table 3.7.3. The percentage of poultry transactions is high, but the percentage for cows, sheep and goats remains at the level of 71 to 77%.

Table 3.7.2 Facilities Related to Livestock Product Distribution

Unit: Location

Facilities / Cercle	Livestock Market	Slaughterhouse	Milk Processing Plant
Baraouéli	1	7	
Bla	0	6	
Macina	2	1	
San	2	2	
Ségou	6	3	1
Tominian	3	3	
Total	14	22	1

Source: Cartographie de la Repaublique du Mali

Table 3.7.3 Percentage of Transactions on Livestock Markets in Ségou Région

Unit: Head, Fow

Livestock	Cows		Sheep		Goats		Poultry	
Cercle	Shipment	Sale	Shipment	Sale	Shipment	Sale	Shipment	Sale
Baraouéli	17,520	11,086	32,221	22,768	42,579	33,147	85,140	76,910
Bla	11,390	1,675	28,821	15,663	20,747	14,168	79,298	79,273
Macina	6,260	4,451	25,792	15,984	30,655	21,025	31,815	31,815
Niono	31,407	25,689	49,247	32,387	50,226	30,681		
San	16,548	8,144	61,105	37,666	49,854	34,214	45,152	42,152
Ségou	62,049	53,861	76,944	63,725	78,266	71,498	47,212	37,942
Tominian	5,023	3,023	34,670	30,347	38,073	33,035	227,484	215,055
Total	150,197	107,929	308,800	218,540	310,400	237,768	516,101	483,147
Percentage of transactions		71.9		70.8		76.6		93.6

Source: Rapporte annuel 1997 de la DRE Ségou

The largest of the slaughterhouses within the study area is located in Ségou cercle. The slaughterhouse is not equipped with a refrigerator, but it has a processing capacity of 40 cows and 120 sheep and goats per day. The facilities include carcass hangers, washing equipment, drainage, skin dryers and paddocks. Inspectors from the Ministry of Rural Development make daily inspections of the slaughtered carcasses. The Government of Mali has drawn up a plan for the construction of refrigeration facilities at three sites in Ségou, Sikasso and Kai, but has not implemented it yet due to the lack of budget. Some slaughterhouses other than that in Ségou cercle have outdoor facilities with

no hangers, resulting in many problems of sanitary control.

Within the study area, there is one milk processing plant in Ségou cercle. It has a daily processing capacity of 2,000 liters of fresh milk for drinking. This plant also produces yogurt using imported powdered milk. Fresh milk is brought directly to the plant by the farmers. As there are no dairy farms in the neighborhood, milk collection is inefficient. Milk consumption is increasing and there are plans to expand the plant, but establishment of a production and collection organization shows almost no advancement. There are no farmers' organizations for joint transportation or small-scale processing in the production areas. Therefore, the farmers are not in a position to improve their incomes through value-added livestock processing.

(3) Distribution of Sylvicultural Products

With regard to wood distribution, the Act Relating to the Use, Transportation and Marketing of Wood (Portant Organization de L'exploitation du Transportation et du Commerce du Bois LOI N^{O} 95^{-003}) stipulates the method of determining the annual cutting quantity, wood certification system and penal regulations.

On the other hand, the price of wood, which is the fuel that accounts for most wood consumption, and the prices of other non-wood fuels in major cities in Mali are shown in Table 3.7.4.

Table 3.7.4 Shifts in Fuel Prices in Major Cities

(Unit: FCFA/kg)

City	Firewood		Charcoal		Gas		Petroleum	
	1997	1998	1997	1998	1997	1998	1997	1998
Bamako	24	26	70	68	320	320	225	225
Gao	31	41	92	81	440	440	313	313
Kayes	15	21	69	80	460	460	226	225
Koutiala	17	20	64	78	465	476	200	200
Mopti	23	25	76	66	410	410	200	200
Niono	24	21	96	94	460	460	200	200
Ségou	18	19	71	64	415	415	200	200
Sikasso	17	18	59	60	357	357	200	200
Tombouctou	29	41	59	134	1,080	1,137	265	211

Source: Le Bulletin d'Linformation sur l'Energie Domestique au Mali (N^{O}. 06 Mars 1999)

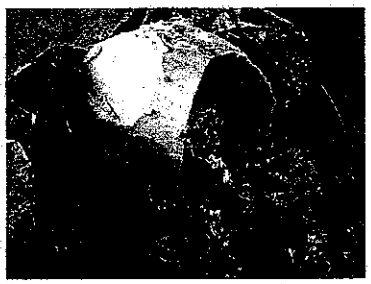
Firewood is stabilized in the price range of 20 to 40 FCFA/kg and is widely used as a cheap and stable energy source. However, tree growth is slow and the domestic demand for wood is deemed to be much higher than tree growth.

In Ségou City, wood products (in particular, furniture) are a thriving business. The wood material used includes plywood, primary sawn wood and decorative laminated thin sheets that are imported from neighboring countries. In normal woodworking plants, several workers are employed to mainly produce chairs, desks, beds and cupboards.

One of the foods produced from forestry resources is shea butter, made from Karite seeds. It is traded in the study area and in the agricultural villages, and is a valuable product from which cash can be obtained. It is also sold and bought at the regular markets held every week. Making shea butter is considered a skill unmarried women must learn before they get married. Soap is also made from shea

butter. However, in the study area, especially in the villages, soap is not manufactured because the caustic soda necessary for manufacturing soap is not available.

Liquid shea butter (Kokoun village)



Shea butter at the regular market

Produced soap

(4) Factors Impeding the Development

1) Agricultural products

① Prices vary considerably, linked with the yearly fluctuations in cereal production, and the incomes of farmers remain unstable.

② Due to poor access conditions and the lack of a means of transporting produce from the villages to the markets, farmers must make transactions in conditions that are advantageous to the brokers, and prices are beaten down.

2) Livestock products

① The groups concerned with distribution are not fully organized, raising the distribution costs.

② A means of providing the producing areas with information on price trends in the consumer areas, including export markets, has not been established.

③ It is difficult to secure purchasers at village markets held once a week.

3.8 Soil Conservation

(1) Characteristics of Soil in the Study Area

The Government of Mali implemented the Soil Resource Inventory Project (PIRT: Projet Inventaire des Resources Terrestres) in 1983 jointly with the US Agency of International Development (USAID). The main analytical items are described below. The information on these items is not so different from the current conditions because the properties of the soil do not change in a short time.

1) Categories of soil properties (physiographic landform, texture of top soil and subsurface)

The soil areas by soil type in the study area are shown in Table 3.8.1. Most of the study area is accounted for by Alfisols. The soil type distribution in the study area is shown in Figure 3.8.1. Alfisols is often seen in the tropics where there is a definite dry season. About two-thirds of the soil type area is accounted for by Ustalfs that is dried for 90 days or more a year and the remaining soil is classified into Aqualfs that is saturated with water or subject to inflow for a certain period.

Generally, Alfisols has potentiality to increase production through improvement of the soil and fertilizer management. However, it has the disadvantage that it may erode the soil if the growth of vegetation is poor under very dry conditions.

Table 3.8.1 Soil Areas by Soil Type in Study Area

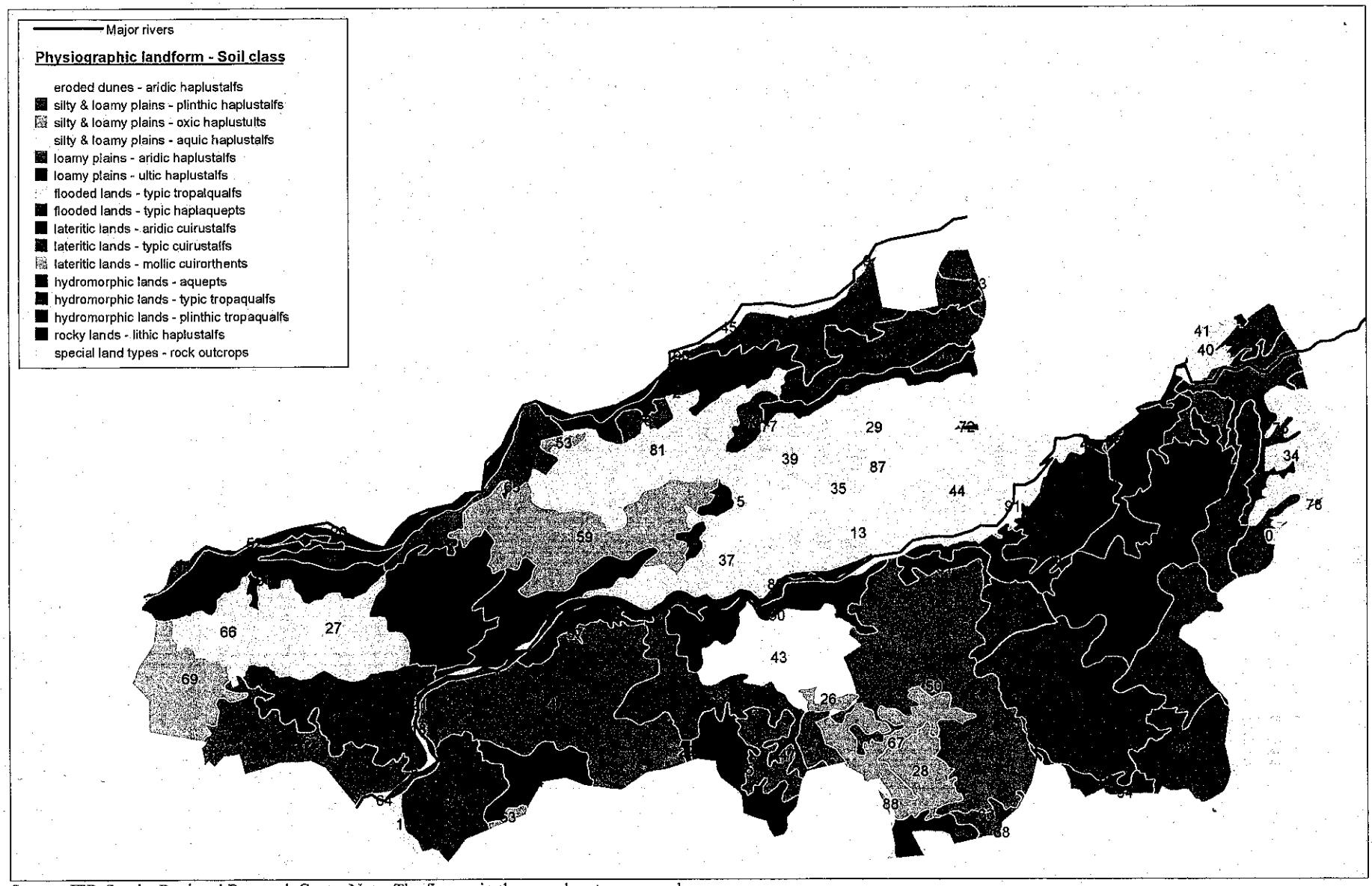
Soil Type	Area (ha) in Study Area	Percentage (%)
Alfisols	2,690,301	85.5
Entisols	178,543	5.7
Inceptisols	188,815	6.0
Ultisols	81,419	2.6
Aridisols	6,268	0.2
Total	3,145,347	100.0

Source: IER

2) Soil depth

The soil layer in the study area is generally deep (100cm or more), but some areas have a shallow (25cm or less) soil depth in Baraouéli cercle and in the south of San cercle.

Figure 3.8.1 Soil Distribution in Study Area



Source: IER-Sotuba Regional Research Center Note: The figures in the map denote area numbers.
Note: If the suffix is -alfs in the soil classification (example: haplustalfs), it denotes that the soil is Alfisols.

3) Soil erosion and present state of soil erosion

Degree of soil erosion is affected by the following four factors.

① Physiochemical property of soil: Soil property, soil structure, organic contents, and so on
② Climate and meteorological factors: Wind strength, precipitation and strength of rainfall
③ Topographical factors: Slope of field and length of slope
④ Coating of soil surface: vegetation, accumulation of organic matters, and mulch

In the analysis of soil erodibility levels based on the above factors, the following can be pointed out:

- Slopes in the study area are not very steep, and the present condition of erosion and the erodibility level are evaluated as low to middle level.
- The area which is at middle erodibility level includes the southwest of Baraouéli, the west of Bla, the area along the Niger River in Macina, the basin of the Bani River, the northeast and south of San and the south of Tominian. The area almost overlaps the relatively steep slope area.

(2) Actual Conditions of Soil Erosion

1) Water erosion

The study area is flat terrain in general, and has little trace of gullies or rill erosion. Interviews in the field provided some information on the parts where soil erosion (especially in farmland) is taking place even in the area that has been evaluated as low erodibility level in the above analysis. In the study area, sheet erosion has expanded widely. Care should be taken because it is invisible and apt to be overlooked. The difference with the above results of soil analysis (1) is deemed to be caused by ongoing vegetation changes due to disorderly tree cutting and excessive grazing.

2) Wind erosion

In the study area, strong winds that blow before rainfall are the cause of wind erosion. Generally, the faster the wind speed near the ground surface, the more the resultant wind erosion. Thus, flat and denuded land, having nothing to block winds, is extremely susceptible to erosion. A typical example in the study area is a millet field in the early phase of the rainy season. In particular, the sandy soil is most influenced.

Although only a few reports exist on specific values of wind erosion damages, the area from lat. 10° to 14° N including the study area is estimated to have wind erosion damages of around 10 to 50 t/ha per year[1]. In contrast, water erosion damages are estimated to be 5 to 40 t/ha per year. Obviously, wind erosion has influence comparable to water erosion.

Soil carried by winds from fields moves and accumulates around nearby trees and obstacles and in grassland, where the surface roughness is high and the wind speed lowers. In other words, wind erosion advances in denuded fields while soil accumulates in fallow fields and grassland. Soil is not absolutely lost but gets distributed in different locations.

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[1] Lal,R., 1993. Soil erosion and conservation in West Africa. World soil erosion and conservation (Primentel, Dd). Cambridge University Press: 349