

Vol. 1 Technical Guide: Project Planning to Combat

Desertification

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Chapter 1 Introduction

1.1 Background

In the Sahel, a region characterized by areas where desertification is already progressing or is expected to soon begin, a variety of countermeasures are required. These include maintenance and improvement of productivity in agricultural lands, increasing food production, environmental preservation, and alleviation of poverty. However, because the countries of the Sahel are under severe financial conditions due to delays in industrial promotion and development of underground resources among other problems, many measures to prevent desertification are being implemented based on international support from bilateral or multinational assistance or NGOs. Unfortunately, however, the conventional countermeasures that have been implemented through this assistance have not shown sustainable results due to a number of factors, including residents' lack of awareness of the issue and their lack of inexperience in maintaining and managing facilities. This is in addition to overemphasis on technical solutions and lack of attention paid to the will of local people. This situation has led in recent years to internationally recognized application of a method known as *Terroir Management (Gestion du Terroir)* in the Sahel. This method, which covers the formulation of plans through to the implementation of projects and is based on local people's participation, is being applied to development at the village level.

When implementing sustainable measures against desertification, it is important to lend support to the formulation of plans by residents of the region based on an understanding of the above-mentioned situation.

**Terroir Management*

The use of *Terroir Management* has spread widely in recent years with the realization that rural development programs conducted by governments are not sustainable. *Terroir Management* is a participatory approach in which local people analyze the natural resources in their *terroir* (residential area), formulate a project for their use, and then implement, manage, and evaluate the project. This method is applied to almost all the development projects at the village level in the Sahel.

Terroir Management was adapted as a realistic measure for the prevention of desertification at the "Conference on Strategy to Combat Desertification in the Sahel Region", held in Nouakchott, Mauritania, in November 1984. It is being used by the Government of Niger as the basis for its desertification countermeasures and rural development.

1.2 Objectives

Based on the large number of measures related to combat desertification carried out in the Sahel until now, the Japan Green Resources Corporation (JGRC) has conducted a study on desertification countermeasures in Niger over the past 10 years. JGRC has also conducted similar studies with the participation of local people in Burkina Faso and Mali. JGRC has prepared this guide as a means of presenting the technology and know-how it has gained through these studies to technical personnel that will assist local people who are attempting to formulate development plans for public participatory countermeasures against desertification. However, it should be remembered that this guide is not intended to be an authoritative document on the specifics of plan formulation. It was prepared based on the presumption that plans will be formed after the relevant issues are clarified, and that planning methods will be constantly improved based on regional conditions and responses gained from local people.



Aiming to restore pasturelands by building stone boundaries.

Chapter 2 Development Principles

In order to promote development through *Terroir* Management, the residents of the *terroir* must take it upon themselves to understand and analyze natural conditions in the region as well as social and economic factors, and they must firmly conceptualize the necessity and content of their own countermeasures. Accordingly, it is important to establish development principles, such as objectives and policies, in order to effectively implement this process.

2.1 Development Objectives

Based on discussions held with the residents of the *terroir*, issues to be solved and objectives should be established so that environmentally destructive farming can be replaced by sustainable farming and a basic living environment can be established for local people. During this process, it should be kept in mind that the will of the local people has priority.

As is shown in Figure 2.1.1, desertification in the Sahel has been progressing due to both human factors (such as over-cultivation and over-grazing as well as excessive collection of wood for cooking fires) and natural factors (such as decreasing rainfall and frequent occurrence of droughts). Furthermore, reclamation of fields that were fallow or relatively unused in order to produce food in the face of poverty and an expanding population has had the effect of accelerating the desertification process. While in previous times, it was possible to move to new lands when crop production fell due to poor soil quality, the rapid population growth in the region has meant that this is no longer possible. Accordingly, as a means of preventing the further spread of desertification, it is necessary for local people to settle in a particular area; to gain a full understanding of environmental problems that are closely connected with food production, livestock feed, and collection from fuelwood forests (in other words, problems that arise from imbalances in supply and demand); to recognize the importance of desertification countermeasures; to have a clear sense of objectives in carrying out these countermeasures; and to become involved in development projects. It should be noted that, when establishing objectives, the amount of time that will be needed should be set based on consideration of the content of the proposed project.

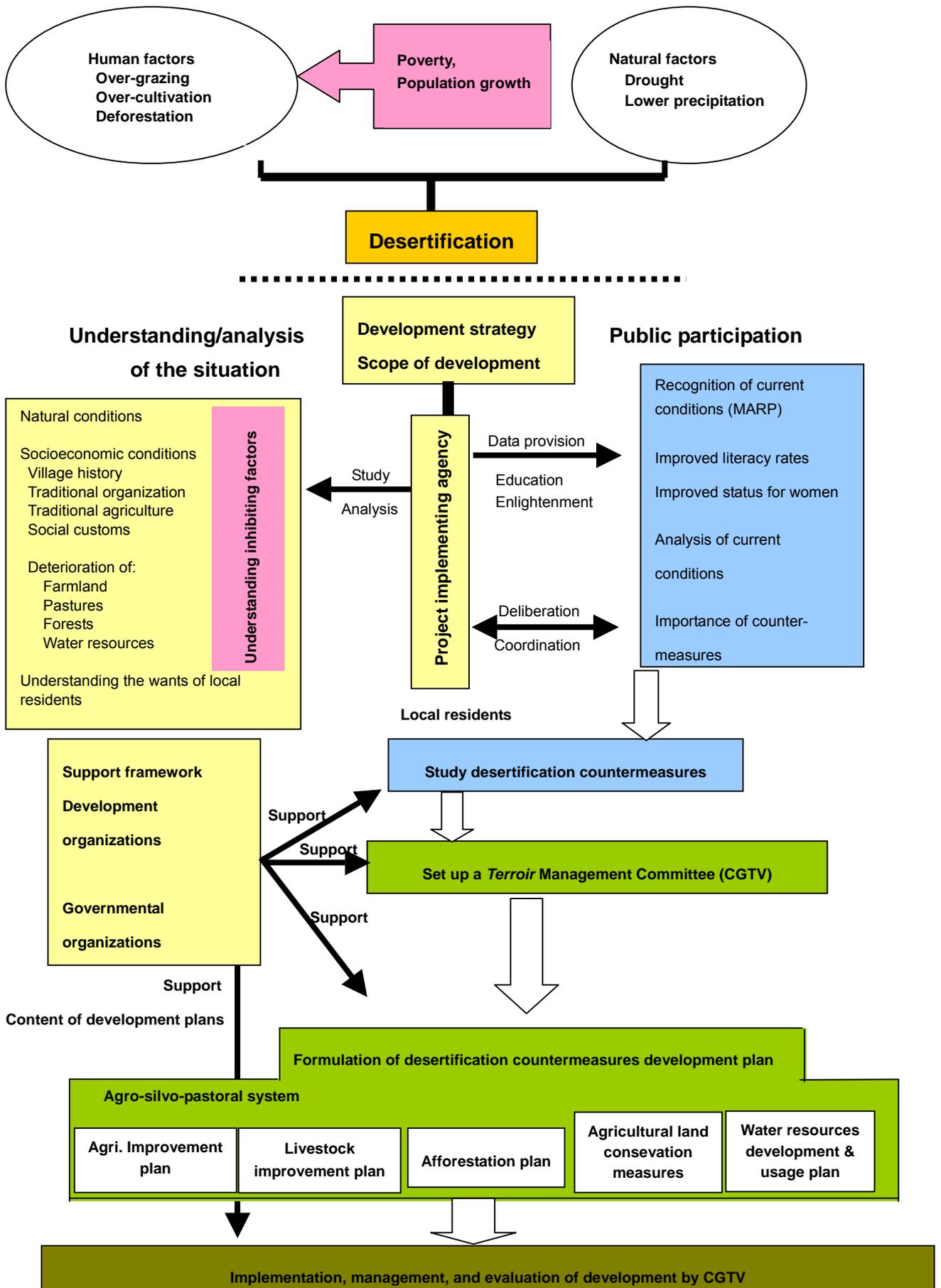
2.2 Development Strategies

After development objectives are identified, a basic development strategy should be clearly articulated that outlines the methods that will be employed to reach these objectives.

2.2.1 Basic Strategy

Traditional development led by governments failed to lead to sustainable development because they placed priority on technical measures and did not seek participation from the local people that would benefit from development. This was despite the fact that the problem of desertification is rooted in the social and economic mechanisms of the region. In response to this situation, *Terrior* Management (*Gestion du Terroir*)—whereby local citizens recognize the importance of their own involvement in activates, take the initiative in analyzing the natural resources in their *terroir* (residential area), and become involved in all parts of the development process, from selection of countermeasures and formulation of plans to implementation, management, and evaluation of projects—has been emerging as the basic development approach in recent years.

Figure 2.1.1 Process of Project Planning to Combat Desertification



The local people of the Sahel Region, having been left behind in efforts to introduce and extend new technologies, subsist on low-level agriculture, livestock raising, and forestry activities based on traditional skills. Furthermore, low education levels mean that local people have difficulty understanding, analyzing, and formulating measures to deal with current conditions. It is therefore important to construct a strong support system made up of such bodies as governments, project implementation agencies, and regional NGOs that can provide thorough guidance and education to local people. In addition to specific strategies for regional development, the entities involved should support local people's efforts to formulate effective development plans for combating desertification as a basic policy.

2.2.2 Establishment of the *Terroir* Management Committee

As was mentioned in "Development Strategies" above, *Terroir* Management, which is based on community participation, is a prerequisite for village-level development. As is shown in Figure 2.1.1, planning of desertification countermeasures and implementation of these countermeasures are carried out through establishment of a *Terroir* Management Committee (*Comité des Gestions Terroirs Villageois*, hereinafter referred to as "CGTV"). CGTVs are founded based on local people's understanding and analysis of current conditions. Because, together with formulation of anti-desertification plans, a support structure is established that provides enlightenment to local people and education to human resources, smooth management of the CGTV becomes possible. In this way, local people gain a sense of "ownership" and "empowerment" for development.

2.2.3 Content of Development

Conditions facing local people in the Sahel vary according to location. Because of this, the content and priority of development change drastically according to social conditions, such as the long-established living habits of local people and historical trends. This means that there are myriad issues to consider in development to combat desertification. These range from measures to improve agricultural, livestock, and forestry activities; agricultural land conservation strategies to prevent erosion; and establishment of water resources and irrigation facilities for irrigated farms to establishment of basic infrastructure (such as roads and educational and public health facilities); and establishment of lending mechanisms, grain banks, and mills as means to support local people.

Development cannot be expected to be sustainable if it does not go hand in hand with the participation and cooperation of local people (at their own responsibility*) as well

as efforts to improve technical capacity. A major trend in development of recent years has been use of a participatory method whereby, after developing local people's awareness regarding local conditions, the parties involved determine the needs of local people for a project and have local people themselves decide the content of development based on respect for priorities. Then, these parties have local people implement the project and manage it after development is completed. However, major infrastructure that forms the backbone of a region cannot be established through the work of local people alone. Accordingly, it is important to clarify the roles of national and regional development strategies and to promote public participatory activities that are in line with these strategies.

*Local people have great expectations for development. That is why, in the interest of avoiding local people's overdependence on the supporting party when implementing a project, it is important to provide clear instruction on the scope of the project, local people's duties and obligations to the project (in the beginning, primarily provision of labor), and their responsibilities for managing the project in a sustainable manner. At the same time, it is important to foster local people's capacity to absorb development.

2.3 Scope of Development

2.3.1 Defining the Scope of Development

Based on consideration for the concept of "community participation", it has become a common development trend to form a single *terroir** made up of one to several villages that have a strong sense of fellowship when defining the scope of development. By doing this, the residents of the community themselves are able to take responsibility for the development process involved in management of natural resources in the region, and they are thus able to engage in *Terroir* Management. However, because various tribes may live together in the community, there may be cases in which one tribe has a superior position over the others. It is therefore necessary to study the historical and social background of the target villages and to take a fine-tuned approach that takes into account development sustainability.

* *Terroir* is defined here as an area containing farmland, fallow lands, forests, pastures, and open fields that are managed by the village a traditional community within the village.

2.3.2 Confirmation of the Scope of Development

When establishing the scope of development, it is important to understand limiting factors in the area, such as geographical location, potential of farmland and forests,

living conditions of local people, etc.

Detailed topographic maps do not exist for most villages in the Sahel. That makes it necessary to conduct surveys using aerial photographs and GPS equipment (to determine village boundaries) and to interview village leaders, elders, and property owners in order to determine the scope of the site. There will also be cases where the borders between villages are not firmly established or where neighboring villages share land. In particular, it is necessary to confirm the borders with a neighboring village if facilities are to be built in an area close to a border. This is important from the standpoint of avoiding trouble with regard to land use when implementing development.

Furthermore, it is important to avoid future conflict between villages that are implementing development and those that are not. Based on this, one way of effectively promoting projects is thought to be the carrying out of certain activities in surrounding villages by classifying villages into two types: base villages and supporting villages.

2.4 Relation to Other Development Plans

A survey should be conducted in the target region to identify development projects that are currently under way as well as those that are completed. If it is found that a project is under way, a study should be undertaken to ensure that its objectives do not overlap with the planned project and to determine possibilities for coordination.

Furthermore, if there are areas in which the relevant support agency does not have plans for development, it might want to collaborate with other development agencies that can cover these areas.

Also, it is important to confirm whether or not development projects are being carried out in neighboring regions. For example, if a "Food for Work*" program or other project is underway whereby local people receive food as compensation for work, the local people in nearby projects may ask for similar treatment. In some cases, this may result in lower will and capability of the local people of the relevant village to work. Also, large disparities in the compensation offered by the projects may lead to dissatisfaction among local people, which may result in their refusal to cooperate with development. This is one of the most important things to keep in mind at the beginning of a project if the support agency hopes to promote its project based on partnership with the community.

***Regarding “Food For Work”**

The “Food for Work” program of the World Food Program (WFP) is a form of public participatory development that provides food without monetary charge. At times, provision of food to local people simply as compensation for development-related labor can lead to dependence on the program as a means of obtaining food — without urging their involvement in active measures to combat desertification. However, in cases where food supplies become depleted due to drought or other conditions, thereby making it urgently necessary for local people to participate in development projects, employment of the Food for Work program is sometimes unavoidable. At such times, local people’ full understanding of the reasons for the program must be obtained. Accordingly, it is necessary to fully consider the conditions that the local people are facing and to take a flexible approach. It must also be remembered that this approach may lead to serious difficulties in the future.

2.5 Relation to National and Regional Development Plans

2.5.1 Coordination with Superordinate Plans

In regions in which development is planned, studies should be carried out to determine whether superordinate plans applying to the region exist. Such plans may take the form of national or regional development plans; agriculture, livestock, and forestry plans; or public investment programs.

Rather than having development agencies formulate their own plans in an individual and uncoordinated manner, it is better from the standpoint of widespread effectiveness to bring these plans into accord with those that were formulated by national and local government bodies. In order to do this, it is necessary to prepare a strategy that brings these different plans into conformity when implementing development. Furthermore, when formulating plans, it is important to engage in sufficient coordination with the government body having jurisdiction over the relevant region beforehand and to confirm the priority of the planned project as well as possible areas of coordination, etc.

While it is possible for a development agency to implement a project on its own, a relationship with government bodies responsible for extension and other activities is essential in post-project follow-up. In fact, it is important to get the government to take responsibility for a number of different aspects, including the necessity for personnel support and follow-up for organization of local people following development; improvement of agricultural, livestock-raising, and forestry skills; and mastery of resource management. However, this relationship must be tied to quick realization of development results and their sustainability.

2.5.2 Convention to Combat Desertification (CCD)
(omitted)

Chapter 3 Current Conditions in the Area

When preparing development plans for the Sahel, it is extremely important to consider natural and socioeconomic conditions, as there are many cases in which development efforts have been unsuccessful because failure to consider these conditions resulted in nonparticipation on the part of the local people. In order to avoid repeating this kind of failure, it is important to fully understand natural and socioeconomic conditions, to analyze these conditions, and to formulate a plan that is harmonized with the region.

This chapter will present a number of items related to current conditions that should be understood when developing plans to tackle the issue of desertification. These items should be well known to project implementation agencies that intend to support development plans drawn up by local people, and they are useful as data that can be provided to local people. The items should also be kept in mind when conducting educational and enlightenment programs aimed at local people.

3.1 Natural Conditions

Analyses of topography and resource distribution, which are the most basic characteristics of the village, should be carried out as well as efforts to understand the amount of natural resources available (such as land and water in the region). Furthermore, development plans (such as basic infrastructure plans) should be used as fundamental sources of information. All of these are also useful as references when conducting education programs designed to help local people manage their *terroir* on their own.

3.1.1 Climate, Surface Water and Groundwater

In order to formulate water resources and irrigation development plans, it is important to gather and study data on such items as temperature, precipitation, humidity, evapotranspiration, wind speed, water levels of rivers and marshes, and groundwater levels.

The Sahel, which has an average yearly rainfall of between 250 and 750 mm, has an evapotranspiration rate that exceeds precipitation. It is therefore classified as a semi-arid region. There is a clear distinction between the rainy season and the dry season, and water resource levels vary greatly depending on the time of year. Areas that are covered by surface water throughout the year are limited to very large rivers and lakes. In much of the region, it is not uncommon to see water temporarily appear in wadis and small marshes from the rainy season into the beginning of the dry

season.

Groundwater is classified as artesian water or unconfined groundwater. Unconfined groundwater is further classified, depending on its location, as stratum water in aquifers made up of alluvium, etc., or water in cracks in the bedrock. Unconfined groundwater is a highly cyclical resource that is greatly affected by rainwater seeping from the surface to underground areas. This makes its sustainable use possible if appropriate water intake measures are followed.

In areas of the Sahel that are located along major rivers, irrigation using river water occurs. On the other hand, however, most areas that are distant from large rivers have almost no large-scale water use facilities. People living in these areas use unreliable sources of surface water (such as rainwater or marsh water) or groundwater obtained from wells. In terms of drinking water, there are many problems associated with water quality that are in addition to shortages. There are also many areas where water for livestock is lacking.

3.1.2 Topography, Geology, and Soil

While preparing an effective land use plan that is based on an understanding of natural conditions, it is important to gather existing materials (such as maps, etc.) in order to formulate a plan for development of water resources, etc. Furthermore, on-site investigations should be carried out on topography (swamps, hilly areas, flatlands, plateaus, inclines, corrie/wadis, etc.), geology, soil, etc.

Topography studies should use on-site investigations to gain an understanding of boundaries between related village *terroirs*, the size and location of wadis and corrie, and inclines. And, using topographical maps of the appropriate scale (1:1,000 to 5,000), measurements should be made of the scale and area of the discharge basin for each wadi for notation on the map along with the results of regional conditions identified by the study. Also, information on sloping areas is important in selecting methods for constructing countermeasures to deal with these inclines as well as location and distribution of these countermeasures, and therefore these areas should be indicated using an appropriate classification system (for example, 0 to 2°, 2 to 8°, 8° and above). Also, knowing the size and location of wadis and corrie is important when determining the priority of facilities as well as numbers/locations of bed consolidation facilities when implementing measures to stop expansion of flow channels or erosion countermeasures. For this reason it is important to measure the width and depth of inclines in order to gain an understanding of the degree of erosion. Using existing materials and on-site inspections, geologic surveys should classify areas of sandy soil, clay, and rock while at the same time studying and making

notation of surface conditions (such as whether or not there is a crust, etc.). When developing groundwater, it is important to classify aquifers and to determine their size. This information is used when studying the scope of an area to be targeted for activities, to select appropriate construction methods, and to examine places for construction.

Knowledge of *terroir* boundaries is employed to clarify the region that requires activity as well as the villages that will be involved in said activity, and when implementing public participatory action plans.

3.1.3 Land Use

A study on current land use conditions and vegetation should be carried out for preparation of a land classification map. Also, efforts should be made to determine how fallow lands are established, how farming is carried out (rainwater fields, irrigated fields, or paddy), and use of pasturelands and forestry (forests, fuelwood forests, etc.). Use of floodplains and possibilities for farmland development should also be studied. Transhumance in the region should also receive attention.

In classification of land, diagrams and other materials should be prepared as needed on 1) current use of vegetated lands, 2) soil classification, 3) slope classification, 4) fallow lands, 5) unused lands, and 6) productive lands. These materials are used in preparing effective and comprehensive land use plans for the region.

In traditional farming, a pattern of five to six years of grain cultivation followed by a fallow period of 10 or more years was adhered to so as to increase the land's capacity. However, the area of land used for cultivation has continued to expand in line with population growth, and because of this, the area of land set aside as fallow has dropped severely, which is leading to deteriorating land productivity.

3.2 Social Conditions

Social conditions such as village history, tribal composition, population, and customs can have a large impact on decisions regarding regional characteristics, selection of technology to be employed, and operation and management of facilities when preparing development plans. Accordingly, it is important to conduct a prior study on village conditions in order to formulate a development plan that is suitable for the region.

3.2.1 History

A study should be implemented that covers the history of the village, as this is a means for understanding the background behind movement and settlement of local

people, family lineage of village leaders, confrontations that have led to conflicts in the past, master-servant relationships, etc.

Villages can be composed of a single tribe or be a mixture of various tribes. In addition, it is possible that those living in the village have a complex relationship with each other (e.g., mixed neighborhoods of settled and migratory residents, master-servant relationships, language differences, differences in traditional occupations, etc.). Therefore, it is necessary to study the history of the village in order to learn of the above-mentioned relationships before a project begins so that obstacles to development can be circumvented.

3.2.2 Tribes and Village Composition

(omitted)

3.2.3 Religions

(omitted)

3.2.4 Populations and Households

(omitted)

3.2.5 Social Stratification

It is important to study regional social systems and village structure with regard to elderly/young people, men/women, farmers/livestock raisers, and other forms of social organization and heredity-related strata. This is in order to learn of the placement of local people within the social structure as well as their roles so that a plan can be formulated that is in harmony with the region.

1) Outline of Social Stratification

In general, villages and all of the lands associated with villages are traditionally ruled by a leader or a group of village elders, and village residents have no democratic voice. Furthermore, women have low status in the community; they are considered to be subordinate to the head of the household and their husbands, and they take on much of the hard work required for daily living. The heredity-based social classes that one may find in a region include blacksmiths, ceramists, furniture makers, weavers, storytellers, and former slaves. While these classes no longer have institutional importance, this social structure and custom are still firmly entrenched in regional society. Furthermore, it is said that marriages between persons of a hereditary-based class and those of the free class are rare.

In Burkina Faso, a system is in place whereby a locally born resident is appointed and installed by a governor to serve as his legal administrative representative in the village. This representative, known as a “*déligué*”, takes complete authority from the traditional village leader for all village lands, and this sometimes results in conflict with the traditional village leader.

2) Apportionment of Labor

Apportionment of labor is determined by the head of the household or his wife. Roles are generally determined according to gender, with men being engaged in productive, religious, or political activities. Women are charged with household duties (cooking, laundry, drawing of water, collection of firewood, children’s education) while at the same time helping in farm work, making handicrafts, etc. Children from the ages of six or seven also help in drawing water and collecting firewood. When the average daily working time for women is longest, there are times when they must work 10 hours or more each day.

3.2.6 Status of Organization of Local People

(omitted)

3.2.7 Language and Literacy

It is important to gain knowledge of the primary languages used by each tribe in the target region so that education and enlightenment programs can be directed at local people. Furthermore, it is important to identify the extent of illiteracy among local people, as this will have a major impact on the success of development.

1) Regional Languages

The official languages of the countries of the Sahel are French (with English and Portuguese used in some regions) as well as the major regional languages. However, in actuality, the overwhelming majority of residents in the region use their local language.

In Niger, the Hausa tribe uses Hausa when conducting business, and 60% of the nation’s citizens speak this language. Other languages used include Djerma, Gourmantche, and Puhl. In Burkina Faso, Mossi (the language of the Mossi tribe, which makes up the majority of the population) and Dhila are spoken. And in Mali, the major local languages include Bambara and Songhai. In addition, there are many other languages that are spoken depending on the local tribe.

2) Literacy

In recent years, the number of people learning to read and write through school education is increasing, and this is improving the literacy rate. However, shortages in teachers and the fact that local people are spread out over a large area have slowed the establishment of schools. This means that, in all countries of the region, only some 25 to 30% of elementary school-age children actually attend classes.

Also, the literacy rate is lower in rural areas than in urban areas, and women have a lower literacy rate than men. In rural areas, people who have attended schools or who have traveled to cities to find work can speak rudimentary French; however, the number of people with a firm understanding of the language is extremely small.

The ability to read and write has a major impact on whether or not development that is introduced to a region, as well as efforts to promote management of development by the community itself, will succeed. From the standpoint of securing key persons that will take the lead in promoting organization of local people, it is important to study the degree to which education and extension can be carried out in the community at the earliest stage of a development plan.

Table 3.2.7.1 Basic Education Attendance Rate, Adult Literacy Rate, etc.

Country	Compulsory education (age)	Years	Tuition	Attendance rate	Adult literacy rate
Niger	7 to 15 yrs.	7	None	23	13.1
Burkina Faso	7 to 13 yrs.	6	"	29	18.7
Mali	6 to 14 yrs.	9	"	25	29.3

*Basic education attendance rates and adult literacy rates were taken from *Poverty and Human Development* (United Nations Development Program [UNDP]); school attendance rates are the percentage of children attending elementary school from 1993 to 1995.

*School System in Niger

In Niger, children attend basic education schools for six years, beginning when they are 7 years old. While the attendance rate is extremely low at 23%, the rate of those who actually graduate from school is even lower. Furthermore, the attendance rate for girls is very low, with some documents indicating that it is only 36% that of boys. Children who graduate from elementary school can continue to secondary education if they pass an entrance examination. Secondary education is made up of a four-year period (known as *college*) that is followed by a three year period (*lycée*). After graduation from secondary education, those that pass the necessary admission requirements (obtain a *baccalauréat*) can go on to university. Education up to the

age of 15 is free; however, worsening financial conditions in Niger and rapid growth in the number of school-age children has resulted in a situation whereby educational facilities fall short.

3.2.8 Infrastructure

When initiating development, it is necessary to conduct a study on basic facilities in the village—such as roads, water use facilities (wells and reservoirs), electrical and communications facilities, and facilities connected with living environments—and to comprehend the degree to which these facilities meet demand. This study should establish the conditions surrounding primary facilities, such as location and construction, year of construction (as well as the builder), degree of deterioration, etc.

1) Roads

Major roads in the Sahel are paved (asphalt or laterite), however lack of funds means that these roads are insufficiently maintained. As a result, wear and tear is quite evident. Other roads linking villages are rural roads (known as *pist*) that are almost always unimproved, making it difficult to transport farm products and materials. In addition, the number of roads that are impassable increases greatly during the rainy season.

2) Water Use Facilities

While water use facilities are relatively well established in urban areas, drinking water facilities in rural areas are insufficient. Although small pools can be seen (although only rarely), they are used for livestock or irrigation. Facilities and water ways for drawing water are nonexistent at pools, meaning that water is principally drawn through human labor. On rare occasions, use of small pumps that were supplied by NGOs or other organizations can be seen.

Wells are used for drinking water or for livestock, and sometimes for both. With the exception of some small areas along the Niger River, local people depend almost entirely on wells for their drinking water. Marsh water is generally used for livestock, however wells are used in areas where surface water is hard to obtain. It is not uncommon to find that these wells are suffering from decreased function, burial by sand, or other problems that lead to water shortages.

3) Electrical and Communications Facilities

Almost no villages in rural areas of the Sahel are serviced by electricity or gas. Therefore, almost all cooking in homes is carried out using firewood or charcoal. Likewise, telephones and televisions are almost never seen in rural areas. However,

the availability of local-language broadcasts means that a fairly large percentage of farming households own radios. In Mali, technical guidance relating to development projects is sometimes provided to farming households over the radio.

4) Facilities Related to Living Environments

The average life spans at birth, mortality rates of children under five, and mortality rates for pregnant and parturient women for the countries in the Sahel are as shown in Table 3.2.8.1. In looking at the Figure, it is obvious that all of the countries of the region rank extremely low among the nations of the world. In addition, the countries of the Sahel lag far behind other countries in terms of infrastructure that supports daily living, such as educational facilities, hospitals, medical clinics, pharmacies, etc.

At least a minimum amount of facilities that support daily living is needed in order for people to get on with the business of everyday life. While people in all areas require access to all services related to daily life, the number of people receiving such services in the Sahel in particular is extremely small. Furthermore, people's living environments are made that much harsher by the fact that roads and transportation systems in these areas are exceedingly underdeveloped. In addition to establishment of living environment-related facilities, there are a myriad of measures that must be taken in these countries, including those that target food supply and poverty, which have a direct effect on the health of people in the region.

Table 3.2.8.1 Living Conditions in the Sahel

	Life expectancy at birth	Infant mortality rate (per 1,000 births)	Mortality rate for children under five years of age (per 1,000 births)	Mortality rate for pregnant and parturient women (per 1,000 births)
Mali	53.3	145	239	1,200
Burkina Faso	44.4	110	169	930
Niger	48.5	191	320	1,200
All developing countries combined	64.4	64	94	491

*1997 figures from *Globalization and Human Development*, UNDP

***From Torodi (Niger)-Ogori Data**

Health care facilities in the village of Torodi, Niger, comprise of only one medical clinic attached to the medical precinct of Say and three rural health bureaus. The one medical facility in Say must serve the needs of some 31,000 people. On top of this, only approximately 35% of the people using health care facilities live within 5 kilometers of these facilities. This means that 65% of local people live in distant areas, which makes it difficult for them to receive modern health services.

***From CONAGESE (Conseil National pour Gestion de l'Environnement, Burkina Faso) data**

Despite the fact that the infant mortality rate stands at 30%, there is only one doctor to serve some 4,100 residents. Approximately, 30% of all children and women suffer from malnutrition, with from 1 to 5% suffering from severe malnutrition.

3.2.9 Consumption of Resources in Daily Living

For the people living in the Sahel, procurement of food and firewood is one of the most pressing problems. Accordingly, studies should be carried out to gain an understanding of current supply and demand of daily-living resources as well as future supply and demand.

1) Grain

It has become possible to obtain the food needed to feed the growing population in the Sahel by converting fallow lands and pasturelands to farmland. However, this has led to continuing losses in lands that are traditionally held fallow (fields that are allowed to rest for a certain period of time following harvest in order to improve the soil's capacity) as well as losses in per-unit productivity due to continuous cultivation of single grain crops without fertilizer. Development objectives in the Sahel are dependent on how food self-sufficiency can be obtained, and all strategies must include some mention of food procurement.

It is important to know the per capita amount of grain that must be consumed to support daily living, as this serves as data when examining future supply and demand of food. While this amount serves as a basic value for predictions made in national and regional planning, it should be remembered that various forms of data exist and that consumption rates vary according to whether people live in urban or rural areas, or are farmers or livestock raisers.

Consumption rates for grain as studied by JGRC over a two-year period in the village of Magou are as shown in Table 3.2.9.1.

In the JGRC study, the per capita amount of grain consumption covered a

considerable range, but averaged at 250 kg/year. Data released by Tillaberi Department, in which Magou is located, in its “National Environmental Plan for Sustainable Development” shows that the per capita grain consumption rate in rural areas is 250 kg/year, while that for urban residents is 200 kg/year.

Food programs in the countries of the Sahel generally contain the objectives mentioned below. It is believed that the necessary calorie intake of a person engaged in farming activity is 2,300 kcal per day, of which 80% comes from grain with the remaining 20% being obtained from meat and fats. This means that 1,600 kcal are obtained from grain. If converted into the amount of millet and sorghum ingested, this means that the person consumes 550 grams of millet and 685 grams of sorghum. If these figures are computed out over the course of a year, the person would eat 200 kg of millet and 250 kg of sorghum each year. And, in precise terms, people living a nomadic lifestyle consume a relatively high amount of dairy products, which means that the amount of grains that they consume is lower, while farmers with few livestock consume slightly more grain. Also, overall necessary calorie intake varies depending on how children’s intake of calories from grain is reflected on it.

In 1999, the Farming and Livestock Ministry in Mali issued a master scheme for the rural development sector entitled *Schéma directeur du Secteur Développement Rural (1999)*. This report noted that the average amount of nutrition supplied to each person in 2000 is 2,450 kcal per day, of which 98% is obtained from grain crops. Burkina Faso’s plan for the Sahel uses a basic value for necessary grain amounts of 190 kg per person per year (SP/PANE data, 1995).

Table 3.2.9.1 Study on Grain Consumption Amounts (Mague, Mali)

Farm household	Measurement Study in Farm Households						
	Grain consumption during study period	No. of days	Per day consumption (family)	No. of family members	Daily consumption per person	Yearly consumption per person	Yearly consumption per family
	kg	Day	kg	Person	kg	kg	kg
M-1	171.2	28	6.1	12	0.510	186	2,232
M-8	293.9	28	10.5	21	0.500	182	3,831
M-19	273.8	28	9.8	15	0.652	238	3,569
M-15	235.4	28	8.4	10	0.841	307	3,069
M-17	136.0	28	4.9	5	0.971	355	1,773
M-24	143.1	28	5.1	8	0.639	233	1,865
Average			7.5	11.8	0.630	250	2,723

2) Use of Firewood

Approximately 95% or more cooking fuel used in homes in the Sahel is firewood. And, as might be expected, the amount of firewood needed has been growing in recent years in proportion to population increases. This growing consumption of firewood is resulting in an increasingly negative effect being placed on the environment. Although gas and other fuels are widely used in urban areas, the fact that firewood tends to be cheaper than fossil fuels means that many families still use firewood for their cooking fuel. Because of this, the firewood industry, which supplies to urban consumers, has become an important source of cash income in rural villages that are near cities. This is resulting in a situation whereby not only local people but also firewood collectors and salespersons are involved, and this is increasing the pressure being placed on forests. Firewood consumption rates as studied by JGRC over a two-year period in Magou are as shown in Table 3.2.9.2. In this study, JGRC observed that firewood is consumed at a rate of approximately 439 kg per person per year. However, differing amounts are paid for firewood use even at the household level, and these amounts fluctuate during the dry and rainy seasons. Because indoor cooking increases during the rainy season, use of charcoal tends to increase to a certain degree. For this reason, the figures in the Figure are presented only as an example.

Looking at standard values in the Sahel, a study report by the World Bank indicates that local people in West Africa and the Sahel consume dry firewood at an average rate of 1 kg per person per day. In addition, data released by Coordination and Engineering Committee for Improved Ovens (*Cellule technique Coordination Foyers Améliorés*) in Niamey uses the following values: rural areas: 0.8 kg per person per day; urban areas: 0.6 kg per person per day. Data for areas of Burkina Faso that are in the Sahel use 0.8 m³ per person per year

Table 3.2.9.2 Study on Firewood Consumption Amounts

Farm household	Measurement Study of Firewood Consumption in Farm Households						
	Firewood consumption during study period	No. of days	Per day consumption (family)	No. of family members	Daily consumption per person	Yearly consumption per person	Yearly consumption per family
	kg	Day	kg	Person	kg	kg	kg
M-1	284.0	28	10.1	12	0.845	309	3,702
M-8	328.5	28	11.7	21	0.559	204	4,282
M-19	315.3	28	11.3	15	0.751	274	4,110
M-15	413.6	28	14.8	10	1.477	539	5,392
M-17	190.3	28	6.8	5	1.359	496	2,481
M-24	227.8	28	8.1	8	1.017	371	2,970
Average	1,759.5		10.5	12	1.001	439	3,823

3.3 Economic Conditions

It is important to study basic characteristics surrounding the regional economy and farming, livestock, and forestry activities, as this produces material for preparing sustainable development plans that conform to the region.

3.3.1 Regional Industry

(omitted)

3.3.2 Farming Economy

A study of the assets, income, expenditure, savings, work away from home, etc., should be conducted on standard farm households.

A farm household's assets primarily consist of a house, land, grain storage facilities, livestock, etc., and may occasionally include carts, farming implements, bicycles, radios, etc.

In terms of the commodity economy, farm households may buy and sell agricultural products and livestock when food supplies are short because of drought or to buy items necessary for daily living; however, in general, agricultural products and livestock are not bought or sold on a daily basis. Ordinarily, livestock is kept as a form of savings, and it is generally cashed in times of emergency, such as illness or drought-related food shortage. A person having a large amount of livestock is

respected, as livestock is seen as a symbol of wealth and prestige. Accordingly, farming households do not have cash savings, and it is common for families that have extra income to increase their assets by acquiring livestock.

In addition, it is common for families to send one or two of their adult sons to neighboring cities or countries to work during the dry season when grain production is low due to drought or other causes, or when a food shortage is expected. Women and girls have many opportunities to handle money when purchasing food or clothes needed for daily life, and they contribute to the earning of cash. In particular, they weave straw mats (called *tatari* in Niger) and make handicrafts and other items for sale in order to gain cash income to purchase daily necessities.

*** Study on outside work in Magou, Niger** _____

In the dry season, it is common for local people of Magou to travel to the capital of Niamey or neighboring countries (or to nearby goldmines) to find work. This leads to a reduction in the amount of agricultural labor that is available and makes farming difficult. This obstacle to production thwarts efforts toward self-sufficient agriculture.

According to a study on outside work that was conducted in Magou in June 1999, of the 127 families in the village, 17 had members that were working outside the village (total of 19 people). Almost all of these people had gone to neighboring countries, with two going to Niamey, 11 to Benin, three to Ghana, two to Nigeria, one to Abidjan, one to Togo, and one to Cameroon. Looking at age, 13 were between the ages of 14 and 30 (about 70%), making it the largest age bracket. Of these, 6 were 19 years old or less (about 50%). The youngest was 14 years old and the oldest was 59.

3.3.3 Status of Farm Management

(omitted)

3.3.4 Markets and Distribution

It is necessary to study the locations of nearby markets, as well as the conditions and amounts involved in distribution of agricultural, livestock, and forestry products as well as handicrafts, etc., from areas of production to areas of consumption. Then, problems areas must be extracted from analysis of this study while efforts are made to examine possibilities for introducing a commodity economy to the region as well as the best times and places for shipping farm products.

1) Market Survey

A study should be conducted that covers dates and locations of markets, seasonal products, product volumes, prices, etc.

Relatively large villages in rural areas and the principal city in the region hold markets (Marché) regularly, usually once a week. Members of neighboring farm households sometimes travel 10 kilometers or more by foot or donkey to get to these markets, where they sell grain, vegetables, livestock, firewood, etc., as well as handicrafts. In large markets, there are several brokers present who buy grain in bulk. These brokers fill bags with this grain for transport to cities. In Marché, other items necessary for daily living are available, and almost anything can be bought there.

Table 3.3.4.1 Prices of Major Grain Products (in Torodi)

Unit: FCFA/kg

Product	Oct. to Feb.	Mar. to May	June to Sept.	Remarks
Millet	45 - 50	75 - 90	90 - 110	
Sorghum	35 - 40	60 - 70	70 - 85	
Corn	30 - 40	60 - 80	None	

While there are cases where government agencies implement studies in major markets (in Niger), data on rural markets is not generally available in these studies. Therefore, it is necessary to gain an understanding of conditions by gaining the cooperation of local authorities and their branch offices.

The grain stores of farm households are at their lowest just before harvest. Prices rise rapidly during times when the difference between supply and demand is at its greatest. Conversely, prices are at their lowest immediately after harvest, when the largest supply is available.

In the Sahel, livestock is kept as a form of savings and, in general, is not sold unless cash is required. Accordingly, amounts and prices of livestock brought to market fluctuate greatly. Prices are particularly high during the Tabaski festival.

2) Distribution Study

A study should be conducted on routes, methods, transport times, costs, amounts, etc., associated with distribution.

In the Sahel, almost all grain and other agricultural products are consumed to support the family, with only a very small amount being taken from the village to the nearest Marché for sale as a means of obtaining family income. Most of this amount is bought by residents of nearby rural areas; however, major products such as livestock, grain, onions, etc., are purchased in bulk by brokers who ship them off to urban and suburban areas.

Transport of products involves use of bicycles and donkeys in addition to walking. Principal markets are being opened that make transport easy. In production areas with roads to villages, brokers come directly to farms by car to buy dry-season vegetables. That is why farm households in areas with well-developed roads are able to sell their products without having to travel to markets. In general, prices for products in areas with poorly developed roads tend to be lower.

If efforts to increase productivity in these regions are going to be considered in the future, it will be necessary, of course, to improve roads. At the same time, it will be important to strengthen producers' organizations and to establish a shipping system that corresponds with markets.

3.4 Socioeconomic Survey Methods

Surveys on socioeconomic conditions in regions and villages and their implementation methods are as follows.

3.4.1 Survey Procedure

1) Document Survey

When collecting data for a socioeconomic survey, it is first important to study documents covering a broad region, including the target area of the survey, in relevant offices of the central government as well as their branch offices. These documents should include such items as statistical data on the region. There are also research institutes, economic research centers, and other bodies located in the Sahel that have a variety of information. Information should also be obtainable from international NGOs and project implementation agencies that are active in the region. Information gathering in the Sahel generally involves visiting these kinds of offices; however, it should be noted that data on individual villages that are being targeted for development are not well managed, even at city offices that have jurisdiction.

2) On-site Survey

Because it is generally difficult to gather data on the target site through the document survey, it is necessary to conduct an on-site survey. At this stage, it should be remembered that local people of the Sahel have little opportunities to meet with outsiders, and this makes it important from the standpoint of gaining accurate information to ensure that local people have a firm understanding of the objectives of the survey and to proceed based on their consent. Accordingly, the survey should be carried out in two stages. In the first stage, efforts should be made to deepen contact with the local people. During this time, friendly relationships should be established while basic information is gathered. After the trust of the local people is obtained, the

second stage of the survey can be conducted by selecting the individuals and groups that will be targeted for each survey item, and by studying the history of the village; agricultural, livestock, and forestry production; and other items related to living environments.

When necessary, work that includes actual observation should be conducted to confirm information that was obtained through interviews.

There are a number of methods that can be employed when conducting interviews. A representative listing is presented in Table 3.4.1.1. along with notations on the merits and demerits for each.

Table 3.4.1.1 Survey Methods and Merits/Demerits for Each

Survey Method	Merits	Demerits
1. House-to-house (per-family) survey Surveyors visit individual homes to ask and receive answers directly from local people.	<ul style="list-style-type: none"> Highly credible data can be gathered. 	<ul style="list-style-type: none"> This method cannot be employed unless the surveyor and the interviewees have built a trusting relationship. This method takes a considerable amount of time compared with other methods.
2. Per-group survey Groups are established according to gender, class, vocation, etc. Questions are then asked to each group.	<ul style="list-style-type: none"> A considerable amount of information can be obtained in a short amount of time. Information that goes beyond the scope of the questions can be obtained. Relationships between persons of different social statuses can be gathered by studying how individuals respond. 	<ul style="list-style-type: none"> Respondents often match their answers with those of others in the group (group leader, influential person, etc.)
3. Semi-direct survey This method involves clarifying information by asking several people questions that do not directly concern them, and by analyzing their responses. (Persons targeted by the survey are respected people that are well acquainted with the region, and those that are better equipped to answer questions than others.	<ul style="list-style-type: none"> It is possible to obtain information on subtle topics (such as mutual relations between tribes) 	<ul style="list-style-type: none"> Survey targets (respondents) may skew their answers somewhat.

3.4.2 Participatory Method Surveys

A participatory development approach commonly taken in the Sahel in recent years is Participatory Rural Appraisal (PRA). Under this approach, one group of experts travels to the project site to delimit the region and to identify development potential by visualizing data, utilizing discussions among local people, etc. This survey style also

helps local people quickly gain an understanding of problems facing rural villages and methods for their solution. It is not the standardized method traditionally used; rather, it derives solutions from discussions based on accurate understanding of current problems. At the same time, simplification and visualization (to the greatest degree possible) of necessary information and appropriate response to residents' reactions are carried out. A representative type of this kind of method is MARP.

1) MARP (Méthode Active de Recherche et de Planification Participative)

MARP (*Méthode Active de Recherche et de Planification Participative*) is established as a survey method for implementing PRA. In traditional survey methods, many experts complain that they cannot get the accurate information that they need on rural villages. Criticisms of these methods include 1) high cost of implementing the study over a wide area, 2) considerable length of time required to conduct data collection, and 3) low reliability of information arising from questions that ignore residents' ability to respond. From these criticisms emerged a new survey method known as MARP.

2) Characteristics of MARP

MARP is a survey method whereby necessary data is collected through intensive and reduplicated interviews so that local people as well as project personnel can gain an awareness of problems. By using a variety of tools and methods that allow even illiterate residents to participate, it becomes possible to collect large stores of accurate information needed to understand conditions in the village. An area that receives particular attention is the rapid building of residents' capacity through the resultant combination of residents' knowledge and experts' technical knowledge. (See "Technical Guide: Promoting Organization of Local People")

***System Approach Method**

In addition to MARP, JGRC uses a unique public participatory approach in Mali that was developed by the *Institut d'Economie Rural Division de Recherche sur les Systemes de Production Rural* of Mali's Ministry of Agriculture. It is a method that promotes smooth implementation of projects by allowing local people to participate. When used in regional development, an individual approach is prepared that utilizes the various special characteristics of regions. Using the Segou region of Mali as an example, an approach was selected that incorporated two systems: a management system for natural resources at the project site and a production system for agriculture, livestock, and forestry.

Regarding the management system for natural resources, an approach was devised whereby a committee made up of local people formulates a regional memorandum of

agreement on natural resources, which is made available both inside and outside the region. Then the local people take the initiative in managing the resources within the region.

With regard to the production system for agriculture, livestock, and forestry, 30% of the farming households in the region are designated for classification according to the major types found in that region. Then, based on the results of research aligning the problem areas of each classification with the problem areas of the region, an understanding can be reached on problem areas facing the designated farming households that are selected from each classification. From there, technical support and guidance that addresses these problems can be spread throughout the entire region. If efforts succeed at the household-level, it is possible to make these same efforts succeed throughout the region.

Chapter 4 Legal System Regarding Natural Resources

When implementing a project, it is important to study legal and traditional systems in the country that are connected with natural resources, and to draw up a plan that is in agreement with these systems. The following is an example of this process using the case of Niger.

4.1 Land Resources

In Niger, the Law regarding Basic Policy for the Rural Code (Law No. 93-015 of February 1993; hereinafter referred to as the Rural Code) was promulgated to establish a basic framework for agriculture, livestock, and forestry. The legal framework for land resources is spelled out in Article 1 (Legal System for Land Resources [paragraph 7-13]) of Section 1 (Objectives and Scope of the Law) of the Law and in Clause 2 (Land Management [paragraphs 116-134]) of Article 1 (Administrative Framework for Rural Society) of Section 3 (Legal System for Rural Society). However, related laws and orders are still not sufficiently in place. And delays have occurred in establishment of the implementation structure and financial measures, which means that the framework is for the most part inoperative. Realistically speaking, common law and Islamic laws have dominance in settling problems associated with land.

Under the Rural Code, all lands related to a project being implemented in a village (farmland, pastureland, wells, planted forests, schools, etc.) must be registered in a land ledger kept by a land issues committee known as the *Commission Fonciere* (Presidential order No. 96-367 of October 1997). Thus, projects must be implemented with the prerequisite that the *Commission Fonciere* will be established, and coordination with the Nigerien government is required. However, this system is not yet in operation at the present time.

1) Land Holding Rights and Use Benefit Rights

When implementing development, it is important to understand basic attitudes regarding legal and traditional land holding and use benefit.

In many West African nations, land management under traditional systems prevails. The land owner is the village chief, with land rights being handed down through inheritance from previous generations. While local people have rights to use land, in principle they do not buy nor sell it. Rights are transferred through inheritance and lending/borrowing. However, the concept of "private ownership rights" was introduced into the region in colonial days, and since then some areas have shifted to a system whereby land is bought and sold depending on the tribe and region.

2) Transfer of Land

In principle, families use land that they have inherited from their ancestors, and they grant, rent, or borrow land within the family. And, if permission is received from the village leader, people from outside the village can benefit from land provided that they abide by the village's code of conduct. While usage rights are not limited by any particular time period, in principle, construction of structures that will be used solely by a single family (such as houses or wells) for a long period of time is not permitted. Rent is not generally paid; however, in some places people using land pay rent to the landowner in the form of harvested crops.

4.2 Forest Resources

There are two systems at work in Niger's existing forestry laws: modern forest laws and common law. The basic framework for the laws is outlined in Chapter 1 (Forestry Laws [paragraphs 59 to 64]) of Article 3 (Plant Resources) of the Rural Code. Chapter 2 (Forest Use) describes use of forests according to common law.

1) Modern Forest Laws

Modern forest laws are established by the following major statutes.

- a) Law No. 74-07 of March 4, 1974, establishes forest law. Ordinance No. 74-16 of August 23, 1974, revises stipulations regarding crimes and violations of the forest law that were established in Articles 27, 28, and 33 of the same law.
- b) Revision and enforcement of the law under Ordinance No. 74-16 is covered by Legislative Order No. 74-226/PCMS/MER/CAP.
- c) Distribution and transport of lumber as well as taxation on lumber in large urban areas are covered by Ordinance No. 92-037 of August 21, 1992, and enforcement of the law is covered by Legislative Order No. 92-279/PM/MHE of August 21, 1992.

2) Government-owned Forestland

Government-owned forestland is divided into three categories: government-owned forest preserves (preserved forests), government-owned protected forests (protected forests), and afforestation areas.

No forests that were previously designated as "preserved forests" can be transferred to another party, either as a whole or in part, for as long as this designation remains uncanceled. "Protected forests" include all other forests that are not designated as government owned. Regarding "afforestation areas", the following cases must be considered "bare areas or areas without adequate vegetation".

- a) Sloping mountain areas recognized as requiring preservation
- b) Sandy or unstable banks of all rivers
- c) Areas prone to dangerous gully erosion or landslides

It should be noted that there are cases where land is considered to be a “bare area or area without adequate vegetation” when appropriate rehabilitation of trees is not taking place.

3) Established Usage Rights

The following regulations are established in Law No. 74-07 from the standpoint of usage rights.

- a) Under common law, usage rights are granted in government-owned protected forests and cover forests roads. However, persons using these forest roads cannot ask for compensation with regard to these roads of any kind. Exercise of this usage right is limited under common law so that individual and group requirements of members of society can be met (Article 9).
- b) Application of all usage rights under common law in afforestation areas is not permitted (Article 10).
- c) With regard to activities other than those allowed by laws on harvesting and designation of government ownership (collection of deadwood, harvesting of exudates, fruit and nuts, and plants for food or medicinal purposes), preserved forests are exempt from exercise of common law usage rights (Article 11).
- d) Forestland crop cultivation is prohibited in preserved forests and afforestation areas. (However, this does not apply if there is a cultivation contract in place that has been permitted by law.) (Article 15)
- e) Use of preserved and protected forests by public organizations and individuals under the terms of temporary permits for sale, purchase, and use of felled wood, as well as cutting permits for a set amount of trees, branches, firewood bundles, or stale-unit cutting, is permitted (Article 21).
- f) A list of tree types that should be protected from all forms of unauthorized cutting, stumping, and collection in areas outside the boundaries of villages, gardens, and orchards has been established (Article 16). (Please refer to Chapter 4 of the separately published Technical Guide: Afforestation)

Law No. 74-07 of March 4, 1974 (including revised laws), which was promulgated to administer the above forest laws, contains stipulations covering violations and crimes related to forests, procedures for investigation and confirmation of these violations and crimes, appropriate punishments, and persons permitted to apply punishments. Regulations require that a usage fee be paid in order to obtain permits. Distribution

and sales are particularly covered by Ordinance No. 92-037 of August 21, 1992, and enforcement of this Ordinance is established by government legislation (Legislative Order No. 92-279/PM/MHE of August 21, 1992).

4) Enforcement Status of Forest Laws and Administrative Effect

Forest laws remain unenforced for the most part. In fact, most areas of preserved forests and protected forests are seeing noticeable depletion due to uncontrolled cutting.

In addition, it is clear that forest managers that are supposed to be responsible for enforcement of these laws lack a thorough understanding of them. Reasons for this include the low rank of on-site personnel and inadequate instruction on related laws.

4.3 Legal System Regarding the Assessment of Environmental Impact

Chapter 3 of the Rural Code establishes a basic legal framework with regard to wildlife. Niger is home to 'W' National Park, which is a wetland internationally famous as a habitat for waterfowl that is designated as a World Heritage site, and the neighboring Tamao Wildlife Sanctuary. Niger also contains the Kouré region, which is a habitat for West Africa's only giraffe herd, as well as rivers that are home to hippopotamuses and manatees. A variety of mammals, birds, amphibians, fish, and insects can be found in the region.

While humans are forbidden to live or hunt in national parks and wildlife sanctuaries, population pressures have led to poaching and illegal grazing. Furthermore, unsupervised fires started by people have resulted in frequent wildfires that are threatening the region's rich natural resources. There are instances where hippopotamuses that feed in floodplains must compete with people using the area for farming, and the number of manatees is decreasing due to loss of habitat and poaching.

Although crop cultivation is prohibited in government-owned forests, common law permits the collection of forest products through methods other than tree felling. According to data (1997) from the World Bank's Household Energy Project, residents of a community are permitted to collect deadwood and other items; however, it is generally prohibited to cut down living trees. On the other hand, businesses that receive permits from forest authorities have free access to government-owned forests. Community residents do not have the right to limit or supervise the activities of these businesses, and they do not receive any security bonds against destruction of regional forests. Because of this, a rational forest management initiative has yet to emerge among local people. This means that, even if forests are rehabilitated, the only persons who will benefit are businesses.

JGRC's development program assumes that small-scale and locally initiated development activities will be implemented that will likely have little effect on the environment. However, fluctuations in groundwater levels due to pumping of water from wells, actions such as construction of weirs, and other factors require that consideration be given to environmental impact. Having said this, however, implementation of projects in line with superordinate environmental action plans is thought to be a way of promoting the effects of environmental preservation in the region.

Chapter 5 Support for Agriculture, Livestock, and Forestry

In implementing development, the necessity of engaging in technical transfer and follow-up in the target district makes it important to implement projects in collaboration with regional extension organizations that are involved in agriculture, livestock, and forestry. Naturally, the countries of the Sahel have different extension systems, and this is why it is important to gain an understanding of administrative organization and extension systems for agriculture, livestock, and forestry in each country.

The following is a partial example of the administrative organizations and extension systems concerned with support for agriculture, livestock, and forestry in the relevant countries.

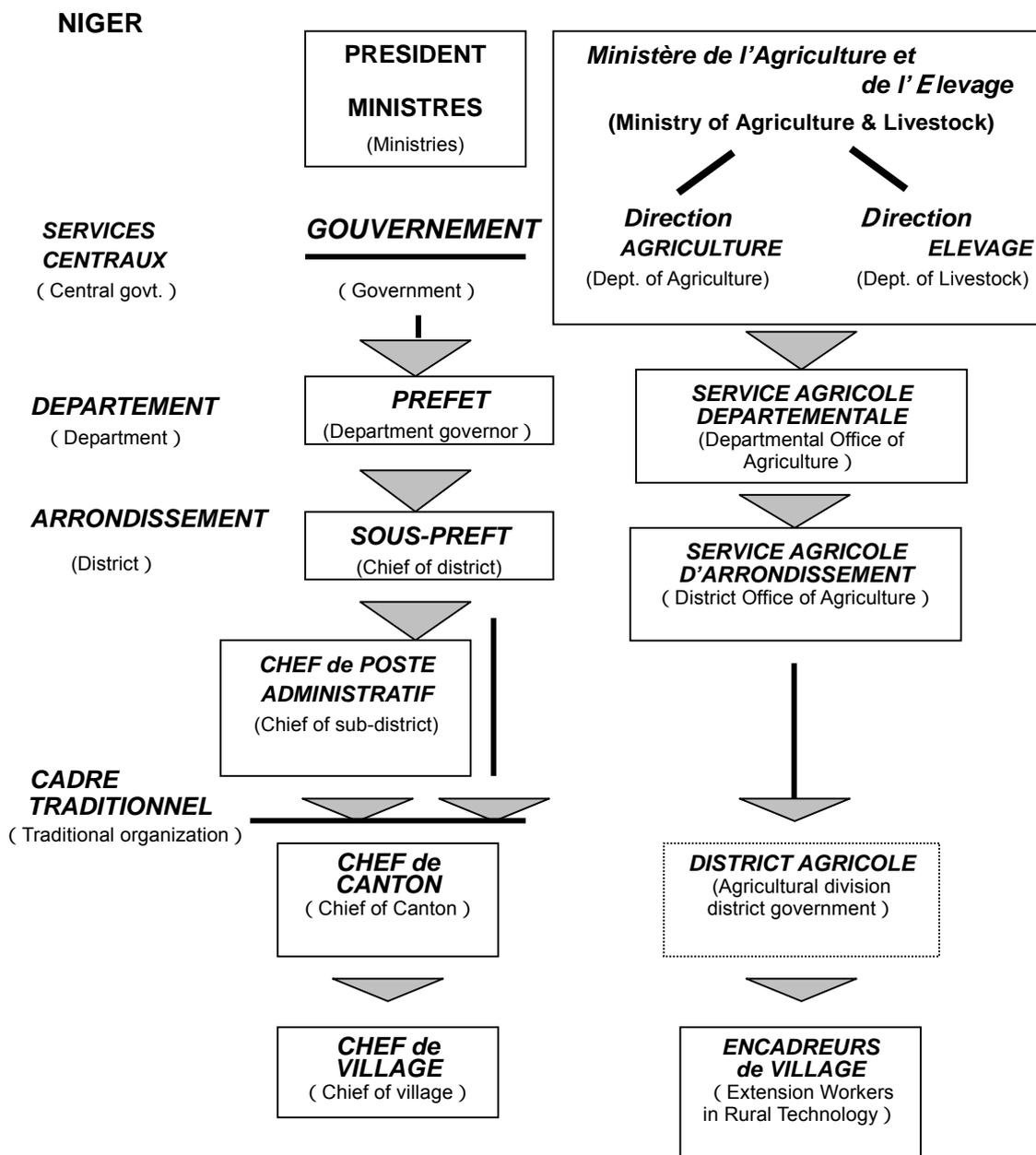
5.1 Administrative System

1) Niger

Niger is made up of seven departments (*département*) and the capital district of Niamey, whose status is equal to that of the departments. Within the departments are 36 districts (*arrondissements*), which are further divided into 21 *communes* (18 urban and 3 rural) and 15 *poste administratif*.

Upon a framework based on an agricultural support and enhancement program entitled *Programme de Renforcement des Services d'Appui à l'Agriculture* (PRSAA), the Ministry of Agriculture, Livestock, and Forestry has jurisdiction of extension administration for agriculture, livestock and forestry. An agricultural office is established in each *arrondissement* as a base for extension activities, and it is here that extension workers in agriculture, livestock, and forestry are stationed. Following the presidential election of 1999, organizational reform is taking place whereby the Ministry of Agriculture and Livestock is being reestablished in the Ministry of Rural Development and the Ministry of Animal Resources, the Ministry of Water Resources is being reestablished in the Ministry of Water, and a new ministry having jurisdiction over the environment entitled the Ministry of the Environment and Control of Desertification (*Min.de l'Environnement et de la Lutte Contre la Désertification*) is being set up. Work is currently underway to establish organization at the bureau level. Figure 5.1.1 shows the extension organization in Niger as established by PRSAA.

Figure 5.1.1 Extension Organization in Niger (in the case of PRSAA)



2) Mali

Mali is comprised of eight regions (*régions*) and one district (Bamako), whose status is equal that of the regions. The regions are made up of sub-regions called *cercles*, of which there are 49. The *cercles* are made up of smaller units called *communes*, of which there are 701 in total.

3) Burkina Faso

Burkina Faso is made up of 45 provinces (*provinces*) that are divided into 350 departments (*département*). Other local government bodies are classified as

communes (urban communes and rural communes), of which Ougadougou and Bobo-Dioulasso are designated as special communes. This system is currently being reviewed, and the governing structures of the rural communes are not yet fully in place. Three provinces in the Burkina Sahel (Seno, Soum, and Oudalan) are cooperating in regional development projects being implemented in the Sahel, and an organization called CRPA (*Centre Régional de Promotion Agro-pastoral*) has been established to support technical extension to regional farmers and livestock raisers. In all of these countries, the organization at the end of the administrative process is the village, as this is the traditional form of citizens' organization.

5.2 Support System

Regarding possibilities for support by regional government for village development, it is necessary to conduct a survey to identify the regional extension structure, the number of extension workers, the frequency of visits by extension workers to provide technical skills, and the content and objectives of extension work. In addition, because it is necessary to identify problem areas, a survey should be conducted to get a grasp of development extension methods being implemented by overseas aid agencies as well as nearby agricultural, livestock, and forestry-related extension work being conducted by NGOs, etc.

1) Support System in Niger

The extension system in Niger was established as follows: Agricultural bureaus were created in each department under the jurisdiction of the Ministry of Agriculture and Livestock Raising (currently the Ministry of Rural Development), and below these bureaus were district agricultural offices to which extension workers were assigned. Under the traditional extension system, villages tended to be dispersed over a large area and there were few extension workers (one worker is responsible for six or seven villages). As a result, work was not properly systematized, workers could not handle the extensive variety of duties required of them, and collaboration between research agencies was weak. In order to improve these areas, the Nigerien government obtained funding from the World Bank to begin an agricultural support enhancement program in 1988 intended to improve the capabilities of extension workers. Through this effort, agricultural bureaus under the jurisdiction of the Ministry of Agriculture and Livestock were established in each department, below which were set up district agricultural offices to which extension workers specializing in agriculture, livestock, and forestry were assigned. These workers then provided guidance at the end-level; i.e., the village (see Figure 5.1.1). Following the pilot project stage (1988 to 1992), PRSAA implemented this system in 25 districts over the five year period from 1993 to

1997.

The objectives of this program were as follows:

- a) Cultivation of a professional attitude among extension workers; fostering of extension workers' ability to identify limits on production and to propose solutions to these limits.
- b) Meeting of producers' technical needs through regulated and continuous training of extension workers.
- c) Establishment of an apparatus whereby extension fields, research agencies, and producers can collaborate so that responses can be formulated to meet producers' many needs.
- d) Organization of an effective job classification system in order to promote efficiency in extension work.
- e) Development of extension workers' enthusiasm for their work by improving working conditions.

Along with supervision and evaluation, a program that can respond flexibly to ever-changing advances in technology was implemented in order to meet these objectives.

As part of this program, the previous organization was reformulated to allow for more effective execution of the program; extension workers specializing in agriculture, livestock, and forestry were brought together into one office; and motorcycles were provided to extension workers for use when traveling to towns to offer instruction. Unfortunately, however, the Nigerien government did not have the means to continue the program after its conclusion. As a result, the extension workers returned to the vertically structured organization that was used before, and the extension structure at the village level slid backward. While consideration of how to continue the extension structure following completion of the project was a matter of primary importance, it must be admitted that, in the end, the results of this consideration were not adequately put into effect.

Furthermore, despite the fact that extension workers were provided with motorcycles to use in their rounds, the poor condition of the roads, small number of extension workers, and lack of funds resulted in a low frequency of visits. This meant that sufficient extension work to raise agricultural production was not properly carried out.

Research agencies with whom collaboration is necessary include the *Institut National de Recherches Agronomiques du Niger* (INRAN), International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), West Africa Rice Development Association (WARDA), and International Livestock Research Institute (ILRI).

2) Support System in Mali

From 1992 to 1998, a national program entitled *Programme National de Vulgarisation Agricole* was implemented in Mali to support extension activities. In addition, from 2001, Mali is planning to implement a program to support farmers' organizations entitled *Programme d'Appui aux Services Agricoles et Organisation Paysannes* (PASAOP) as a means of strengthening the farmers' support structure and of enhancing extension workers' and local people organization. This program will be conducted with assistance from the World Bank (International Bank for Reconstruction and Development).

With regard to the current situation surrounding extension work in Mali, support agencies in each *région* called *Direction Régionale de l'Appui au Monde Rural* (DRAMR) work under the *Direction Nationale de l'Appui au Monde Rural* (DNAMR), which is the rural society support arm of the Ministry of Rural Development. At the *cercle* level, offices known as *Servise Local de l'Appui Conseil et Aménagement et Equipement Rural* (SLACAER) have jurisdiction, while at the *arrondissement* level, *Servise Local de l'Appui Conseil et Aménagement et Equipement Rural* (AACAER) offices are in charge. Finally, extension workers (*Agent Base*) are assigned to perform work at the village level.

Research agencies working in agriculture, livestock, and forestry with whom collaboration must take place include *Institut d'Economic Rurale* (IER), *Service Semencier National*, and the International Center for Research in Agroforestry. Collaboration in production and extension guidance should take place with *Office du Niger* and *Compagnie Malienne de Développement des Textiles* (CMDT) among others.

3) Support System in Burkina Faso

Like Niger, Burkina Faso received funding from the World Bank to implement a project designed to enhance support for producers—entitled *Projet de Renforcement des Services d'Appui Aux Producteurs* (PRSAP)—from 1989 to 1997. This project, which was conducted under the supervision of the Regional Agricultural and Livestock Resources Bureau through *Centre Régional de Promotion Agro-Pastoral* (CRPA), was implemented to reformulate the extension system so that it could improve both quality and quantity in agricultural and livestock production throughout the country while at the same time carrying out technical extension and education for farmers. From 1998 to 2001, a second phase of the project entitled *Projet National de Développement des Services Agricoles* (PNDSA) was commenced, which is currently continuing work connected with support for farmers and livestock raisers.

In the effort to improve agricultural, livestock, and forestry production in the Sahel, it is important to move away from traditional production and to introduce new skills and knowledge to villages. In order to do this, an extension system in agriculture, livestock, and forestry must be established that can provide direct instruction to farmers. In the future, while upgrading organizations that support extension and providing guidance to farmers, it is important for the side that is implementing support to carry out development projects that sufficiently include farmers' education in necessary skills.

Chapter 6 Local Consciousness Raising

In many development projects implemented to date, results have not led to elimination of rural poverty and improved agricultural, livestock, and forestry production. This is because, in addition to insufficient funding provided by the government, factors needed to maintain development were not in place. One of these missing factors was participation by local people. Other problems included inadequate understanding of development issues and low capacity in managing development results on the part of local people. Points needing immediate attention are insufficiency or poor development of measures intended to contribute to improved development awareness and capacity among local people.

Accordingly, it is necessary to obtain public participation in regional development from the planning stage. It is also important for local people to gain an awareness of problems that lead to deteriorating regional resources and environments, and to guide them in studying and implementing countermeasures by themselves. Therefore, it is of utmost importance to motivate local people so that they will take responsibility for managing and maintaining the results of development projects.

It is important to promote residents' participation in necessary development activities by confirming their awareness and intentions for development and by fostering organization of local people. Furthermore, it is important to raise awareness and capacity for development within the entire target region by actively urging women as well as men to participate.

Finally, the success of development projects in a region depends on efforts to confirm the intentions of local people and relevant administrative agencies as well as efforts to gain their support.

6.1 The Wants of the People

In order to help local people a) understand changes that are affecting natural resources in the region and b) become more aware of continuing desertification, it is necessary to interview local people to learn of their attitudes toward the necessity of anti-desertification measures and means of implementing such measures. In addition, it is important to get a handle on their ambitions with regard to development. While it is important for persons implementing the survey to provide advice if local people are not aware of methods for coping with desertification, as much as possible, information should be gained from the local people themselves.

Furthermore, when conducting interviews, it is important to clarify the target of the interview (all residents, elderly/young persons' groups, men/women's groups, etc.) and to place more emphasis on accurate gathering of residents' intentions during

interviews. In particular, women in Islamic society seldom give their opinions to men they have never met before. Because of this, it is important to consider holding interviews that are conducted by female personnel and that are attended by only women when trying to obtain women's views.

6.2 Human Resources Development

It is important to engage in efforts that assume establishment of a CGTV from the preparatory stage of project planning. And, when implementing development, rapid response in terms of selection of projects and methods is required. Accordingly, it is important to study organizational problems and human resources issues prior to the implementation of activities. Furthermore, during the time that citizens are being organized through actual project implementation, key persons that are influential members of the target village (or members of the groups that were formed for conducting interviews on development intentions) must be selected to gather residents' requests and to serve as contact points for substantive coordination. These key persons must then be trained as future leaders.

6.3 The Role of Women

Despite the important economic and cultural role that women in the Sahel play in daily life, they are at the bottom of the social order. Consequently, they are generally not included in important decision-making. Women are involved in many everyday activities involved in daily living—such as housework, childrearing, firewood collection, water drawing, and agriculture—and these roles are becoming more and more important as poverty and environmental degradation continue. It is no exaggeration to say that the people most in need of development are the women of the Sahel. However, women also possess considerable ability to flexibly accept and cope with development.

In this way, it is important to solve such traditional and inherited women's issues as unfair treatment (subordinate status to the head of the household, prohibition from land ownership, etc.) and overwork, and then to improve women's status in society and include them as promoters of development.

6.4 The Wants of Regional Administrative Bodies

While surveying such items as village administration, follow-up structures of regional organizations attached to the national government, and activities of extension organizations and NGOs, it is important to formulate a plan that adequately comprehends the intentions of regional administrative bodies with regard to development and that is harmonized with these intentions.

Chapter 7 Planning Development Projects

Local people formulate development plans based on general consensus through CGTVs. These plans are based on understanding and analysis of conditions in the *terroir* and discussions on the necessity of countermeasures, etc. During the formulation process, it is necessary to clearly identify the specific content of each area of development, beginning with objectives and methods. And it is here that organizations that are promoting development support resident-initiated development plans. The following is a presentation of relevant basic items for technical personnel assigned to governments and project implementing agencies.

7.1 Identifying Basic Objectives

7.1.1 Development Objectives

The local people of a *terroir* determine the issues they most want solved and objectives for solving these issues. Then they develop a basic policy for attaining these objectives and a strategy made up of steps toward effective implementation of the policy.

Development project plans that are developed by local people themselves form the backbone of *terroir* management. Unfortunately, however, education and technical extension in the Sahel are underdeveloped, and local people do not have sufficient awareness of anti-desertification measures nor do they possess the means for implementing such measures. Accordingly, it is essential that governments and project implementing agencies step in to provide support and guidance by building development objectives and policies around local people's intentions.

It is important for project implementing agencies to constantly provide easy-to-understand information to local people while helping local people understand the problem areas as well as the methods and effects of development. This includes explaining these points to illiterate persons through use of pictures and diagrams, and inclusion of these points in residents' education, etc. Because of this, the project implementing agency (which is the main support agency) must guide local people toward thinking about development objectives and policies while at the same time raising their awareness of underlying conditions. It is vital that support agencies promote development by offering relevant advice while also working to ensure that development is placed squarely in the hands of local peoples.

1) Target Year

When formulating plans for a development project, it is important to envision specific

project activities, to establish a project implementation period, and to set a target year for attainment of project objectives. Then, it is important to clarify such items as population increases expected to occur by the target year, etc., as a precondition for development.

Population in the Sahel is generally increasing at a rate of 2.5 to 3.5%. With this in mind, it is necessary to calculate the population that will be targeted in future years and to consider the results of this calculation when implementing development measures. If there are superordinate plans from national or regional authorities in effect, it is important to consider the target years of these plans as well as their thinking regarding population increases, etc.

For the project implementation period, it is important to envision a period during which the project implementing agency can carry out support and a period during which local people can continuously maintain and manage the project while sustaining project activities. Accordingly, consideration of these points is essential when establishing target years.

2) Development Policy

Formulation of specific development policies is vital to attaining objectives. These basic policies, which include methods to be used in attaining objectives, are drawn up based on consideration of obstructing factors and preconditions in the region. Then, concrete strategies are prepared so that these policies can be effectively implemented. Policy items are met and objectives are achieved when this strategy is put into effect.

The basis for development is the activities of the CGTV, which include recognition of conditions surrounding regional resources existing within the *terroir*, selection of countermeasures; and formulation, implementation, management, and evaluation of development plans by the local people themselves. However, it is extremely difficult for local people to undertake such activities by themselves at the beginning. That is why it is essential that they receive support based on a framework that is made up of such bodies as governments, research institutes, NGOs, and the project implementing agency.

Many objectives in formulation of a basic project structure include statements that are represented by “self-sufficiency in food, firewood, and animal feed”. The “policy” for attaining these objectives usually includes such items as a) improving rainwater agricultural production, b) improving pasturelands, and c) planting of fast-growing forests for firewood self-sufficiency. Finally, the “strategy” for realizing this policy

usually includes a) expanded organization of local people (establishment of special committees), and b) enhancement of technical extension. Using these conditions, proposals for specific project activities are then tied into the following development plan.

7.1.2 Outlook for the Target Year

Following implementation of a development project based on the needs of local people, conditions in the project area are identified as of the target year. From this, it becomes possible for local people to gain a fresh understanding of the significance of the project.

It is believed that showing conditions as they are in the target year following implementation of a project to local people is an extremely effective means of gaining their participation. Population in the Sahel is growing in nearly all countries at a rate of 2.5 to 3.5%. A rate of, say, 3% would result in a population that is 1.3 times the size of the present one in 10 years, and one 1.8 times the present size in 20 years. Because of this, it is expected that regions that are self-sufficient in food will experience a breakdown in their ability to support their daily living if conditions continue at the present rate. In the Sahel, where it is difficult to prepare soil, it is important to implement anti-desertification measures in existing areas and to increase food production. This also applies to the firewood that is used as fuel by local people. In attaining self-sufficiency in food and firewood, which is the fundamental issue facing residents of the region, the major question is to what degree self-sufficiency can be attained through implementation of sustainable agriculture, livestock, and forestry. Clarifying the outlook for self-sufficiency can be effective in answering this question.

7.2 Producing a Master Plan

The master plan sets as its objective the "shift from exploitive agriculture, livestock, and forestry activities to those based on sustainability". In order to meet this goal, it brings together formulation techniques for directions to take anti-desertification measures in the region, techniques for establishing the project, calculation of the amount of facilities needed and project costs, examination of capital, etc., based on existing conditions.

In addition to this guide, JRGC is preparing technical guides that are related to anti-desertification measures for each relevant field, including agriculture, livestock raising, afforestation, agricultural land conservation, development of water resources, use of water resources, and promoting organization of local people. JRGC hopes that readers will refer to these guides to view how specific development plans are

formulated. This guide will present some of these plans as examples for reference when demonstrating formulation of development plans.

7.2.1 Land Use Plan

1) Summary of Issues

In recent years, population increases and transformation of fallow areas and natural grasslands into farmland have resulted in an expansion in the area of land used for cultivation in the Sahel. This has produced a decrease in traditional fallow lands between cultivation cycles and accelerated soil exhaustion. Furthermore, continued single-crop farming due to shortened fallow periods and non-use of fertilizer has meant that per-acreage production is falling.

On the other hand, increased numbers of livestock and fewer natural pasturelands due to expanding use of land for agriculture have resulted in even more overgrazing. Soil deterioration in natural pasturelands is occurring in a manner similar to that seen in farmlands. In addition, damage caused by nomadic grazing and transhumance, frequent conflict over land that arises from competition between farmers and livestock raisers, and improper soil management are factors leading to soil exhaustion.

Areas of exhausted soil are abandoned, and this contributes to increased soil degradation in the *terroir* as a whole.

2) Basic Policy for Formulating Land Use Plans

Land use plans are formulated based on the following basic policy in order to promote proper land use.

(1) Formulation of a Proper Land Use Plan

- a) Based on existing land use conditions (such as natural conditions [topography, soil, vegetation, water resources, etc.]; establishment of fallow areas; land use connected with agriculture, livestock, and forestry; etc.), a new and appropriate land use plan is formulated that does not lead to soil degradation and which allows for harmonized land use for agriculture, livestock raising, etc.
- b) Formulation of the land use plan is based on consensus among the local people in the *terroir*, and takes land-related laws and attitudes toward traditional land use benefits into account.
- c) Because it is difficult to make judgments based on establishment of a legal land system and residents' awareness of land when changing boundaries or configuration of used areas, an appropriate land use plan should be devised that makes as few changes as possible to existing land statuses.

(2) Establishment of a Land Management System

In order to establish order to land use at the village level, the CGTV should promote appropriate land use and establish a land management system.

3) Points to Consider in Formulating a Land use Plan

Points that should be remembered when formulating a land use plan are presented according to the following land use classifications.

(1) Agricultural Land Use

- a) In order to make sustainable agriculture, livestock raising, and forestry activities possible in the Sahel, it is important to create an integrated agricultural basis (rice cropping, fruit and vegetable cropping, grain cultivation using rainwater, fruit farming) that meets topographical, soil, climatic, water resource conditions as well as residents' needs, and then to use land and other natural resources efficiently. Furthermore, land use that allows the construction of a framework for agriculture, livestock, and forestry activity that can work with and supplement livestock raising (use of animal power and animal droppings) and forestry (windbreaks and agroforestry) should be conducted.
- b) Efforts should be made to raise land productivity, transfer unnecessary cultivated land to fallow land, and restore soil fertility.
- c) Low areas such as floodplains have significant potential as farmlands because of their rich soil and easily available water. Also, use of these kinds of low-lying lands can be highly effective from the standpoint of land use efficiency. Accordingly, appropriate land use can be promoted by establishing a general farming system that covers all areas—from floodplains to sloping lands and highlands.
- d) When selecting low-lying lands in floodplains for use as farmland, natural preservation must be kept in mind despite the fact that large amounts of land are not expected to be developed in the foreseeable future,.

(2) Livestock Raising Land Use

- a) In order to ensure order and efficiency, pasturelands within regions where settled livestock raisers are active (natural pasturelands and fallow lands near villages) and those for others such as nomadic raisers (natural pasturelands set aside especially for grazing) should be separately classified and managed.
- b) Placement and maintenance of appropriate passages for herding livestock should undertaken to ensure harmonic land use between those engaged in

livestock raising, agriculture, and forestry.

(3) Forestry Land Use

- a) In the interest of ensuring harmony with agriculture and livestock raising, land use that falls in line with forestry activities should be conducted according to topographic conditions.
- b) While individual use of cultivated lands and land near water areas for planting is permitted, it is desirable that forests in laterite highlands and on steep slopes be shared as joint activities will be required.

(4) Other Land Use

- a) With regard to development of water resources through improvement of marshlands and use of small dams, a study should take place that will allow compatible use of surrounding lands by those involved in agriculture, livestock raising, and forestry.
- b) When efforts are made to rehabilitate degraded lands through farmland conservation measures, it is necessary to implement measures that cover land used by a number of local people. Because of this, it is important to conduct a pre-implementation study on use of relevant lands.
- c) When facilities are constructed in areas near village boundaries, it is important to confirm where boundaries exist between villages.
- d) Shared-use lands (such as shared seedling farms, areas for vaccinating livestock, and livestock watering areas) should be selected based on consideration of erosion and environmental preservation concerns.
- e) In order to raise efficiency in distribution of products, it is desirable to secure land for construction of main roads to villages during formulation of the land use plan.

7.2.2 Agricultural Improvement Plan

1) Summary of Issues

The following issues must be resolved in efforts to stop the progress of desertification, which is a cause of inadequate food supplies.

- a) Exploitive agriculture: This practice is a cause of insufficient food supplies. It leads to soil exhaustion caused by over-cultivation (uncontrolled land clearing, shortening of the time that lands are left fallow, simplification of the grains that are cultivated, etc.) while contributing to desertification.
- b) Lack of agricultural infrastructure and resources: The infrastructure and resources that are necessary for efficient agriculture are lacking due to

financial considerations, and this is restraining agricultural development.

- c) Reluctance to move away from traditional varieties and farming methods: Cultivated varieties and farming methods that are currently used cannot contend with the drastic changes to the environment that have occurred in recent years, and this is leading to reduced production.
- d) Indirect causes: Because the amount of income that can be obtained through agriculture is limited, local people frequently try to gain income by selling firewood and charcoal. Over-felling of trees that occurs as a result is becoming an indirect cause of desertification.

2) Realization of Sustainable Agriculture

Based on current issues facing the Sahel, efforts should be made to realize sustainable agriculture through implementation of the following policies while at the same time placing importance on “securing food supplies”, which is the main objective of agriculture.

(1) Basic Policies

- a) Improvement of agricultural production: Securing of adequate food supplies while reducing exploitive agriculture that is based on over-cultivation by introducing high-volume varieties as well as technology.
- b) Diversification of products: Securing of food supplies, intake of proper nutrition, reduction of soil exhaustion caused by single-cropping, and sustainability of agricultural production through introduction of agricultural products that meet environmental conditions.
- c) Effective use of resources: Stable use of environmental resources through rehabilitation and protection of soil fertility levels through use of animal dung and plant waste as well as increased efficiency in water resource use.
- d) Improvement and stability of farming household incomes: Reduction of over-cultivation and over-cutting of forests (which lead to deforestation) as well as movement of populations to urban areas through increased capacity to earn a stable income from agriculture.

(2) Methods

In order to make sustainable agriculture possible in the Sahel, it is important to create an integrated agricultural basis (rice cropping, fruit and vegetable cropping, grain cultivation using rainwater, fruit farming) in a manner that meets topographical, soil, climatic, and water resource conditions as well as residents' needs. It is also necessary to make efficient use of natural resources and to use land and other natural

resources efficiently, while introducing technologies and products that meet these conditions. Furthermore, an agricultural framework must be constructed that gives consideration to multi-faceted agriculture that can work with livestock raising (use of animal power and animal droppings) and forestry (windbreaks and agroforestry), and that allows each field to supplement the others.

The following presents topography-specific agricultural strategies that combine collaboration with other fields.

a) Lowlands (Especially Wadi Floodplains)

In the Sahel, there are numerous low-lying areas, including floodplains and depressions. Although these areas are not highly developed, they have considerable potential for agricultural development. Wadi floodplains are particularly underutilized, and it is thought that focusing on these areas might be a positive developmental approach.

Because the floodplains flood during the rainy season, they are an appropriate place for paddy rice cropping. And their fertile soil can be used during the dry season to cultivate cash crops. If these types of cultivation are to be introduced into the region, it will be necessary to build infrastructure for paddy fields as well as irrigation facilities. It is also thought that, when considering such aspects as sustainable management by local people and profitability, the most efficient approach would be toward small-scale use. Also, because water tends to move swiftly through the floodplains, embankments and other anti-flood facilities will have to be built in areas that are prone to flooding.

With regard to cultivation, varieties and technologies that are appropriate to the environmental conditions in the region must be brought in. For example, consideration must be made for introducing improved varieties of rice that mature quickly as well as selection of vegetable crops that are suitable for clay soil.

b) Sloping Areas (Areas Stretching from Lowlands to Upper Flatlands)

Sloping areas as covered in this survey extend from the tops of floodplains and depressions to the plateaus (located above the lowlands, large areas of comparatively flat ground that are above sloping areas) where primarily millet is grown. In addition to millet, potato crops such as sweet potatoes and cassavas as well as some vegetables are grown in these areas. Also, because these areas are close to the lowlands, groundwater is easy to obtain as it is not far below the surface. Other characteristics of these regions include gentle sloping and clay soil.

By taking advantage of these characteristics, it is possible to conduct both self-sufficient and cash-crop agriculture by introducing bean crops (which are an

effective cash crop) during the rainy season and by actively employing crop-rotation and mixed-crop methods into millet production. If a millet yield is more than sufficient to meet self-sufficiency needs, then there is room to cultivate vegetables and other cash crops by bringing in appropriate technologies and varieties. While wells must be dug if this area is to be used during the dry season, its location above the floodplains means that collection of water is relatively easy, and therefore large amounts of labor and expenses are unnecessary. Furthermore, it is possible to consider developing farming methods that include introduction of vegetable and fruit crops as well as sustainable agroforestry.

It should be noted, however, that there is a danger of erosion occurring in sloping areas, and this makes it necessary to consider establishing farming methods that include measures to preserve farmlands, such as “alley cropping”.

c) Plateaus

The majority of field cropping in the Sahel occurs in these plateau (upland) regions. Cultivation centers on millet and sorghum, which are the principal food crops in the region, and it is necessary to consider enhancing these fields. Strategies include introducing use of animal dung and crop rotation or mixed cropping in order to improve soil fertility, introducing high-quality varieties, etc.

Costs associated with these efforts are limited to those needed to build manure and compost pits and those needed to bring in seeds for high-quality plants. These can be done at a price so moderate that farmers themselves can procure the necessary funds. Because improved productivity in millet and sorghum cropping has high priority among farmers, it is thought that these strategies would be easiest to implement.

(3) Introduced Technology

This section will classify cultivation technologies that can be introduced into the Sahel into separate categories (rice cropping, cultivation garden plants [vegetables and fruits] and field crops), and will limit the points of consideration it presents to those selected from the separately published “Technical Guide: Agriculture”.

Details on cultivation technology make reference to technical guides published by local agricultural research institutes, etc.

a) Rice Cropping

- Crops should be selected as follows: In areas where the water depth is 1 meter or more during the growing period, floating rice (*riz flottant*) is appropriate. In areas with a water depth of from 50 cm to one meter, deep water rice (*riz immersion*)

profonde) should be selected. And in areas having a depth of 50 cm or less, short-root, high-yield varieties should be selected. Even in floodplains, rice cropping in paddy fields protected by embankments entails yearly costs, and from this standpoint it is important to raise productivity. That is why improved varieties with the potential for high yield should be selected.

- In the effort to obtain high yield, transplant cultivation (transplanting of rice seedlings) is preferred, and in this case, it is important to pay particular attention to seed selection and seedling management. Rice crops are especially susceptible to damage from birds after ripening, and this makes early harvesting necessary.

b) Vegetable Cultivation

1) Clay soil areas in lowlands

- Leaf vegetables are appropriate in lowlands. Root vegetables do not grow well in overly wet areas and should therefore be avoided.
- Additional soil should be added, particularly when clay soil is present.
- Drainage is generally poor, so the amount of water used in irrigation must receive proper attention.
- Areas that are flooded during the rainy season are comparatively fertile. Therefore, while watching growth conditions, fertilizer application should be conducted with an eye toward avoidance of over-fertilization.

2) Clay soil areas in sloping areas, etc.

- While all standard vegetables can be grown, fruit vegetables that have particularly good resistance to heat and dry periods are best.
- While fertilizing soil by applying compost and animal dung, efforts should be made to improve ability to retain water.
- It is necessary to limit damage by disease and pests by making certain that field rotation consisting of several crop varieties is practiced.

c) Field Cropping during the Rainy Season

If cultivation of field crops, which generally occurs in plateaus and sloping areas, is properly matched with seasons that have the most rain, it is possible to receive a reasonable yield using traditional technology. In this case, the following measures should be taken to increase yield.

- Introduction of fast maturing varieties that are adapted to the shortening rainy season.
- Soil fertilization through production and use of *parcage* and compost made from animal dung.

- Introduction of such cultivation methods as crop rotation and intercropping so as to avoid soil exhaustion.
- Introduction of agricultural land conservation measures (use of zaï is particularly effective [please refer to the Technical Guide: Agricultural Land Conservation]).
- Study on application of animal power already used in parts of the region in order to reduce labor.
- Low-water farming used when water levels in rivers and depressions fall from the end of the rainy season into the dry season is also effective in lowlands.

d) Fruit Cultivation

In regions extending from sloping areas up to plateaus, it is wise to consider combined introduction of rainy-season grains, bean crops, and vegetables, etc.

- Mangos and lemons are easily introduced into the Sahel.
- Better productivity can be pursued through grafting technology.
- General management technology is the same as afforestation technology (Refer to the Technical Guide: Afforestation).

(4) Establishment of Facilities

a. Necessary Facilities and Materials

This section will outline facilities that should be established for the agricultural strategies presented above.

(a) Establishment of Paddy Field Infrastructure

- 1) It is necessary to construct embankments in floodplains in order to prevent flooding. The size of these embankments depends on location; however, in cases in which a suitable amount of land cannot be procured, embankment construction costs and irrigation costs will rise above production. Profitability concerns therefore make it desirable to avoid construction of large embankments.
- 2) When low cost is desired, small embankments that can be constructed by farmers themselves should be built. Paddy fields should be introduced in which water levels can be regulated by building water inlets.
- 3) Furthermore, in cases where only small ridges will be built rather than embankments, one possible method is to build paddy fields in relatively high areas where the possibility of flooding is low. Irrigation can be performed through use of pumps.

(b) Irrigation Facilities

- 1) Lowlands: During the period appropriate for dry-season vegetables (November to

March) and sometimes longer, cultivation is economical if farmlands close to areas where water can be obtained, such as rivers and ponds, are selected. This is because the only irrigation facilities needed are pumps and water storage tanks. However, drilling of shallow wells is necessary if the catchment area soon dries up or if water for other uses (such as for drinking) is required.

- 2) Sloping areas: Water veins in areas that are close to floodplains and depressions are generally near the surface, which means that well-drilling is fairly inexpensive and little labor is required for drawing water. Because of this, it is best to drill wells in lower parts of sloping areas as much as possible to secure irrigation water for the dry season.

(c) Livestock Fences

Livestock are allowed to range freely in the Sahel and they often enter and disrupt vegetable fields, which causes extensive damage to production. This makes it necessary to build fences around fields. While fences made of iron posts and barbed wire are effective in preventing livestock from entering fields, simply placing thorny branches around fields can also be effective. In this way, it is important to build fences in accordance with economic means.

(d) Compost Tanks (Pits)

Compost pits can be easily constructed if farm implements (such as shovels) and sun-dried bricks are available.

(e) Seeds of Newly Introduced Varieties

In general, many foodstuffs such as rice, millet, sorghum, and *niébé* can be obtained at home in the Sahel. Seeds for each type of vegetable are usually purchased; only seeds for major varieties, such as onions and tomatoes, can be obtained at home. It is important to base introduction of seeds on consideration of these facts.

3) Necessary Costs

Please refer to the separately published Technical Guide: Water Resources Utilization and the Technical Guide: Agricultural Land Conservation for details on costs related to paddy field infrastructure (such as embankments), irrigation costs, costs for construction of fences, and costs related to agricultural land conservation.

Regarding costs related to such items as compost production facilities and seeds for newly introduced varieties, because these items will be personal property of the farmer, it is considered appropriate that the farmer assume these costs him or herself. However, support in the form of small-scale financing, etc., is necessary when

introduction is commenced. A study should be performed on methods for easy implementation of this support by including lending mechanisms, seed-change (seed-picking) programs, etc., in the activities of organization of local people.

4) Expected Effects

This section will present effects that can be expected from rice cropping, cultivation of garden crops (vegetables and fruit), and field crops.

These effects are estimates based on tests conducted by JGRC, and they are presented as a reference for the amount of achievement that local farmers can achieve through introduction of the above-mentioned facilities and appropriate technology.

a) Rice Cropping

(a) Low Areas of Floodplains

Rice cropping that is carried out in lowlands and floodplains without embankments has an advantage in that anybody can do it. All that is needed is floating rice that extends its stalks to match rising water levels or deep-water rice. However, yield is greatly affected by rainfall amounts. In general, low rainfall years can see yield of 4 to 7.5 t/ha, although funds for irrigation are required to attain this amount. Years with heavy rainfall nearly eliminate irrigation costs; however, flooding can result in lower yield, or worse, completely destroy yield. Construction of small embankments is an effective means of avoiding risks associated with periods of heavy rain, but they alone do not ensure complete safety.

(b) Upper Sections of Floodplains

If appropriate locations of paddy fields are selected (no danger of flooding based on a study of the maximum flood level in previous years and probable flood level over 10 years), rice cropping can occur with minimum expense allotted to irrigation water. And if high-yield varieties are used, a yield of between 7.5 and 9.4 t/ha can be expected. However, the issue is not elimination of the danger that yield will be damaged by flooding, but rather poor soil fertility and other problems. As countermeasures, efforts should be made to reinforce levees between fields and to implement complete fertilizer management.

Reference: Rice Cropping using Embankments

A stable yield of 5 to 9 t/ha can be expected as long as embankments are undamaged. However, costs associated with construction and maintenance of the embankments as well as irrigation are high. This makes it difficult to realize this kind of yield unless production costs

per unit area are reduced by assigning implementation to the government or a public corporation, expanding farmland area, reducing labor costs, etc.

b) Vegetable Cultivation

(a) Clay Soil in Lowlands

Drainage in these areas is poor, which means that yield is dependent upon the quality of water management. For example, the yield for onions can range from 15 to 33 t/ha for onions and that for cabbage from 15 to 60 t/ha, depending on how water is used. A rather large yield can be expected if irrigation water is adjusted by paying constant attention to the soil water content.

(b) Clay Soil in Sloping Areas, etc.

At the test farm, it was verified that yield can exceed confirmed standard yield if cultivation combines a number of major vegetables (onions, vegetables, tomatoes, etc.) during the dry season. It was also confirmed that a yield for carrots (a vegetable thought to be difficult to grow in the Sahel) of 30 to 40 t/ha can be achieved.

It has been shown that it is possible to grow some varieties of tomato during the rainy season. While yield varies depending on the amount of rainfall, a yield of between 10 to 30 t/ha can generally be expected. This method should be introduced as the rainy season is considered the off-crop season, and therefore vegetables that are shipped at this time can lead to high profits. In this way, by changing the varieties of tomatoes grown and by switching to a system whereby farming takes place year-round, it is possible for farmers to obtain a steady income throughout the year.

c) Field Cropping during the Rainy Season

(a) Major (Essential) Grain Crops

In the case of millet, an increase in yield of 1.5 to 2 times was confirmed if fast maturing varieties are introduced and fertilizing matches conditions. *Parcage* is directly added to animal dung, which increases the effect of fertilizer during periods of heavy rain. However, care must be taken as irregular growth and salt accumulation can occur during periods of insufficient rainfall, which result in a negative effect (reduced yield).

(b) Cash Crops such as Beans

Niébé is a crop that is susceptible to damage from disease and pests. Fertilizer management of *niébé* crops is also quite difficult. For this reason its cultivation by farming households for self-sufficiency purposes should be discontinued. Suitable cash crops that could be planted—for which JGRC attained yields of over twice the

standard yield at its test farm—are peanuts (2 to 3 t/ha), bambara ground nuts (4.5 to 5 t/ha), and sesame (4.5 to 5 t/ha).

c) Fruit Cultivation

JGRC cannot confirm the effects of fruit cultivation. However, in the case of mangoes, harvests can begin as early as two to three years after planting, and a sustainable source of income can be secured if appropriate management is carried out. Furthermore, mature trees are useful as windbreaks and for shade. And they produce not only fruit but also seedlings.

d) Low-water Agriculture

This survey did not produce satisfactory results for sweet potatoes, corn, and *niébé*, all of which were grown using low-water farming. However, it is thought that the merits of obtaining even a small harvest through extensive agriculture are considerable.

7.2.3 Livestock Improvement Plan

1) Summary of Issues

Like agriculture, livestock raising is a major economic foundation for villages in the Sahel. However, in recent years, the amount of available pastureland has been decreasing as farmlands expand, and increases in livestock, nomadic grazing, and transhumance have led to cattle intruding on cultivated lands. Increased grain production and livestock feeding are competing for land use and leading to squabbles over property, while at the same time helping to promote desertification through reduction of the feed base.

In other words, the feed base of natural pasturelands is continuing to be devastated due to soil erosion and overgrazing, and marsh water, which is a vital resource in livestock raising, is drying up during the dry season.

Another reason for lack of feed is the large number of varieties having low productivity on the individual level (despite being adapted to local conditions) that are feeding in the region. Livestock diseases that occur under these harsh conditions also invariably lead to high production losses.

In some areas, there are efforts to return animal dung and urine to farmlands as soil fertilizer by providing millet waste as livestock feed. *Parcage* is traditionally used in this activity. However, almost no measures are being taken to tackle such issues as increased feed production, securement of drinking water, and sanitation management. In this way, traditional rough grazing methods continue to be employed, and human intervention is extremely limited.

It will be very difficult to rapidly change these circumstances as a large number of

factors must be brought into play, including capital and technology. However, there can be no improvement without action. Prevention of progressing desertification and maintaining and increasing livestock production while securing agricultural productivity are issues needing attention in the Sahel.

In order to improve the circumstances surrounding livestock, it is important to gain a grasp of the amount of grassland available and the number of animals in the region, to establish technical standards within an agro-pastoral system, and to raise livestock with an eye toward the total number of animals kept. In addition, it is important to improve feed production, introduce feed trees, and establish such facilities as livestock watering stations and livestock sanitation facilities. Furthermore, efforts must be made to promote livestock as commodity items. Traditionally, cattle were raised as a form of asset, rather than as a marketable item. In the future, a major point for improvement will be to encourage local people to promote meat, milk, and leather as commodities.

While input will of course be necessary when implementing the improvement measures mentioned above, this should be based on procurement of local capital and labor if possible. However, if a certain amount of initial investment should take place, it is important to study an improvement plan whereby local people can engage in sustainable implementation of these measures after the initial investment is made. In this case, the plan must be accepted by local agriculture, livestock, and forestry administrators as well as local people, and it must be something that can be put in actual motion.

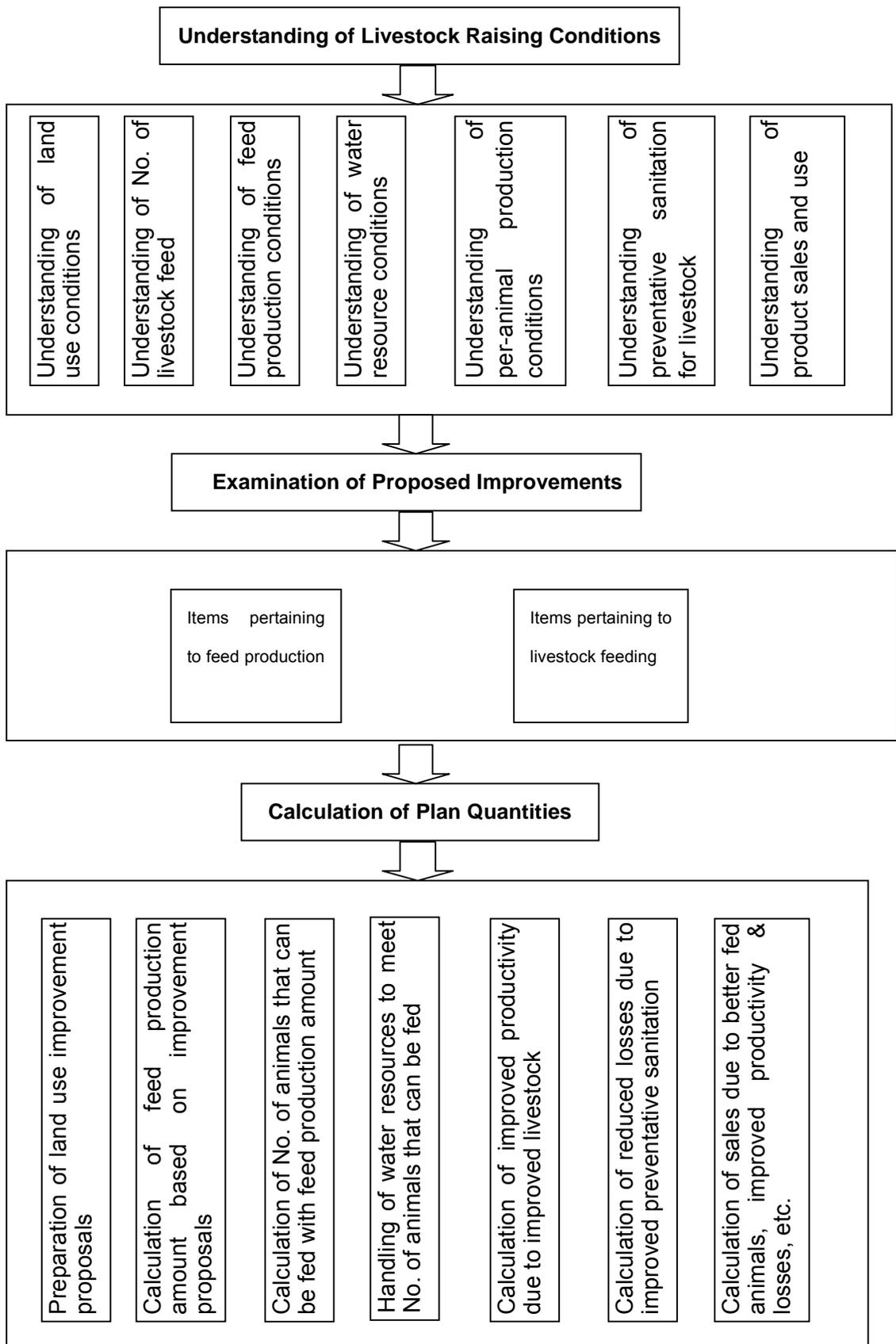
Based on these standpoints, the following method is thought to be appropriate in preparing a regional livestock raising improvement plan.

2) Improvement Method

When preparing a livestock raising improvement plan, work must include ensuring that the content is adapted to actual conditions in the target region and ensuring that improvements are sustainable. This especially requires that consideration be made for the fact that the plan is targeting farmers that still use traditional methods, and that the plan must be simple even for areas that are only minimally impacted.

The procedure shown in Figure 7.2.3.1 is used when preparing the improvement plan. The first thing required is a study of current conditions. This includes the number of animals being raised as well as factors related to the feed production base and livestock feeding. Next, an examination should be carried out to identify areas that need improvement and to rank these areas in terms of priority. In carrying out this examination, it is important to perform calculations on project quantities following improvement and to devise responses based on consideration for plan output.

Figure 7.2.3.1 Procedure for the Livestock Raising Improvement Plan



3) Improvement Plan

This section will discuss improvement proposals for the target region by dividing them into “items pertaining to feed production” and “items pertaining to livestock feeding”. For the former, procurement of feed during the dry season is the main factor, and for the latter, improvement of per-animal productivity and reduction of losses are the main factors.

While specific items are as presented below, it is necessary to select these items based on actual conditions in the region and to implement them in accordance with priority.

(1) Items Pertaining to Feed Production

- 1) Improvement of natural pasturelands, productivity of fallow fields, use, and sustainability

Improvement: sowing of pasture grasses, planting of feed trees, rehabilitation of vegetation through soil preservation

Non-grazing: rehabilitation of wild grass through building of fences

- 2) Improvement of crop waste (stems and leaves) productivity, use, and sustainability
Waste supply method, improvement of processing and usage methods

- 3) Promotion of production and use of inexpensive and high-quality feed supplements

Drying of wild grass, storage and use of crop waste, and preparation of feed supplements

- 4) Improvement of crop waste productivity by promoting use of draft animals and animal dung/urine

Tilling and other activities by draft animals, manufacture of fertilizer in compost pits and enclosures, dropping of dung and urine

(2) Items Pertaining to Livestock Feeding

- 1) Improvement of quality by raising per-animal productivity

Livestock improvement: introduction of high-quality varieties

- 2) Implementation of measures (disease, nutrition) to reduce production losses

Livestock health care and sanitation: education on and implementation of preventive vaccines, procurement of drinking water during the dry season

- 3) Implementation of measures to attach added value

Feeding in improved facilities: establishment of improved feeding facilities, fattening using feed with some purchased content

4) Necessary Expenses

Funds needed to prepare the above-mentioned improvement plan are as shown in Table 7.2.3.1. Facilities and equipment to be improved, the scope of improvement, quantity, etc., should be selected based on actual conditions in the region. In addition, it is important to consider using locally procured equipment and supplies when possible.

Table 7.2.3.1 Necessary Expenses

Unit: FCFA

Item	Details	Breakdown	Unit	Unit Price	Source of Unit Price	Remarks
Feed Production	Drying of Wild Grass Implements	Large scythes	Set	40,000	Current price in Burkina Faso	
		Rakes	Set	5,000	"	
		Donkey carts	Set		"	
		Packing	Set		"	
		Grass sheds	Bldg.	50,000	"	3m × 2m (sun-dried bricks)
	Improved packing (15m×15m)/ place 225 m ²	Chicken wire	m	1,800	2000 price in Mali	2.5m ² / head / (15m×15m)
		Post (2 m)	Post	4,000	1999 price in Mali	20m × 4 × 4step
	Farm implements for draft animals	Ploughs, etc.	Set	55,000	2000 price in Mali	Plow 25,000; hiller 30,000
	Fences to close off non-grazing areas of natural pasturelands	Barbed wire	m	100	2000 price in Mali	1 ha/household
		Posts (2 m)	Post	4,000	1999 price in Mali	950m/side × 4side × 4step
		Plants	Tree	100	2000 price in Niger	(950m ×4side × 1place) /3m
	Sowing of wild grass	Styro	Kg	500	Amount paid in this study	5kg/ha
		Andropogon	Kg	300	On-site price	5 kg/ha
	Livestock Production	Digging of marshes				
Vaccination sites		Metal	Set	1,500,000	Est. price in Niger	
Introduction of cattle (Azawakh)		Males	Head	600,000	1999 price in Mali	1 bull for 30 adult cows
Chicken feed		RIR introduction	Chick-en	5,000	1999 price in Mali	1 cock for each household
		Improved chicken house	Bldg.	50,000	1999 price in Mali	3m × 2m (sun-dried bricks)

7.2.4 Afforestation Plan

1) Summary of Issues

It is commonly known that the Sahel Region of West Africa suffers from shortages of firewood and charcoal. This means that afforestation is essential from the standpoints of environmental preservation and anti-desertification. However, it is not thought that local people who are struggling to get by day to day would be interested in planting trees (something that takes a considerable amount of labor, time, and expense) just for firewood collection purposes while they can still get firewood from natural vegetation. In addition, permanent residents of the Sahel have a strong tendency to see things on individualistic terms. They are therefore not accustomed to joint activities, and this would make a large-scale and intensive afforestation project for firewood purposes extremely difficult to implement.

In the first stage of such a project, individual families should begin small-scale afforestation projects using multi-purpose tree varieties as part of a household-based agricultural system. When results begin to emerge from the planting of these trees, it is desirable that afforestation for the purpose of obtaining firewood and management of natural vegetation that is used by local people each day for firewood be tied together as a second stage. It is expected that, if residents' appreciation of afforestation slowly rises by seeing the results of activities carried out in the first stage, they will become sensitive to reductions and shortages in natural resources, and this will lead them to implement countermeasures at an earlier stage.

Furthermore, there are cases depending on the country where underdeveloped laws related to afforestation mean that local people will not come to own the trees that they plant. That is why it is important to be aware beforehand of the circumstances of common law while also sufficiently conducting education activities on the legal system for local people when beginning afforestation activities.

2) Plan Formulation

(1) Understanding Resource/Consumption Amounts and Tree Use

Currently available methods for understanding resource amounts are extrapolation based on existing documents, extrapolation of timber amounts using aerial photographs, extrapolation of vegetation indices using satellite images, and extrapolation using on-site surveys. All of these methods have both advantages and disadvantages. That's why it is vital to select the most effective method in accordance with conditions.

The amount of consumption can be classified into three use categories: fuelwood, timber, and other (food or medicinal purposes, etc.) A survey conducted by JGRC on the amount of fuelwood used in Niger concluded that 1.14 m³ per person per year is

used in rural areas, and 2.15 m³ per person per year is used in urban areas. By using these figures and regional population figures, it is possible to project firewood consumption in the target region based on the rate of population increase. “Timber” as used here refers to wood used in houses, warehouses, fences, etc., that are generally built in rural areas.

Data collection needed to gain an understanding of how trees and forest resources are used can be conducted through interviews with local people and market surveys.

(2) Selection of Afforestation Form

While working to harmonize afforestation efforts with agriculture and livestock raising, it is desirable to select a form of afforestation that includes consideration of land use for each type of topography. Results are easily obtained by comprehensively combining afforestation carried out at the individual level with that carried out by the community. For example, as is shown in Table 7.2.4.1, while it is possible for individuals to plant trees in cultivated fields and near water areas, planting by individuals in laterite highlands and sloping areas is difficult and produces little effect. Accordingly, it is necessary to conduct joint activities in these kinds of places.

Table 7.2.4.1 Forms of Afforestation with Consideration for Topography and Land Use

Topography	Land Use	Afforestation Form
Laterite highland	Pastureland (grazing area, feed trees, firewood forest)	Grazing forest
Steep slope	Agricultural land conservation (soil stabilization using constructions and afforestation, feed trees) and vegetation rehabilitation	Protected forest
Cultivated areas on gentle slopes (including highlands)	Fertilization of cultivated areas (boundary trees, windbreaks, boundary forests, afforestation for purpose of fertilization, forests for secondary forest products) Agricultural land conservation	Multi-purpose planting, boundary planting
Near water areas such as marshes and depressions (floodplains)	Farming that combines fruit trees and high-income trees (nuts, leaves), vegetables, and rainwater cultivation. Garden development (vegetable and fruit tree cultivation) Establishment of firewood and timber forests	Hedges, multi-purpose planting, production forest

(3) Afforestation Plan

a) Afforestation Classifications

(a) Small-scale and Individual Afforestation

In spurring local people to take action in afforestation, it is first vital to raise their awareness of the environmental problems that confront them. This requires first educating residents and then surveying them to determine what methods they wish to employ to solve these problems.

When conducting this survey, it is important to clarify the objectives of afforestation and to indicate the different forms of afforestation (please refer to the Technical Guide: Afforestation) so that local people will have an understanding of the necessity of afforestation. An effective ways of doing this is to help local people obtain a mental image of afforestation by using simple pictures and other devices that describe each form so that they can chose one. Or, if similar afforestation activities have taken place nearby, local people could be taken to view these activities in order to help their understanding.

Through the above actions, it is possible to identify the persons who wish to implement afforestation and to define the specific content of afforestation activities. Furthermore, it is necessary to determine the varieties and number of trees to be planted by surveying actual planting locations and speaking to the people in charge of planting there. Because there are incidences where planting cannot be carried out because the target area is flooded or due to circumstances facing those wishing to conduct planting, it is important to confirm conditions prior to afforestation and to guide planting preparations. It is also important to provide technical guidance on planting methods through demonstrations to be held at the time of planting. Furthermore, maintenance activities following planting that include building enclosures made of brushwood fencing*, etc., are required to promote the growth of trees and to protect them from livestock damage. The fact that planting carried out until now has not included sufficient maintenance of this sort is a point for self-reflection.

*"Brushwood fencing" refers to a hedge intended to protect vegetable fields, orchards, etc. It is built by erecting supports into which tree branches and millet stocks are woven.

(b) Community Afforestation

If residents' awareness of afforestation is developed through the results of small-scale and individual activity, it is possible to move on to community afforestation as a second stage. While the amount of afforestation required can be figured out on paper by looking at the amount of existing resources and consumption amount (which were

identified at the planning stage), actual afforestation according to this amount faces numerous difficulties arising from land use problems. Furthermore, because there have been many examples of community afforestation efforts failing in the past, organizational structures, post-afforestation management responsibilities, distribution of profit during times of harvest, and other issues must be clearly resolved.

b) Implementation Plan

(a) Obtaining and Raising Seeds

It is desirable to obtain as many seeds as possible on site, as trees that are found in the region are best adapted to regional soil, climatic, and other conditions. Accordingly, it is important to know the season in which local trees bear seeds. Local people have a firm knowledge of when seeds ripen. Therefore, it is important to confirm which varieties bear seeds at which times by interviewing local people. Seed trees that are selected must be a) healthy trees, b) large trees or trees that produce many seeds, and c) trees having superior quality (having high seed production, leaves animals wish to eat, large fruit, etc.).

Technical guidance is required when raising seedlings. Organization of everyday irrigation activities will experience difficulty if local people do not have a clear understanding of the significance of afforestation,.

(b) Planting Technology

1) Planting season

During the first half of the rainy season, rainwater seeps into the soil. The water content in the dry soil creates conditions suitable for plants to grow. Specifically, the time for planting should be decided based on confirmation that rainwater has seeped down to a level below that of the planting hole. Accumulated rainfall of over 100 mm is used as a rough standard for making this judgement. It is desirable that a further 30 mm or so of rainfall occur during planting.

2) Preparation of supplies and equipment

Supplies and equipment needed for planting should be prepared and arranged prior to implementation. These items should be easily obtainable locally and be inexpensive. Corn and millet stocks to be used as mulch should be set aside during the previous annual period.

While it is important to use the water-harvesting method in order to effectively utilize surface water, it is also necessary to prepare planting holes. In areas of hard soil, such as laterite and clay, it is effective to dig planting holes ahead of time and to fill them with fertilizer, etc.

3) Fix planting

Healthy seedlings that have been raised in cool conditions (shade) at the seedling farm are transported to the planned planting site and set into the ground.

In order to improve the rate at which seedlings take root during planting, around 10 dried millet stocks should be inserted vertically around the seedling in order to improve the passage of air and water. Or, in the case of clay soil, sand should be added for the same reason. And, if even more effective root taking is desired, covering the ground around seedlings with a mulch made up of grass and millet stocks following planting is recommended.

(4) Maintenance

a) Maintenance Organization

Post-planting care involves watering (if possible), branch trimming*, building of protective enclosures, and thinning of small forests, etc. Even if local people undertake these activities, there have been cases where livestock raisers cut down trees or where outsiders come to forested brush areas to search for and cut down firewood. It is extremely difficult for individuals to do anything to stop this. That is why it is important for local people to have an awareness that afforestation is a community undertaking so that they will organize themselves to protect and manage their environment.

*“Branch trimming” refers to the cutting of some branches in order to shape a tree into the desired form.

b) Methods for Post-planting Care (Pruning, Cutting, etc.)

Trimming of trees is necessary in order to ensure that trees are able to adequately fulfill their desired functions in farmlands, etc. Also, hedges reduce crop area or provide too much shade if they are allowed to become too big, and for this reason they must be pruned (trimmed) at appropriate times.

Generally, tree trimming is carried out for a number of reasons that include enhancing the appearance of the tree, improving its health condition, improving production of timber, and preserving farmland. In farmlands and other areas, trimming is carried out to obtain animal feed and firewood, to ensure that trees do not hinder the growth of crops, etc. In actuality, farmland owners rarely trim trees, as this is often done by persons related to livestock raising.

c) Methods for Preventing Livestock from Feeding on Trees

The main enemy of afforestation in the Sahel is not the dry climate; rather the biggest danger facing trees is being eaten by grazing or nomadic livestock and termites.

Human intervention to control damage by termites is difficult, as the only measure that can be employed once damage begins is to let nature take its course. However, damage from livestock is believed to be controllable through the use of protective fences.

JGRC performed comparative tests using barbed wire, hedges, and individual enclosures made up of three types of cage (wood cage, metal cage, and millet stock cage). The results indicate that individual enclosures made of wood cages are the most practical in terms of cost and durability.

3) Inspiration and Enlightenment

While there various methods available to inspire and enlighten people, it is desirable for local people who are the target of enlightenment activities to actively participate in two-way dialogue on relevant issues, rather than the implementing side simply taking it upon itself to lead discussion. At this time, it is easier to gain the understanding of issues through use of visual tools such as picture cards or slides. In order to enhance residents' awareness of how their environment has changed over the years, it is effective to have village elders describe what they saw in previous years to their fellow residents. Positive results may also be obtained by conducting observation tours to more advanced regions where highly successful projects have been carried out.

4) Necessary Expenses

(1) Expenses for Producing Seedlings

In most cases, seedlings grown on publicly operated seedling farms are distributed free of charge. However, it is an unfortunate fact that the necessary amount of high-quality seedlings cannot be supplied because of financial difficulties and because the materials and equipment of seedling farms have aged. It is thought that this has resulted in a situation whereby many residents build seedling farms to grow their own seedlings.

Minimum tools required in seedling raising are pots and watering cans. Necessary facilities include enclosures to discourage feeding on seedlings by livestock, covered areas, and water facilities.

In a JGRC survey, the minimum amount of funds required (when water from a nearby marsh was available) was 496,483 FCFA when 10,000 seedlings were produced (depreciation of three years). A seedling harvest rate of 66.6% was recorded at this time, with production cost being 74.5 FCFA per seedling.

It is expected that even more money would be required if a well were to be constructed for seedling production.

7.2.5 Water Resources Development Plan

1) Summary of Issues

Residents in much of the Sahel are dependent upon groundwater drawn from wells for their drinking water. However, there are many regions that experience chronic water shortages because the number of wells is insufficient and because the act of drawing water and maintaining wells consumes a large amount of labor and money. Groundwater levels drop during the dry season, which leaves wells dry. Also, although there are many places with bored wells that use pumps to draw water, there are many cases in which these wells are abandoned if their pumps break down. This is because pump maintenance is insufficient and because the money, parts, technicians, etc., needed for repairs are lacking. Furthermore, there are many quality problems associated with using groundwater for drinking purposes.

Although water for livestock and irrigation can be obtained during periods when surface water from marshes and other sources is available, groundwater is generally used after surface water sources dry up. Surface water sources such as marshes tend to be unreliable, as the period during which they can be used is easily influenced by the size of storage and the amount of rain that falls in a particular year. There are not many wadis or small marshes that can hold surface water for a long time following the rainy season. In particular, surface water tends to dry up quickly in years with little rainfall, which means that local people must depend on groundwater for long periods of time. This results in a considerable amount of labor being allocated to securing resources and drawing water.

As is illustrated above, lack of water supply facilities, insufficient supply capacity and stability, poor management of supply facilities, and other factors are leading to chronic water shortages. This is placing pressure on residents' daily living while hindering sustainable agriculture, livestock, and forestry activities as well as rural development.

2) Improvement Methods

Usable water resources in the Sahel are few compared with regions having heavy rain. However, because the amount of water used compared with the overall amount of water naturally generated by water resources is still quite low, there is room for development. This means that identification of unused water resources and their efficient development will be important issues for the foreseeable future.

On the other hand, it is also believed that future implementation of large-scale river and groundwater development, decreased generation of groundwater in line with denudation caused by progressing desertification, climatic changes, and other factors will result in the drying up of water resources becoming a serious issue. When

formulating development plans, sufficient attention must be paid to future environmental trends that will affect water resources.

Table 7.2.5.1 presents major causes of water shortages in the Sahel at the present time and improvement methods.

Table 7.2.5.1 Major Causes of Water Shortages in the Sahel and Improvement Methods

Major Causes for Water Shortages	Improvement Methods
<p>Use of groundwater has not progressed Small number of wells Traditional wells become unusable when their inner walls collapse, etc.</p> <p>Amount of water that can be drawn by a single well is low Wells dry up when groundwater level falls Wells cannot be built in areas with high groundwater availability</p> <p>Use of wells requires extensive labor Houses (places where water is used) are located far from wells Excessive labor required to draw water Pumps break down -Pumps are old -Pumps are not properly maintained -Money not available to repair pumps</p>	<p>Construct new wells Refurbish traditional wells into modern large bore diameter wells</p> <p>Drill deeper wells Select appropriate well sites based on surveys</p> <p>Construct new wells</p> <p>Refurbish upper well constructions for improved water drawing efficiency Change to human-powered water drawing with large bore diameter pumps Install new pumps Improve pump maintenance Establish a system for procuring funds needed to repair pumps</p>
<p>Use of surface water has not progressed Few places where surface water can be used Little water is stored in marshes Water in marshes soon dries up</p>	<p>Construct small dams, etc. Dredge marshes to expand storage capacity “</p>
<p>Drinking water obtained from wells is contaminated Wells are not properly maintained Contaminated surface water from around the well seeps into groundwater</p> <p>Harmful materials are found in well openings, etc.</p> <p>Water in traditional wells becomes polluted because inner walls collapse, etc.</p>	<p>Establish pump maintenance Refurbish upper well constructions to prevent seepage of polluted water to groundwater Keep livestock at distance from wells Construct wells for drinking water (and for livestock water) Cover wells Change to bored wells Refurbish traditional wells into modern large bore diameter wells</p>

3) Plan Formulation

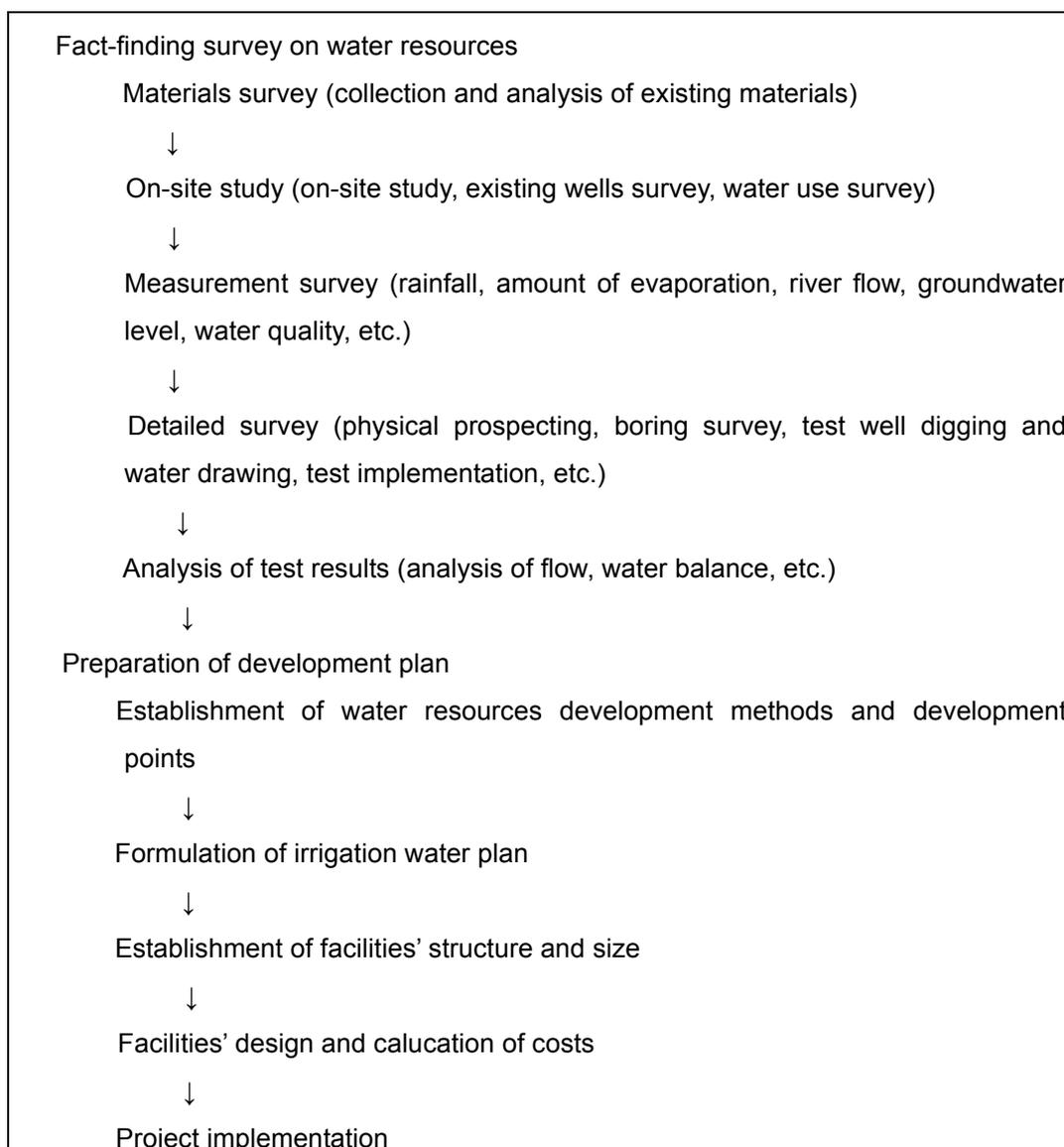
(1) Plan Formulation Process

Usable water resources in a targeted water resources development region are greatly affected by hydrological conditions that include regional climate, topology, and soil quality. Furthermore, there are cases where water resources that can be targeted for development are limited by development objectives, the areas needing water

resources, usage methods, necessary water amounts and quality, etc.

After these hydrological conditions as well as the objectives and usage methods of water resources development are properly understood, a water resources development plan is formulated. Table 7.2.5.2 illustrates the process for formulating water resources development plans.

Table 7.2.5.2 Process for Formulating Water Resources Development Plans



(2) Selection of Water Resources Development Methods

Based on water resources conditions in the Sahel, water resources development must meet the following conditions in order to resolve water shortages and promote sustainable agriculture, livestock, and forestry activities as well as rural development.

- a) Sustainable use of water resources is possible
- b) Comparatively inexpensive water resources can be obtained
- c) Sophisticated technology and construction equipment are not required in water resources development
- d) Maximum effort is made to locally procure supplies needed for water resources development
- e) Maintenance of facilities can be conducted easily

- f) Water amounts and quality that meet objectives can be obtained
- g) A water resource can be obtained nearby the location of water use

Table 7.2.5.3 Methods for Water Resources Development

Classification	Development Methods
Surface water	<ul style="list-style-type: none"> • Construct small dams to store water in wadis • Increase water storage amount by dredging and damming marshes and depressions
Groundwater	<ul style="list-style-type: none"> • Develop shallow groundwater using wells near wadi floodplains • Develop shallow groundwater using wells in areas near small dams, marshes, etc. • Develop shallow groundwater in fractured rock and weathered areas using wells in peneplain areas • Secure and improve quality of drinking water by constructing and refurbishing wells

As is shown in Table 7.2.5.3, development methods that fulfill the above-mentioned conditions include construction of new small dams, improvement of marshes, and construction/refurbishment of wells. These methods are used as a basis when formulating plans.

(3) Points to Consider when Formulating Plans

Wadis are commonly seen in the topography of the region. Some wadis have depressed areas toward the rear of narrow portions that expand out, and this makes them suitable sites for building small and efficient dams to hold in water. It is also possible to increase the amount of water that can be stored by dredging out the bottoms of marshes and depressions and by building embankments around them. By building small dams and improving marshes, etc., the period of surface flooding and be extended, and water can be used during the dry season. If water held by dams and marshes dries up at the end of the dry season, wells can be built in neighboring areas. Through joint use of both groundwater and surface water, water usage throughout the year becomes possible.

In small dams and marshes in particular, the amount of groundwater that is generated increases through underground seepage from stored water. Therefore, establishment of wells around dams and marshes will allow the use of a relatively bountiful supply of groundwater.

On the other hand, many excellent aquifers are distributed throughout the alluvial layers of wadi floodplains. These floodplains are affected by groundwater generation from wadis and are therefore areas of relatively bountiful groundwater. While wadi floodplains are not commonly used, they can become places of new vegetable

cultivation by building wells that will allow use of groundwater during the dry season. When developing groundwater in wadi floodplains, failures in well digging can be avoided by estimating geologic conditions such as bedrock depth beforehand. In this case, a simple soundwave study is effective.

In peneplain areas, which are distant from marshes and wadis, shallow groundwater in fractured rock and weathered zones must be used. There is a tendency in these areas for the groundwater level to be low, and for the amount of water that can be obtained to be low compared to stratum water in alluvium and other layers. In order to determine appropriate sites for wells and identify associated factors, an electrical exploration should be carried out as well as a preliminary study on geologic composition, weathered zones, fractured zones, etc.

Furthermore, when selecting the type of well to be built from the various types available (bored wells, modern large diameter wells, and semi-traditional wells [improved traditional wells]), consideration must be given to such factors as use objectives, construction costs, water drawing method, and maintenance methods.

(4) Maintenance and Management Plan

Facilities' maintenance and management are an extremely important part of sustainable operation. For this reason, it is necessary to confirm the maintenance and management system for the facility at the planning stage.

In principle, local people (the beneficiaries) will assume responsibility for maintaining facilities that were newly constructed or refurbished as part of water resources development. For this reason, a facilities management committee made up of local people that will use the facilities should be established to implement appropriate maintenance. Costs for maintenance and management should be procured from collection of usage fees, etc., from users by the committee.

Furthermore, enlightenment and education activities on maintenance and management of facilities should be implemented for local people.

Table 7.2.5.4 presents an example of well maintenance and management.

Table 7.2.5.4 Well Maintenance and Management Methods

Item	Maintenance and Management Methods
Water quality improvement	<ul style="list-style-type: none"> • Drinking water wells shall be used for drinking water, not for livestock. • When wells are used for both drinking water and livestock, the drinking area for livestock will be moved to a point distant from the well. • Water drawing equipment (rubber bags, strings) will not be allowed to directly touch the ground. • Drainage around the well shall be good, and no dirty water will be allowed to seep in around the well. • Cleaning around the well shall be performed regularly. • A cover shall be used if the well is of the large bore diameter type.
Management of large bore diameter wells	<ul style="list-style-type: none"> • Regularly remove bottom sludge. • Reinforce the well's upper portion.
Management of bored wells	<ul style="list-style-type: none"> • Perform regular pump maintenance. • Repair pumps.
Maintenance/management cost	<ul style="list-style-type: none"> • Collect monthly usage fees from users.

4) Necessary Expenses

Expenses for water resources development consist of survey and design expenses, facilities construction expenses, and maintenance and management expenses.

Survey and design expenses can vary greatly depending on the types of surveys needed, quantities, precision, survey scopes, survey periods, etc. For example, in the case of a small-scale dam, plans are formulated based on the results of geological surveys, hydrological surveys, soil quality surveys, etc. At the same time, designs that are in accordance with established standards must be prepared, which adds to survey and design costs.

In the same way, facilities construction costs can vary greatly depending on the form and size of the facility, local conditions, etc. Table 7.2.5.5 shows construction expenses for newly constructed wells based on a study conducted by JGRC. Construction expenses for each well type vary and are affected by conditions at the construction site, such as the hardness of the soil, etc.

Table 7.2.5.5 Construction Costs for Newly Constructed Wells

Well Type	Expense	Remarks
Modern large bore diameter well	250,000 to 400,000 FCFA/m	
Bored well	80,000 to 130,000 FCFA/m	
Semi-traditional well	60,000 to 80,000 FCFA/m	Scrap corrugated steel pipe was used as a casing component.

In principle, maintenance and management costs are borne by the local people

(beneficiaries). In addition to money for daily maintenance, a facilities usage fee must be established and collected so that money can be allotted to expected repair costs during times of breakdown.

7.2.6 Water Resources Usage Plan

1) Summary of Issues

In the Sahel, there are countless wadis from which rainwater routinely or intermittently flows only during the rainy season. Many of the floodplains of these wadis have high potential for water resources development as well as comparatively fertile soil. However, financial and technical problems have meant that nearly all of these wadis remain undeveloped, unused, or underused.

Water resources usage plans are developed based on the water resources development plans mentioned in the previous section. They establish a production base for effective joint use of unused or underused land, and are formulated to establish production activities for sustainable agriculture, livestock, and forestry.

2) Plan Formulation

The water resources usage plan reflects the intentions of relevant residents in the region. It is based on the presumption that local people will engage in independent and sustainable use of water resource as well as regional conditions that were identified by the results of an on-site survey. It is composed of a) a construction plan and detailed design for facilities, b) a construction implementation plan, and c) a maintenance and management plan.

(1) Data Collection

In order to formulate a rational water resources usage plan covering design, establishment, operation, and maintenance of appropriate facilities through understanding of regional conditions and demands with regard to water usage, the following basic data must be collected.

a) Understanding of Usage Aims for Water Resources

Because issues connected with water resources in the region cover a broad range, it is important to conduct on-site fact-finding studies, to hold dialogues with local people to identify their demands and intentions, to formulate countermeasures that are necessary in the region, to fix the priority of these countermeasures, and to define water use aims that will be the foundation of the “water resources usage plan”.

b) Understanding the Forms of Water Resources, Their Locations, and the Quantity of Water Resources to be Developed

Based on the separately formulated “water resources development plan”, on-site surveys should be conducted as needed, and the forms, locations, and quantity of water resources to be developed should be determined.

c) Selection of Appropriate Areas for Irrigated Fields, etc.

Studies on distance from water resources, topography, soil fertility, and makeup of necessary facilities should be undertaken to facilitate selection of appropriate locations if irrigated and low-water fields, floodplain paddies, etc., are to be established along with water resources usage facilities.

d) Collection of Relevant Data

Data pertaining to the following items should be collected with reference to on-site studies and previous projects:

- 1) Evapotranspiration of necessary crops for determining appropriate irrigation water usage amounts if irrigated fields are to be established;
- 2) Number of heads of livestock to receive water if a watering place for livestock is to be established: and
- 3) Basic data on such items as amount of evaporation and seepage in the target region if low-water cultivation or floodplain paddy rice cropping is to take place

(2) Design of Water Use Facilities

Based on the intentions of local people and regional conditions as identified by on-site studies as well as on basic data, the kinds of appropriate facilities should be selected in accordance with water use aims, and a suitable plan should be drawn up. The following is a listing of representative facilities and points that should be kept in mind.

a) Design of Surface Water Retention Facilities

When water resources are to be used for floodplain paddy rice cropping or low-water cultivation, or in watering places for livestock, holding ponds and mini-dams should be constructed to retain flowing surface water from the rainy season as long as possible or to generate groundwater.

1) Points to remember when designing surface water retention facilities

In order to hold flowing surface water from the rainy season for as long as possible, it is vital to control loss from evaporation from the water's surface or seepage into the earth. It should be remembered that an effective means of

controlling such loss is to build holding facilities that take up little area but are quite deep. Also, spillways of appropriate size should be established to protect the facility as well as to ensure the safety of people living downstream and their assets.

2) Points to remember when establishing floodplain farmland

When conducting paddy rice cropping and low-water cultivation in floodplains that are created by the establishment of surface water retention facilities, there are instances where it is important to create facilities and infrastructure such as small embankments, ridges, and waterways. Accordingly, appropriate zones for agricultural use within the floodplains should be selected based on the results of on-site surveys, and the composition and scale of necessary facilities that are in accordance with topographical conditions in these zones should be studied.

3) Points to remember when designing watering places for livestock

When using water use facilities as watering places for livestock, configurations must ensure that water will be retained for periods of time. Another important point is to ensure that slopes and passageways are designed to allow animals' safe passage into water retention areas.

b) Design of Small-scale Irrigation Facilities

When dry-season vegetable cultivation is carried out using newly developed water resources, it is necessary to establish small-scale irrigation facilities that will transport irrigation water from the source to the field.

1) Setting the size of irrigated fields

Calculation of the area capable of supporting irrigation should be carried out based on appropriate irrigated water amounts determined with reference to the quantity of water resources development and previous projects. Then, the size of irrigated fields should be determined by taking into account the demands of local people as identified in on-site surveys.

2) Study of irrigated plot distribution and policy for allocating croplands to local people

Plot distribution should be decided based on topographical conditions in the irrigated field as well as its size. Also, when determining plot distribution, consideration should be given to topography within the area, soil fertility, and rational distribution of such water use facilities as waterways and water tanks.

Each cropland that has been subdivided will have some inequities in terms of production conditions. It is desirable to study basic policies for allocation of croplands beforehand so that this issue does not disrupt discussions between

farmers participating in irrigated crop production.

3) Detailed plan of small-scale irrigation facilities

The type and construction of small-scale irrigation facilities should be durable, have low construction and operation costs, and be easy to maintain. They should also be determined based on economic conditions in the region as well as the technical standards of local people that will use the facilities. Furthermore, it is important to implement an appropriate design based on the results of on-site surveys and basic data that has been collected.

(3) Facilities Implementation Plan

Based on the type, size, composition, and location of water use facilities and production infrastructure, work should be classified as that to be conducted with community participation and that to be entrusted to specialized businesses. Then a plan covering specific implementation methods and periods; amounts of necessary equipment, supplies, and capital; and procurement methods should be decided for each classification.

a) Plan for Surface Water Retention Facilities

When constructing surface water retention facilities, work that involves comparatively large amounts of earth and sand often requires use of large construction machinery. Also, work that requires large amounts of labor, such as slope protection for dams and spillways and establishment of farmland in floodplains, will call for the participation of local citizens. With regard to materials and equipment needed for work conducted through community participation, a study must be carried out to identify a) necessary amounts of capital for procuring large construction machinery and implements not owned by participating residents, and b) methods for procuring this capital.

b) Plan for Small-scale Irrigation Facilities

Items involved in establishing small-scale irrigation facilities and irrigated fields vary depending on the location and topography of the planned site as well as the details of construction. However, in general, the following procedure is followed: a) cutting and clearing out the roots of weeds and shrubs as well as removal of unwanted items, b) land improvement, c) surveying, c) division into plots, and e) establishment of water use facilities. Work that involves use of comparatively large amounts of earth and sand necessitates use of large construction machinery, and in many cases building of concrete constructions and other similar work requiring specialized technology is often entrusted to a general contractor. However, local citizens can be called upon to do supplementary work and work that requires large amounts of labor. With regard to

materials and equipment needed for work conducted through community participation, a study must be carried out to identify a) necessary amounts of capital for procuring implements not owned by participating residents and for outsourcing work to general contractors, and b) methods for procuring this capital.

(4) Maintenance Plan for Water Use Facilities

Proper maintenance of water use facilities results in better performance and extended lifetime, and leads to reduced expenses. Water use facilities are normally used jointly by relevant residents in a region, and a constant supply of money and labor is needed to operate and maintain these facilities. For this reason, it is desirable to establish an organization made up of users (hereinafter referred to as the “water users’ organization”) that will manage and operate the facilities.

A number of items should be established by the maintenance plan for the water use facilities, including usage rules for the facility and water; composition of the water users’ organization; burden of expenses and fee collection related to operational expenses, etc.; content of and implementation method for maintenance activities carried out by the water users’ organization; and participation in maintenance by local people that make up the water users’ organization.

a) Points to Remember regarding the Maintenance Plan for Surface Water Retention Facilities

With regard to facilities that retain surface water (such as mini-dams and holding ponds), in addition to maintenance of actual facilities themselves, such as dams, it is also necessary to devise agricultural land conservation measures in rear discharge basins and erosion control measures in wadis in order to prevent reductions in capacity due to the influx of earth and sand into retention facilities. For this reason, an action plan should be studied that will a) help water users’ organization members understand that this kind of work and use of the facilities go hand-in-hand, and b) implement said work.

b) Points to Remember regarding the Maintenance Plan for Small-scale Irrigation Facilities

An examination should be carried out on items and methods for guiding persons in charge of facilities operation in water users’ organizations with regard to necessary maintenance skills for the type of facility, including routine inspection items, operating procedures, emergency repairs during times of breakdown, etc. At the same time, a study should be conducted on procurement of necessary tools and repair materials.

3) Necessary Expenses

(1) Construction Expenses

The amount of funds necessary for establishing water use facilities should be calculated based on the amount of labor needed for construction, expenses for construction equipment, and expenses for purchasing materials. These expenses will vary according to the size and composition of these facilities. In cases where difficulties arise due to the technical level of local people, or where processing of iron or steel components or building of concrete forms is required, funds for consigning work to specialized businesses are required. (Please refer to the Technical Guide: Water Resources Utilization for details on expenses for establishing water use facilities.)

(2) Maintenance and Management Expenses

As part of work to maintain water use and water resources facilities, constant funding is required to purchase materials and to procure construction machinery. In addition, when engine pumps are used to draw water, funds to cover fuel and oil are required. These expenses must be borne by the local people that use the facilities. Accordingly, it becomes very difficult to achieve sustainable production if increased income obtained through use of the facilities is insufficient to cover these expenses. That is why it is important to project necessary maintenance expenses and the amount of increased income beforehand, and to confirm that local people have sufficient capacity to assume these expenses.

7.2.7 Agricultural Land Conservation Plan

In the Sahel, vegetation is declining and soil quality is deteriorating due to drought, atypical climatic conditions, and excessive cultivation and livestock grazing. In this region with worsening production conditions for agriculture, measures to prevent soil erosion and to protect farmlands are essential. These measures must be centered on strategies to prevent loss of topsoil from water or wind erosion and to promote seepage of rainwater into the earth through rehabilitation and improvement of soil productivity in order to secure a basis for supporting sustainable production.

The rainy season in the Sahel is characterized by large amounts of precipitation falling in a short period of time. In areas with little vegetation, rain strikes the ground directly and creates a thin crust of clay. These factors work to suppress seepage of rainwater into the ground, which leads to the movement of large amounts of topsoil through flowing. An agricultural area that loses, say, 1 mm of topsoil due to this phenomenon over the course of a year would not appear to be greatly affected; however, the fact is that, at this rate, a farming household's 1 ha field would lose approximately 15 tons of

fertile soil. A 3 ha field would lose almost 50 tons. This kind of loss would make the field unusable as farmland if left unchecked. Local people must be made to understand that, even if efforts are made to rehabilitate farmland after the fact, it takes many roundtrips by donkey cart to bring in the large amount of soil that is needed. When implementing an agricultural lands conservation plan, it becomes clear that, rather than carting in 15 tons per hectare of soil per year, it is better to make an honest effort to save the 1 mm before it is lost.

The agricultural land conservation plan creates a framework whereby local people can gain an awareness of the danger presented to them by this phenomenon (which occurs in their own farmlands), obtain an understanding of the importance of countermeasures, and move forward with enthusiasm and a sense of voluntary cooperation. The plan clarifies the content of specific measures and implementation methods that will contribute to establishment of sustainable agricultural and livestock activity.

1) Summary of Issues

The agricultural land conservation plan must formulate appropriate strategies and implementation plans that can be voluntarily implemented by local people in a sustainable manner. These strategies and plans must reflect evaluations on soil deterioration in the region as well as residents' intentions as identified in on-site surveys. For this reason, the results of on-site surveys must be compiled for study of conservation policies.

(1) Current Status of Soil Erosion

By conducting a detailed study of the site, conditions regarding soil quality and erosion can be indicated on a topographical map. In addition, an in-depth study on crop yields and density/types of plants should be conducted to help analyze degrees of soil deterioration. Based on these studies, selection of the required extent of countermeasures and their methods should be examined.

(2) Methods for Obtaining Residents' Participation

The results of on-site surveys on frequency and length of fallow periods; area of fallow fields; production systems for agriculture, livestock, and forestry in the target region; and organizations and frameworks for joint activity in regional society can be used as materials to study methods for combining public works measures and farming measures as well as strategies for promoting public participation.

2) Conservation Action Plan

(1) Plan for Guiding Enlightenment Activities

a) Provision of Data to Local People

It is important that local people understand the phenomena that are occurring in their fields and villages, the importance of agricultural land conservation plans, and the importance of countermeasures. For this reason, on-site surveys should be conducted with a representative from the region in attendance, and meetings should be held to report the results of these surveys to the local people. Furthermore, conducting study tours to areas where projects were previously implemented can be effective in this regard as they allow participants to see the effects of countermeasures with their own eyes.

b) Establishment of Organization of Local People

Organization of local people must be mobilized in order to promote participation in agricultural lands conservation plans and to implement efficient measures. It is important to move forward in establishing organization of local people based on dialogues with the local people on organizational composition, procedures for establishment, and content of activities. At the same time it is vital to respect traditional social customs in the region that were identified by on-site surveys on regional society. If a framework for community activity already exists, it is important to conduct a full study to determine possibilities for putting this framework to work. (Please see the separately published Technical Guide: Promoting Organization of Local People)

Furthermore, conservation measures should be implemented based on the voluntary participation of local people. Or, depending on the circumstances in the region, if it is shown that combining conservation measures with other motivators, such as application of the Food for Work scheme of the United Nations' World Food Program (WFP) or simultaneous implementation with other measures demanded by the region, a study should focus on ways to promote residents' participation that includes these items. However, the results of JGRC surveys and recent trends indicate that resident participation that is overly dependent upon the Food for Work program does not necessarily produce satisfactory results.

c) Provision of Technical Training

Implementation of specific agricultural land conservation measures will be extremely difficult if local people are not trained in the technology needed for these measures. That is why selection of leader candidates should take place based on dialogues with the local people, followed by implementation of technical training on agricultural land

conservation/soil erosion prevention measures. The content of training and methods for procuring necessary equipment should be studied beforehand.

3) Plan for Implementing Conservation Measures

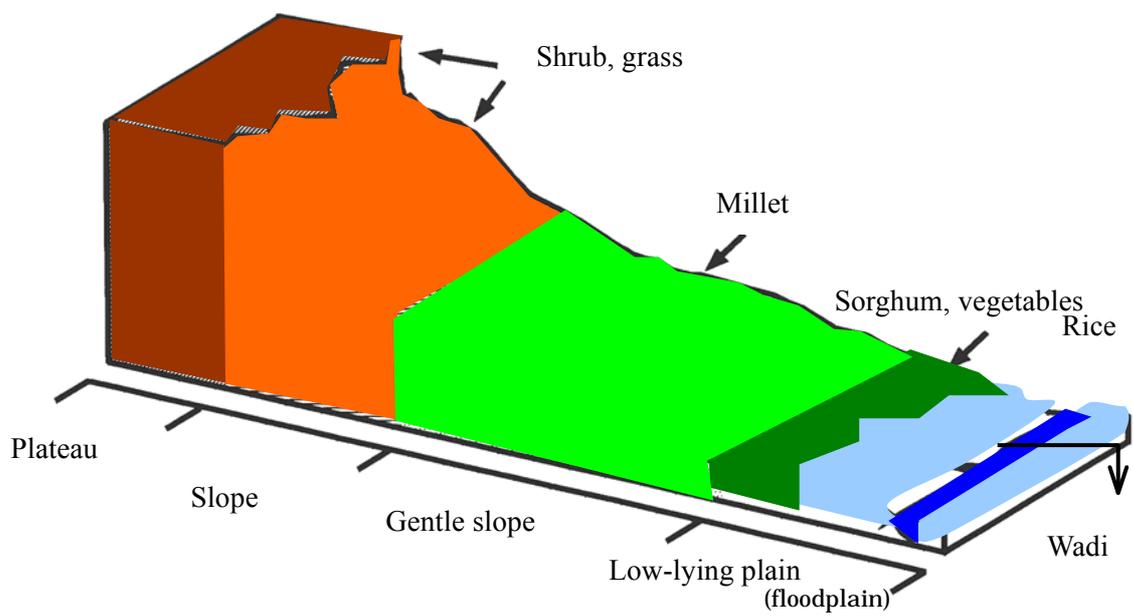
(1) Content of Conservation Measures

Based on the results of on-site surveys, the regions that require measures should be defined and a study of the specific content of measures (methods and quantities to be used) should be carried out.

The agricultural land conservation method illustrated in Figure 7.2.7.1 is commonly used in the Sahel. However, it should be remembered that the method that is most appropriate for the target region should be applied based on consideration of its particular characteristics (topography, soil quality, desired conservation effects, etc.).

The degree of implementation for each method in the targeted region should be computed so that the specific content of implementation (types of materials needed, number of workers, date of commencement, work period, etc.) can be studied.

Figure 7.2.7.1 Topographical Characteristics, Land Use, and Presumed Land Conservation Measures in the Survey Region



Plateau	Steep slope		Gentle slope	Alluvial plain, floodplain	
		Colluvium	Slope with deposits of collapsed soil at the bottom (cultivation area)	Riverbank	Low moisture area
Gradient 0-1%	5-10	2-5	0-2%	0-5	0-1%
Grazing ban Grazing land management Managed reforestation for lumber development	Grazing ban	Protection Reforestation Small embankments for protections Stop zone with good permeability	Developed discharge channels Hedges at zone borders Introduction of water and soil conservation technology Reintroduction of trees into agricultural fields	Reforestation Riverbank protection	Development of reservoirs Effective land usage (improvement of traditional rice cultivation, utilization of grass resources)

Major soil conservation technology in this zone

Conservation technology	Half-moon	Stone dike	Contour ridge	Stone windrow	Zai
Outline diagram					
Characteristic	No transport required	Few topographical restrictions	No transport required	Few material restrictions	Large harvests
Topographical restrictions (surveying required)	B	A	C	B	A
Ability to inhibit surface runoff	B	B	A	B	C (early rainy season only)
Terracing effect	C	A	A	B	C
Construction period	B	C	B (work during the rainy season)	B	C
Durability	C	A	B	B	C
Effect on cultivation	B	B	B (only around ridges)	C	A
Appropriate area	Eroded area	Plateau vicinity, gullies, etc.	Toward the bottom of slopes	Midway on slopes	Eroded area

Note: A, and B C are relative assessment points meaning favorable, somewhat poor and poor, respectively.

Reference values (such as number of workers per unit extension, amount of stone, and number of work days) surveyed by JGRC are presented in technical guides.

(2) Necessary Expenses

In accordance with a concrete implementation plan, computations should be made on types and amounts of materials and equipment, such as shovels and carts, needed to carry out the measures. Approximate items and amounts based on surveys conducted by JGRC are presented in technical guides as a rough standard. Equipment should be divided into two groups: that which participating residents can bring to the project site and that which must be purchased. A study should be conducted on the amount of money that will be needed for equipment purchase.

7.2.8 Organization of Local People

1) Summary of Issues

While local people of the Sahel have some sense that their environment is in worse shape than it was in the past, delayed education and technical extension over many years has resulted in poor awareness of relevant issues. This makes it difficult for local people to analyze current conditions and implement countermeasures on their own. On the other hand, traditional development projects were not able to obtain residents' participation because they placed heavy emphasis on technical aspects, and it is clear that this made many of these projects unsustainable. From self-reflection on these circumstances arose development based on *Terroir* Management, in which public participation forms the backbone of projects. This system is now becoming the mainstay of development in the countries of the Sahel. Unfortunately, however, there are many projects that, despite aiming to be public participatory in nature, are not able to obtain this objective. There are also other projects in which although the community participates, it does not take the central role in implementation. That is why, when making efforts toward development, it is important to give full consideration to these circumstances by thinking about ways of ensuring that local people are aware of the necessity of measures to stop desertification and that they implement these measures.

2) Establishing Organization of Local People

Anti-desertification measures must have the understanding and solidarity of all residents in the *terroir*. However, in looking at their social and economic background, it becomes clear that, in general, Sahel residents are not skilled at engaging in organized activities. Accordingly, it is important to build a support system made up of such bodies as government, project implementing agencies, research institutes, and

NGOs when implementing development. As part of this support, work must be undertaken to promote and guide the CGTV in the development district. By doing this, it becomes important to turn residents' attention toward the deteriorating environment and to make them aware of problem areas and the necessity to take countermeasures. Then, through CGTV activities that are based on public participation, it is necessary to develop residents' "ownership" for development projects as well as their ability to govern themselves (or in other words, "empowerment").

Please refer to the separately published Technical Guide: Promoting Organization of Local People for details on establishing and promoting CGTVs.

3) Formulation of Development Plans

When formulating sustainable development plans, it is important to gather the demands that local people themselves have for development and to prepare a plan that puts local people at the core.

In order to do this, the development agency must work to enlighten local people while building their trust before development can begin. Residents' cooperation is essential in efforts to work in a systematic manner using the *Terroir* Management scheme.

Procedures for work by support agencies and work based on residents' initiative are as follows:

(1) Procedures for Formulating Development Plans

a) Work by support agencies (government, project implementing agencies, NGOs, etc.)

- 1) Identification of superordinate plans
- 2) Comprehension of the content of relevant laws
- 3) Comprehension of social and economic conditions in the village
- 4) Promotion of enlightenment and building of trust with local people
- 5) Understanding of local people's intentions
- 6) Identification of existing organizations in the village
- 7) Development of leaders
- 8) Support for educational and technical extension
- 9) Economic support

b) Work by Residents

- 1) Dialogue among local people
- 2) Awareness and analysis of current conditions
- 3) Study of necessary measures
- 4) Establishment of CGTV

- 5) Preparation of development plan proposals by CGTV
- 6) Establishment of special committees as sub-organizations within CGTV
- 7) Discussions and agreement between CGTV and the project implementing agency
- 8) Formulation of development plans
- 9) Project implementation by CGTV
- 10) Maintenance, management, and evaluation of development by CGTV

(2) Points to Remember when Formulating Plans

Formulation of development plans by local people themselves forms the basis of the *Terroir* Management scheme. However, delays in educational and technical extension among other factors mean that current Sahel residents lack knowledge of anti-desertification measures as well as of ways of methods for implementing these measures. Because of this, it is difficult for local people to decide for themselves how to act on their intentions without guidance from government and development agencies

Development agencies must constantly provide easy-to-understand information to local people while working to ensure that they understand current problem areas as well as methods and effects of development. Furthermore, these activities must be carried out at the same time that education for local people is being implemented. In order to achieve this, support agencies, of which development agencies are the central players, must provide guidance that will help local people implement measures on their own while simultaneously raising local people's capacity to understand current conditions. Support agencies have the vital responsibility of providing local people with advice while ensuring that they have the primary role in development activities.

4) Types of Measures

It is believed that measures related to anti-desertification include production measures for agriculture, livestock, and forestry; water and soil preservation; development of water resources; and improvement of living conditions. Please refer to the development plans and separately published technical guides for each field for specific measures and content. This section presents systematized activities to implement these measures using JGRC as an example.

(1) Operation of CGTVs

CGTVs are made up of a general assembly, secretariat, an administrative body, and an auditing department. Special committees that are endorsed by the general assembly are placed in the administrative body to implement a variety of projects. These special committees are established as necessary to implement activities set by

the CGTV, and a chairperson is assigned to take charge of committee members from the secretariat, etc. The auditing department is established to conduct regular audits on the bookkeeping of each special committee.

When the CGTV implements comprehensive measures, it establishes special committees for such areas as agriculture, livestock raising, forestry (environment), and living improvement. Each committee determines, implements, operates and manages projects to be implemented in its area of jurisdiction. When implementing each project, the committee prepares a set of regulations upon which it implements the activities in its jurisdiction.

a) Special Committees (Examples)

(a) Agricultural Committee (Chairperson)

This committee implements activities related to variety improvement; agricultural land conservation; cultivation of dry-season vegetables; rice cropping; field irrigation; support for agriculture, livestock, and forestry (grain bank, mills, small-scale financing); etc.

(b) Livestock raising Committee (Chairperson)

This committee implements activities related to livestock improvement, pastureland (grassland) improvement, and improvement of livestock distribution. It also establishes livestock watering facilities, etc.

(c) Living Improvement Committee

This committee establishes roads, drinking water, public health facilities (simple medical clinics), etc.

(d) Environment (Forestry) Committee (Chairperson)

This committee implements small-scale seedling farms, planting technology, anti-erosion measures, etc.

b) Fundraising Activities of CGTVs

One of the activities of agricultural committees in CGTVs is support of agriculture, livestock, and forestry. These activities are part of a system whereby the CGTV provides material and monetary assistance to union members that implement each project. These activities include operation of small-scale lending mechanisms, grain banks, mills, and dry-season vegetable cultivation. While these activities also support other projects, at the same time they are effective as a means of raising funds for the CGTV as profits gained are added to its capital. These profits are used in all kinds of activities as self-development funds, and they play a large role in making it possible for the CGTV to engage in sustainable operations.

The following sections will present examples of representative activities.

(a) Small-scale Lending Mechanisms

The following examples can be presented as small-scale lending mechanisms operated by CGTVs. The capital of these systems is managed by a special committee known as the "Small-scale Finance Management Committee".

i. Cultivation Credit

This is credit offered to groups producing agricultural products. During the growing season, the CGTV lends out irrigation pumps, gasoline, fertilizer, pesticides, and other such items, making note of the expenses connected with each. Then, following harvest, it calculates these expenses including interest for collection from each group member (with share determined by field size).

ii. Loaning of Agricultural Capital

At the beginning of the rainy season, the CGTV loans agricultural capital in the form of cash to members who require it on the condition that they will repay the amount in millet following harvest. The money is loaned based on a price for 100 kg of millet set by the CGTV. This price is set higher than the market price the farmer would receive if he or she took his or her millet to market at the time of the loan. The CGTV stores the millet it receives for repayment for sale at a high price during the off-crop season. The difference between the amount of the loan and the amount of sales is kept by the CGTV as profit.

iii. Financing for Fattening Small Livestock

During the Tabaski* festival, the price of lamb rises to four times normal. Local people therefore borrow funds from the CGTV prior to the festival to purchase lambs. They then fatten the lambs for sale during the festival at a high price, keeping the

difference between the amount of the loan and sales as profit.

***Tabaski**

December 10 according to the Islamic calendar is Id ul-Adha (feast of the sacrifice). During this time, men and women dress in their finest attire to gather in front of the mosque and worship. Then each Muslim household sacrifices a lamb (*woso*). Relatives, the local *marabout* (religious teacher), and other believers then share pieces of the lamb with each other.

(b) Grain Bank

The grain bank is set up to supplement insufficient food supplies brought about by reduced grain yield through temporary lending of grain from the CGTV. Using this process, it is possible for local people themselves to adjust grain shortages themselves through the CGTV. In addition, local people need not suffer from fluctuations in market prices that are imposed on them; rather, through the CGTV, they are able to utilize price fluctuations themselves to procure grain at favorable conditions.

The grain bank is operated by a special committee known as the "Grain Bank Management Union".

i. Grain Sales

The grain bank procures grain during the period when prices are low and stores it for sales at below-market price during the off-crop season. In this way, local people do not have to purchase grain at excessive prices when grain stores run out due to drought or other problems. This arrangement reduces the burden on farming households and produces profit for the grain bank.

ii. Grain Lending

The grain bank loans grain in 100 kg bags to local people at an interest rate set by the CGTV. Local people repay the debt in grain at harvest time. This system allows the grain bank to make a profit while at the same time allowing farming households to obtain grain at a cheap price without having to go to market.

(c) Mills

Women living in the Sahel awake with the earliest cry of the rooster to start a full day of chores. These chores, which continue until well into the night, include threshing and grinding millet into flour, preparing meals, drawing water, collecting firewood, raising children, helping in the field, and making handicrafts. Women are usually the

last person in the family to go to bed. Introducing mills into the village will lessen women's workload and allow them to participate in development projects.

Women play a large role in development, and their participation has a large impact on whether or not projects will succeed. Furthermore, establishment of mills consistently ranks among the top demands of village women. On the other hand, use of mills will naturally require collection of usage fees. However, payment of even a small cash fee can be extremely burdensome for women in this poor region who do not receive much income. Accordingly, establishment of mills first becomes effective when means for people to earn cash incomes arise through development activities. In other words, sustainable operation of mills first becomes possible through overall village development.

Mills are operated by a special committee entitled the "Mill Management Committee".

(d) Cultivation of Dry-season Vegetables

Vegetable cultivation is an effective activity because it raises nutritional standards for local people and gives them an opportunity to earn cash. Fields are established using capital provided by support agencies and labor provided by the local people. At a site operated by JGRC, vegetable fields of 100 m² per person (cultivated area: 60 to 70 m²) generated income of 40,000 to 50,000 FCFA. Effectiveness was even further enhanced by combining this activity with a lending mechanism that lends funds to local people for purchase of necessary supplies, such as seeds and fertilizer. In particular, women were able to boost their skills and expand their cash income while at the same time raising their social status in the village by participating.

This activity is managed by a special committee entitled the "Dry-Season Vegetable Cultivation Management Committee".

(2) Enlightenment and Guidance for Local People

For operation of CGTVs to be sustainable, it is important to build a support structure made up of project implementing agencies, government agencies (including agricultural testing and extension agencies), regional NGOs, etc. Then, using this structure, it is necessary to provide support in such forms as enlightenment efforts and guidance through the activities of the CGTV. While there are various ways of accomplishing this, the most important ones are presented below.

a) Technical Extension

Farmers in the Sahel have long been left behind in introduction and extension of new technology related to agriculture, livestock, and forestry. This means that they have had no choice but to apply traditional methods in these fields. That is why it is

important to bring research institutions and extension agencies, in particular, into closer collaboration, to clearly identify skills that can be transferred to farmers, and to implement sustainable technical extension.

b) Training in More Advanced Areas

Use of training in more technically advanced areas can be extremely effective in increasing residents' awareness of issues and in developing human resources. When conducting such training, sufficient time must be set aside to allow participants the opportunity to clarify the objectives of their training and to hold dialogues and opinion exchanges with local people in the advanced areas. Then, following training, participants must be given a chance to tell other residents of the results of their training through "feedback meetings" held in the village.

c) Literacy Education

Literacy rates are extremely low in the Sahel, and many residents cannot read, write, or do arithmetic. This means that, in the management activities of CGTVs, there are demands for improved literacy in such activities as preparation of meeting records, notification of regulations, management of capital, and communication with union members.

Education for children of school age is necessary as these children will be the village leaders in the future. In addition, it is also important to provide literacy training to adults that make up CGTVs, who until now have had few opportunities to receive an education.

d) Education on Improved Ovens

Extension of improved ovens that reduce firewood consumption has been carried out at great lengths in all areas of the Sahel through the support of foreign countries, etc. High expectations have been placed on these ovens as they are able to reduce the amount of firewood used by some 30% compared with traditional stoves. Unfortunately, however, environmental awareness remains low among local people, so extension of these improved stoves is still inadequate.

In many areas—from firewood collection and cooking to drawing of water and agriculture—the lives of women in the Sahel are intertwined with environmental deterioration. These women, who are increasingly feeling the pressure of environmental deterioration, must be educated on destruction of natural resources through extension of these improved ovens. By doing this, it will be necessary to free women from excessive workloads, to raise their status in the community, and to work actively as promoters of development.

(e) Holding of Workshops

- 1) It is first important to identify a partner (group) from among the village's residents that will manufacture the improved ovens. Because this will require continuous extension in the future, it is important to select members that show eagerness for the project and a willingness to participate every day. And, because physical labor is required, it is effective to gain the cooperation and participation of men.
- 2) Next, it is important that teachers be sent to an extension group operated by an NGO or other organization active in the region. Or, a nearby women's group that is making improved ovens and has received education on these stoves could be asked to help.

5) Necessary Expenses

Allocation of funds needed for development should be decided based on discussions held by the project implementing agency and local people. Because Sahel residents generally engage in self-subsistent food production and livestock raising, most have very little in the way of assets. However, when implementing development projects, it is more effective to proceed in a manner whereby local people must assume an appropriate amount of the burden as well as partial responsibility for this burden.

In discussions with development agencies, it is standard to ask local people to provide labor equivalent to labor costs (employment costs) as part of expenses for project implementation. With regard to share of project costs, it is important to determine residents' share based on consideration for their ability to assume such costs.

When projects that will generate profit are to be implemented, a method may be employed whereby the project implementing agency lends capital to the CGTV. The CGTV then repays the loan each year using project profits.

Furthermore, funds will be necessary when extending technology in agriculture, livestock, and forestry to local people as part of development. In order for sustainable agriculture, livestock, and forestry activities to take root in the development district, it will be necessary to secure extension workers that will provide guidance in priority technology in the district during the time required (establishment of objectives). Based on careful consideration of the ripple effect that development will have on neighboring regions, one way of doing this is to employ existing extension workers from government bodies that are supporting development through coordination with the departments in charge of extension. However, it should be remembered that funding for motorcycles, guidance tours, and administrative costs will be necessary.

Finally, it is important that the project implementing agency provide investment to fund education and enlightenment activities for local people as well as observation tours to

more advanced areas.

(1) Organizational Expansion

a) Installation of Mills (Installation of Milling Machines and Mill Facilities)

Installation cost (complete set of machinery 1,685,000 FCFA; mill facilities 150,000 FCFA)

Sun-dried bricks and labor provided by local people: village of Yakouta used as an example.

(Expenses increase if concrete is used.)

b) Establishment of Grain Banks

Establishment of grain warehouses (establishment of facilities that prevent theft and insect damage)

Grain purchase (definition of the size of the bank at the start and procurement of grain from residents' supplies and through support from development agencies, etc.)

c) Establishment of Small-scale Lending Mechanisms

Preparation to proceed with initial capital provided through support and lending from development agencies, etc.

Necessary capital will be procured in accordance with measures implemented by CGTVs.

Through proper management, processes for collection of loans and interest will be clarified, and the scale of operations will grow year by year.

(2) Influence and Enlightenment of Local People (Observation Tours to Nearby Advanced Areas by Rental Car, etc.)

a) Observation Tours of Advanced Areas (Number of tours to be determined based on local people's mastery of technology)

Environment (forestry)

Agricultural land conservation

Mills, grain banks

b) Training

Improved ovens (invitation to NGO or advanced area to send teachers)

Literacy training (education in the local language, invitation to teachers with support from the government)

Training of local people as teachers

Bookkeeping training (for officers of CGTVs)

(3) Technical Extension

a) Assignment of Extension Workers (1 to 2 People)

Motorcycles for technical extension (number to be determined according to size of district)

Fuel, expenses, administrative costs, etc.

7.2.9 Evaluation

1) Necessity of Project Evaluation

The purpose of project evaluation is to determine whether a development plan conforms to its objectives and if it is both rational and efficient. Evaluation is composed of two parts: pre-project evaluation, which serves as an index of project content and objectives for plans prior to project implementation, and post-project evaluation, which serves as a guide for determining the degree to which objectives were met following completion.

Generally, it is thought that the economic effect of investment in development related to anti-desertification measures is extremely low. This is because in many cases development involves efforts to eliminate poverty and to improve food self-sufficiency. Other factors include the fact that most necessary supplies must be brought in from other countries as well as the fact that the Sahel's location in the middle of the continent results in high transportation costs. Finally, there is the fact that agricultural and livestock products from the region do not garner high producers' prices.

2) Content of Project Evaluation

Expanding the content of project evaluations for economic and social effect.

a) Economic effect

Increases in crop production, income (absolute profit), lessening of labor hours, lower production supply costs, etc., can be expressed in monetary amounts. There are many types of methods that can be employed when implementing measures, so it is first necessary to study whether evaluation based on conversion to monetary amounts* is possible.

*Items of anti-desertification measures that can be calculated in monetary amounts

Agriculture and livestock: effect of increases or losses in crop cultivation, increased income, creation of farmland, quality improvement, damage prevention, roads (improved traffic convenience), reduced labor hours, etc.

b) Social effects

There are many aspects that cannot be evaluated or converted into monetary amounts as they are related to national policies or concepts, such as balanced

development throughout the country, elimination of social friction, maintenance of stable food supplies, etc. Alternative methods for attaining objectives are also limited.

- c) Other methods include confirmation of the level of attainment compared to original targets in a post-project evaluation, and evaluation that examines the degree to which individual results of the project (and the effect of development) are sustained after the end of the project.

3) Evaluation of Methods to Measure Economic Effect

In general, calculation of economic effect involves measuring project costs and benefits, using these measurements as indicators for evaluating the project's desirability, and then making a decision on whether or not to implement the project based on the results. Yardsticks used to evaluate the desirability of project implementation are called evaluation standards.

Four primary evaluation standards are presented below.

- a) Benefit Cost Ratio

Dividing the aggregate present value of benefit* (number of years effect will be generated) by the aggregate present value of all costs necessary for construction (initial costs) and costs for management of the project over its lifetime (running costs) produces the benefit cost ratio. The higher this ratio is, the more effective the project.

- b) Internal Rate of Return

The internal rate of return involves calculation of the discount factor obtained by equalizing the aggregate present value of benefit and the aggregate present value of costs. The higher this rate is, the more efficient the project is judged to be. This rate, which is used by the World Bank and other bodies in their project evaluations, is demonstrated in the following equation.

If n years are the number of years in the project's lifetime, B_t is the benefit of t years, and C_t represents costs, the internal rate of return (r) can be asked to satisfy the following formula.

$$\sum_{t=1}^n \frac{B_t}{(1+r)^t} = \sum_{t=1}^n \frac{C_t}{(1+r)^t}$$

(Please refer to the calculation example presented below.)

c) Net Present Value

The larger the difference in monetary amount between the present value of benefit and the present value of costs is, the greater the project's desirability.

Net present value = B - C

B: Overall present value of benefit for n-years of the project's lifetime

C: Present value of costs

d) Net Terminal Value

The larger the difference in monetary amount between the final value of benefit and the final value of costs, the greater the project's desirability. Specifically, this difference is calculated using the following formula.

Net final value = Btv - Ctv

Btv: Final value of benefit after n years

Ctv: Final value of costs

***Present Value** _____

In general, projects are implemented over a long period of time. Using the specified discount factor for benefit and costs that are generated during this period of time, it is necessary to correct values at the present time and make an economic comparison.

For example, if the interest rate 5%, 1 million FCFA would become ¥1 million $\times (1.05)$ = 1.05 million FCFA after one year, ¥1 million $\times (1.05)^2$ = 1.1 million FCFA after two years, and ¥100 $\times (1.05)^{10}$ 1.63 million FCFA after 10 years. Thinking of this as present value, 1 million FCFA becomes 1 million FCFA $\times (1/(1.05))$ =1.1 million FCFA after one year, 1 million FCFA $\times (1/(1.05)^2)$ = 910,000 FCFA after two years, and 1 million FCFA $\times (1/1.05)^{10}$ = 610,000 FCFA after 10 years.

This value, which uses the discount factor to calculate investment values into the future at the present time, is called the present value.

4) Social Effect and its Evaluation

In 1990 the United Nations Development Program (UNDP) issued its Human Development Index (HDI) as an indicator for social evaluation. The HDI established three fundamental factors needed to raise people's capacity and to help them to make full use of this capacity; these are 1) Longevity, 2) Education, and 3) Standard of Living. After assigning these factors a value of between 0 and 1 according to level of achievement, the averages of these factors are used to form an index. The HDI is seen as an important indicator for measuring the level of development in nearby countries or regions, and its application has become quite fractionalized. If data on the region targeted for development is available, the HDI could prove useful as an

indicator in post-project evaluation on the social development effect of anti-desertification measures.

(Please refer to the UNDP's *Human Development Report* for details.)

a) Example of JGRC work in dry-season vegetable cultivation

In vegetable fields allotted to dry-season vegetable cultivation (approximately 60 to 70 m² per person) in the village of Mague, Niger, income was raised by 150,000 to 200,000 FCFA when one-half of the crops were sold. This level of income is extremely effective if it is considered that 80% of the residents in the region are considered impoverished (income of 50,000 FCFA per year).

In establishing a 1 ha field for dry-season cultivation, it is possible to lend 100 m² to 100 residents. For these residents, for whom the only way of earning cash was to work outside the village, implementation of dry-season vegetable cultivation using expanded field area leads to more employment opportunities. This contributes to elimination of farm labor shortages that affect grain cultivation beginning in the rainy season when residents' leave to find work. (JGRC's expenses for establishing the dry-season fields, including establishment of wells, water tanks, and other facilities, totaled 12,840,000 FCFA/ha.)

b) Calculation of Internal Rate of Return (Example)

The following is an explanation of internal rate of return (IRR), which is commonly used by the World Bank and other bodies as a method for evaluating the economic effectiveness of projects.

Using the concept of present value, and based on classification of money flow as benefit (inflow) and cost (outflow), both inflow and outflow are converted into present values. The IRR is the interest rate at the time when the sum totals of these present values equalize, and it is used to determine the relevance of projects. (The present value of χ after t years is expressed as $\chi [1 + \text{interest rate}]^{-t}$.)

Table 7.2.9.1 Examples of IRR Calculation

t year	Cash Outflow	Cash Inflow	Net Cash Inflow	Discount Factor %	Present Value	Discount Factor %	Present Value	IRR	Net Cash Inflow
				20		21		20.86	
			-		×		×		×
1	10	0	-10	0.833	-8.33	0.826	-8.26	0.827	-8.27
2	10	0	-10	0.694	-6.94	0.683	-6.83	0.685	-6.85
3	2	3	1	0.579	0.58	0.564	0.56	0.566	0.57
4	2	7	5	0.482	2.41	0.467	2.33	0.469	2.34
5	2	10	8	0.402	3.22	0.386	3.08	0.388	3.10
6	2	10	8	0.335	2.68	0.319	2.55	0.321	2.57
7	2	10	8	0.279	2.23	0.263	2.11	0.265	2.12
8	2	10	8	0.233	1.86	0.218	1.74	0.220	1.76
9	2	10	8	0.194	1.55	0.180	1.44	0.182	1.45
10	2	10	8	0.162	1.29	0.149	1.19	0.150	1.20
			Net Prsent Value		0.54		-0.09		0.00
			Net Present Value @ %=	20	0.54				
			Net Present Value @ %=	21	(0.09)				
			Internal Rate of Return is		20.86 %				

Using the above table for explanation, is cost (total of project costs and maintenance/management costs); is benefit (increased net profit gained from project implementation); is income; and is the value rebated from the present value using , which is the discount factor (present value when the discount factor is 20%). In the same way, is the present value of after it was calculated using the discount factor in .

Because the IRR involves finding the sum total of when the discount factor becomes 0 in present value, an IRR of 20.86 can be arrived at using the given formula (2) by totaling the present value that was calculated using the two interest rates.

Calculation Examples

$$\sum_{t=1}^n \frac{B_t}{(1+r)^t} = \sum_{t=1}^n \frac{C_t}{(1+r)^t} \dots\dots\dots (1)$$

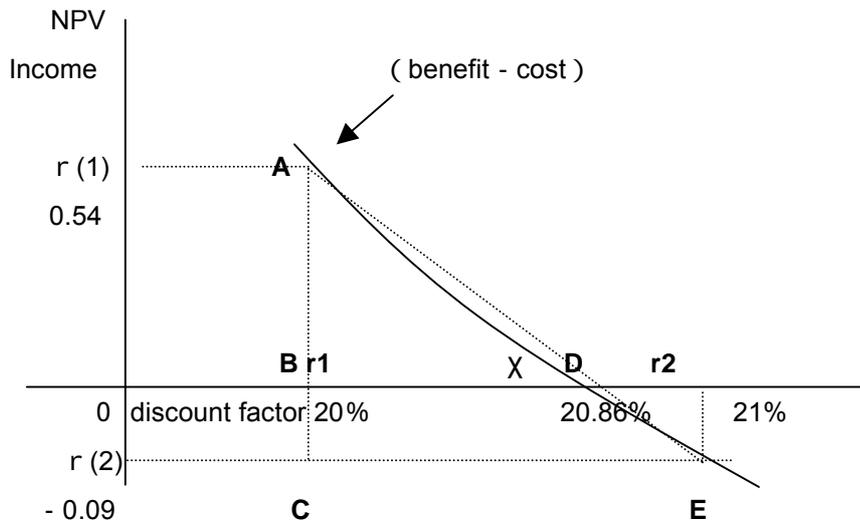
B = Benefit C = Cost
(NPV (r1))

$$IRR = \text{Interest rate(low)} + \frac{\text{difference between interest rates} \times \frac{\text{Sum total of present value of low interest rate}}{\text{Total of absolute present values using two interest rates (NPV (r1) - NPV (r2))}}{\text{(r1)} \quad \text{(r2 - r1)}} \dots\dots\dots (2)$$

$$= 20 + 1 \times ((0.54/(0.54 + 0.09)) = 20.86$$

(Mathematical expression derived from the following triangular analogies)

The following is a graph expressing the items shown in the table above.



In the graph, the present values (benefit – cost) of the two interest rates ($r_1 = 20\%$ and $r_2 = 21\%$ [point $r_2 < 0$])—in other words, the IRR (approximate value)—can be found at the point where χ becomes 0. (The IRR can be obtained from the 0 point between 20% and 21% and the triangular analogies of ABD and ACE.)