Manual for Prevention of Desertification
in Arid and Semi-arid Areas in Asia

Guidelines

— Towards Sustainable Agriculture and Livestock Farming with Forestry —




J-Green

Incorporated Administrative Agency

Japan Green Resources Agency (J-Green)

On publication

Japan Green Resources Agency (J-Green), an incorporated administrative agency, receives an Official Development Assistance budget from the Japanese government (Ministry of Agriculture, Forestry, and Fisheries) and conducts surveys of natural resources, social economies and agricultural conditions, and collects related materials and data, in order to contribute to agricultural and rural community development in developing countries.

Efforts to address global environment problems are the primary theme for J-Green's activities. From a perspective of global environmental preservation, serious problems have arisen, including land degradation caused by population growth, food shortages, poverty and other factors, and the exhaustion of water, natural vegetation and other natural resources.

In arid and semi-arid areas in Asian countries such as China, desertification caused mainly by human activities related to agriculture and livestock farming with forestry, such as overgrazing and salt accumulation, has progressed together with severe natural conditions similar to those found in West African countries. The effects are especially serious in China, where sustainable development and social progress are being prevented by falling ground water levels, drainage of water in rivers, the disappearance of vegetation and occurrences of sand and dust storms.

To address these problems, J-Green has been conducting a study in the Altay Administrative Office Area, Xinjiang Uygur Autonomous Region since 1999, under grants from Japan's Ministry of Agriculture, Forestry, and Fisheries. The goal is to promote measures for prevention of desertification in arid and semi-arid regions in Asia by establishing sustainable technologies for agricultural and rural community development, using the experiences and techniques from measures for prevention of desertification in the Sahel of West Africa.

Agriculture and livestock farming in the Altay Administrative Office Area, Xinjiang Uygur Autonomous Region are centered on agriculture around the oases located at the green periphery of deserts, which are fed by snowmelt from the Altay Mountains, and livestock farming by nomadic pasturing that moves seasonally among mountain pastures. Devastation of natural grasslands as a result of overgrazing – that is, the problem of desertification – has arisen as a result.

J-Green has conducted this study in cooperation with the local pastoral peoples, in order to clarify the causes of such overgrazing, and verify and establish technologies for reducing the devastation of natural grasslands through promotion of sustainable agriculture and livestock farming, based on settlement of these nomadic groups.

This Manual summarizes the results obtained from this study. Consisting of “Guidelines,” a “Technical Guide Manual” and a “Handbook for Agro-pastoralists,” the format is designed to enable local pastoral peoples, along with technicians working at government agencies and other institutions, to utilize the findings easily and achieve practical results.

We earnestly hope this Manual will be used in the Xinjiang Uygur Autonomous Region and similar areas in Asia where agricultural and rural community development aimed at reducing grasslands devastation is being planned or carried out, and will help solve the problems of overgrazing and contribute to sustainable farming by pastoral peoples.

When compiling this Manual, we received guidance and cooperation from many people in both Japan and other countries. In particular, we wish to express our appreciation to the Japanese Ministry of Agriculture, Forestry and Fisheries, the Japanese Embassy in China, the Beijing office of the Japan International Cooperation Agency, the domestic Technologies Investigation Committee, the Ministry of Agriculture of the People’s Republic of China, the Animal Husbandry Office in Xinjiang Uygur Autonomous Region, the city of Altay, Habahe County, and the residents of the survey sites.

March 2006

Japan Green Resources Agency
Director, Overseas Activities Department

Toru Ikeuchi

Preface

Protecting the ecological environment and achieving social development are serious problems that currently are attracting attention from the international community. Achieving sustainable development, through measures such as prevention of desertification and protection of the global environment, is an urgent, serious responsibility on a global scale. Two-thirds of the world's countries or regions, one-fifth of the world's population and one-quarter of all land have suffered damage from desertification. Desertification is directly destroying the foundations of human survival and social development, and has become a factor causing poverty and preventing economic and social development.

The Xinjiang Uygur Autonomous Region, which is located in western China, has the largest, most widespread and most seriously devastated land area as a result of desertification in China, and can be called one of the most severely damaged areas in the world. Xinjiang covers an area of 166km^2, of which deserts, rocky sandy soils and devastated land already exceed 80km^2, or more than 48% of the total land area. Pasture land turned to desert has reached 80 million ha. The task of preventing desertification, and comprehensively restoring land turned to desert and degraded grasslands, is critically important. To control degradation of the environment, the Xinjiang government utilized the opportunity provided by large-scale development in the western area to take effective measures, and during the period from 2000 to 2005 intensively implemented measures to prevent desertification and improve the ecological environment and achieved extensive experience and results in the areas of improving the ecological environment and preventing desertification in Xinjiang. These efforts also laid an excellent foundation for international partnership from the standpoint of prevention of desertification.

To study measures for prevention of desertification through agricultural and rural community development in Asia, beginning in 1999 Japan Green Resources Agency (J-Green) performed a two-year baseline study in areas such as the Altay Administrative Office Area in Xinjiang. The slogan "Human Progress Will Defeat Desertification" in the Xinjiang Uygur Autonomous Region (reduce the amount of devastated land through human efforts), and fundamental concepts such as achieving the prevention of desertification through comprehensive agricultural development and settlement projects, are consistent with the J-Green principal of "promoting the prevention of desertification through agriculture and rural community development." Therefore on September 18, 2001, J-Green and the Animal Husbandry Office of the Xinjiang Uygur Autonomous Region concluded a Memorandum on a Verification Study on Measures for Prevention of Desertification in Asia.

Based on the Memorandum, J-Green conducted verification studies at two sites, in Alahake in the city of Altay and Kerdala in Habahe County.

The studies included two activities. One was research on measures and techniques for prevention of desertification. In cooperation with technicians from China, the study group performing the study conducted extensive research in a broad range of sectors, including irrigation, meteorology, soil, afforestation, diffusion of new varieties of crops, and livestock feeding management. The other activity was preparation of model fields. Fields totaling 18,000 mu were prepared for feed production, windbreak forest belts, irrigation canals and farm roads, and 180 agro-pastoralist households were settled at the sites. As a result of a five-year effort, remarkable results were achieved, and the Verification Study on Measures for Prevention of Desertification in Asia was successfully concluded.

The results obtained by the Verification Study on Measures for Prevention of Desertification in Asia have been compiled in a Manual for Prevention of Desertification in Arid and Semi-arid Areas in Asia. The manual includes “Guidelines, a “Technical Guide Manual” and a “Handbook for Agro-pastoralists.” The Manual, which incorporates the knowledge and efforts of both Japanese and Chinese experts, provides positive guidance and valuable references for projects to prevent desertification in Xinjiang and Western China. We believe publication of this volume will make a positive contribution for promoting exchanges between Japan and China.

On the occasion of the publication of this manual, we wish to express our appreciation to the leaders and experts of the organizations involved, and to the residents in the study areas, including the Japanese Ministry of Agriculture, Forestry, and Fisheries, the Japanese Embassy in China, the Japan International Cooperation Agency, Japan Green Resources Agency, the Ministry of Agriculture of the People’s Republic of China, Foreign Affairs Office in Xinjiang, and the Altay Administrative Office.

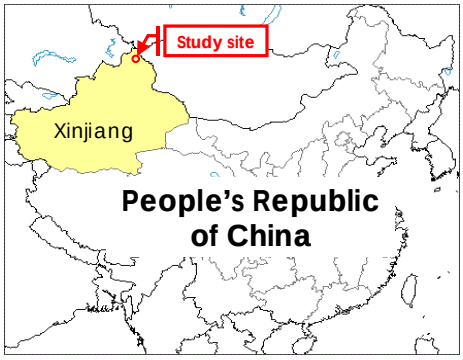
March 2006

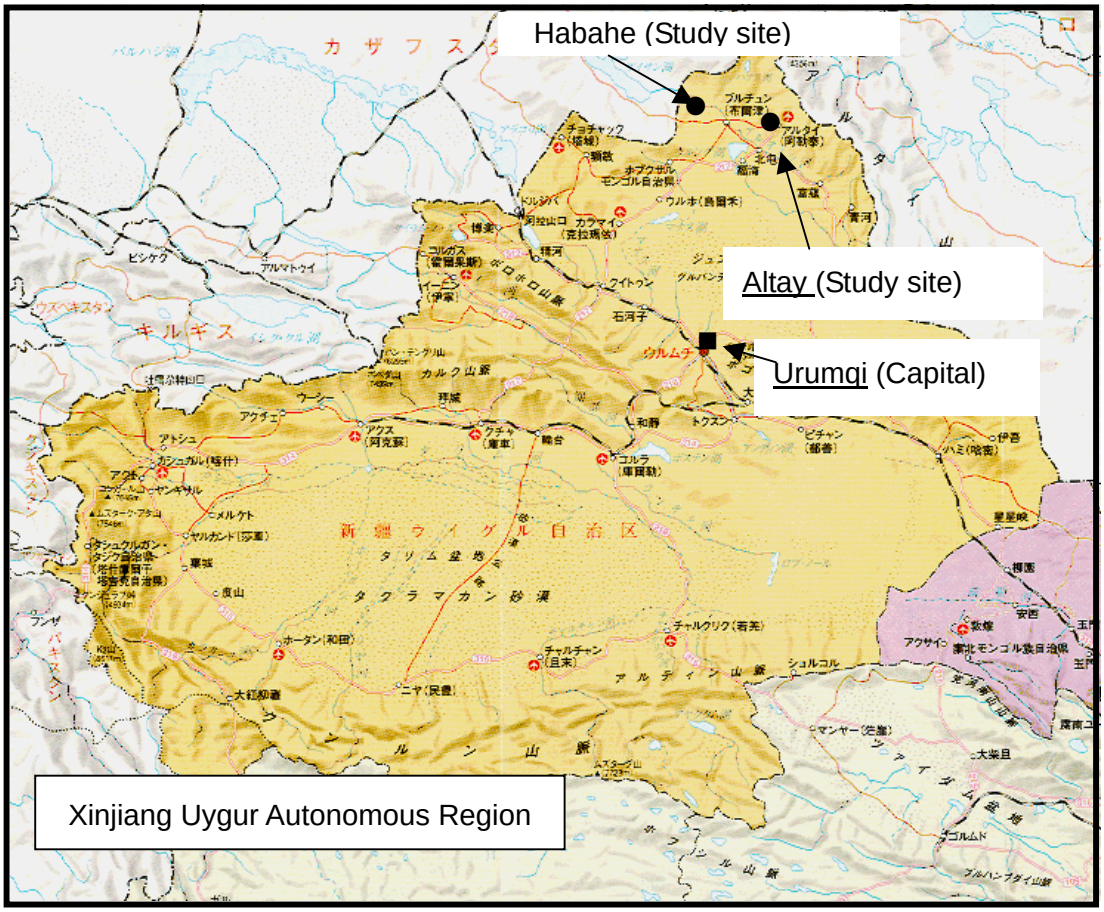
Director, Animal Husbandry Office
in Xinjiang Uygur Autonomous Region

Hubaidoula Hasaiyin

Study on prevention of desertification in arid and semi-arid areas in Asia

Site map





Manual for Prevention of Desertification in Arid and Semi-arid Areas in Asia

Contents

Volume 1 Introduction

Chapter 1 Study on Prevention of Desertification in Arid and Semi-arid Areas in Asia

1.1 Background of the study

In arid and semi-arid areas in Asian countries such as China, desertification caused mainly by human activities related to agriculture, livestock farming and forestry, such as overgrazing and salt accumulation, has progressed along with severe natural conditions similar to those found in West African countries. Especially in China, which accepted the United Nations Convention to Combat Desertification in February 1997, desertification is expanding at an average rate of 2,460km^2 per year, and China is one of the countries in the world suffering most seriously from desertification.

Desertification is a serious environmental problem that is preventing China from achieving sustainable development and social progress. Because of drainage of water in rivers, falling ground water levels, a decrease in vegetation density and frequent occurrences of sand and dust storms, the amount of arable land is decreasing, and desertification is spreading. As a result, desertification has a tremendous affect on agriculture and livestock farming, and establishing measures for prevention of desertification rooted in the local society and economy has become an urgent need.

On the basis of this background, Japan Green Resources Agency (J-Green) conducted a study on the present status of desertification and measures for prevention of desertification in China and the countries in Central Asia over a six-year period beginning in 1993, with a grant from Japan’s Ministry of Agriculture, Forestry, and Fisheries. As a result, degradation of natural grasslands caused by overgrazing of livestock was found to be expanding, especially in the Xinjiang Uygur Autonomous Region in China where nomadism, the typical farming pattern in arid and semi-arid areas, is practiced widely.

There are a number of reasons for these circumstances. In the traditional nomadic cycle, livestock farmers will let their herds graze even in seasons with insufficient grass resources because they have no arable farmland. Moreover, although settlement programs enable such farmers to produce winter feed, growth in the number of livestock is not halted because farmers continue a farming pattern that depends only on the sale of livestock.

Based on the results of this study, J-Green initiated a Study on Prevention of Desertification in Arid and Semi-arid Areas in Asia (referred to below as the “verification study on prevention of desertification") over a five-year period from FY2001 through FY2005, which took into consideration the problems in previous settlement programs, with the objective of examining development methods and

verifying techniques aimed at the development of sustainable agriculture, livestock farming and forestry based on the settlement of agro-pastoralists.

The Altay Area in the Xinjiang Uygur Autonomous Region in China was selected as the study site. Although some settlement programs have been conducted in this area, these have not reduced overgrazing, and degradation of natural grasslands is still expanding.

In this study, we use the expression “agro-pastoralist” to describe settled nomads who are engaged in agriculture and livestock farming in a settlement.

1.2 The traditional nomadic system and degradation of natural grasslands in the Altay Area

Nomadism in the Altay Area takes the form of seasonal migration, utilizing the differences in vegetation and weather depending on altitude. Its range and routes are mostly invariable. The nomadic routes lie between the lowlands and low altitude mountainous locations. For topographical reasons it involves horizontal migration over long distances, rather than vertical migration, with farmers covering a distance of about 500km per year. The range and routes of this migration basically are determined by the local government, giving consideration to the quantity and conditions of grass in each season, and nomads migrate to natural grasslands based on grassland use rights granted from the local government. In the traditional nomadic system, however, nomads would graze their herds even in autumn, winter and spring, when grassland vegetation is scarce, because they did not own feed crop farmland, and this had led to excessive loads being placed on the respective autumn, winter and spring pastures.

1.3 Problems of previous settlement programs in the Altay Area and the need for new measures

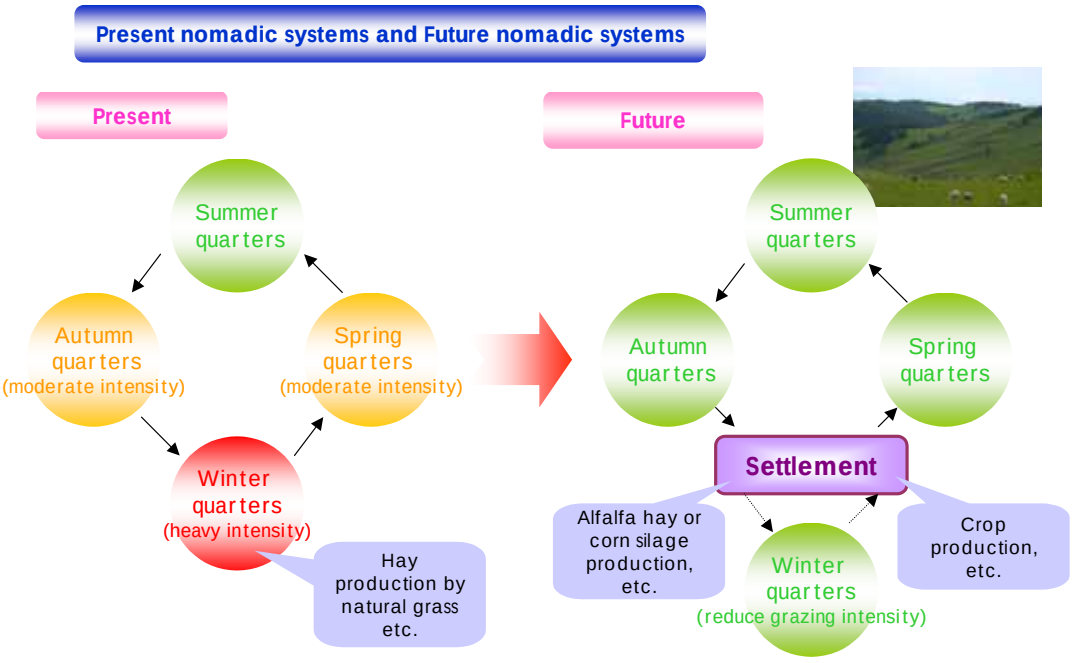
For agro-pastoralists who live through nomadism with sheep and other animals, natural grasslands are an important basis of production. For sustainable nomadism, grasslands conservation is vitally important. As described above, however, degradation of natural grasslands is expanding because of overgrazing from an increase in livestock, and previous settlement programs have partly promoted such overgrazing.

That is, because of a lack of awareness concerning degradation of grasslands from overgrazing, the production of feed crops and cash crops in the producing areas created in previous settlement programs functioned to promote growth in the number of livestock, and this increased the load on natural grasslands. The primary cause of such circumstances was the fact previous settlement programs were implemented as measures to reduce the number of nomads and alleviate poverty, and this can be said to have produced the following issues.

Issues identified in previous settlement programs

(1) Production of winter feed in settlements led to an increase in the number of livestock.
(2) Production of cash crops in settlements was not linked to a reduction in the number of livestock. (Continuation of grazing by herders)
(3) Agriculture and livestock techniques to preserve natural grassland were not applied. (Lack of supportive technology and execution models)
(4) Creation of infrastructure in settlements was not based on the wishes of those living in the settlements. (Lack of basis for livelihood after settlement)
(5) A nomadic system giving consideration to natural grasslands preservation was not created. (Lack of commitment to observance of laws and regulations)

To address such circumstances, measures to enable agro-pastoralists to maintain stable agricultural production activities without placing a load on natural grasslands and a mechanism for cooperation with governmental agencies managing natural grassland, are needed. Therefore the objective of the study was to propose measures towards development of sustainable agriculture, livestock farming and forestry by agro-pastoralists, based on a pasturage system that would not place a load on natural grasslands from settlement, while overcoming the problems found in previous settlement programs.



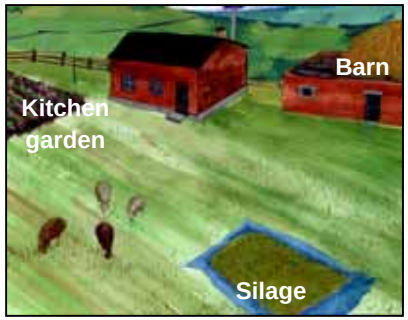
[Previous settlement programs]

Monoculture production system

Nomadism in violation of regulations

Spring, autumn, winter pastures

[This settlement program as a measure for prevention of desertification]



Development of settlement

Establishment of agriculture, livestock farming and forestry in the settlement

Promotion of observance of laws

Pastures with 3 types of functions

Chapter 2 Concept of Measures for Prevention of Desertification in the Altay Area

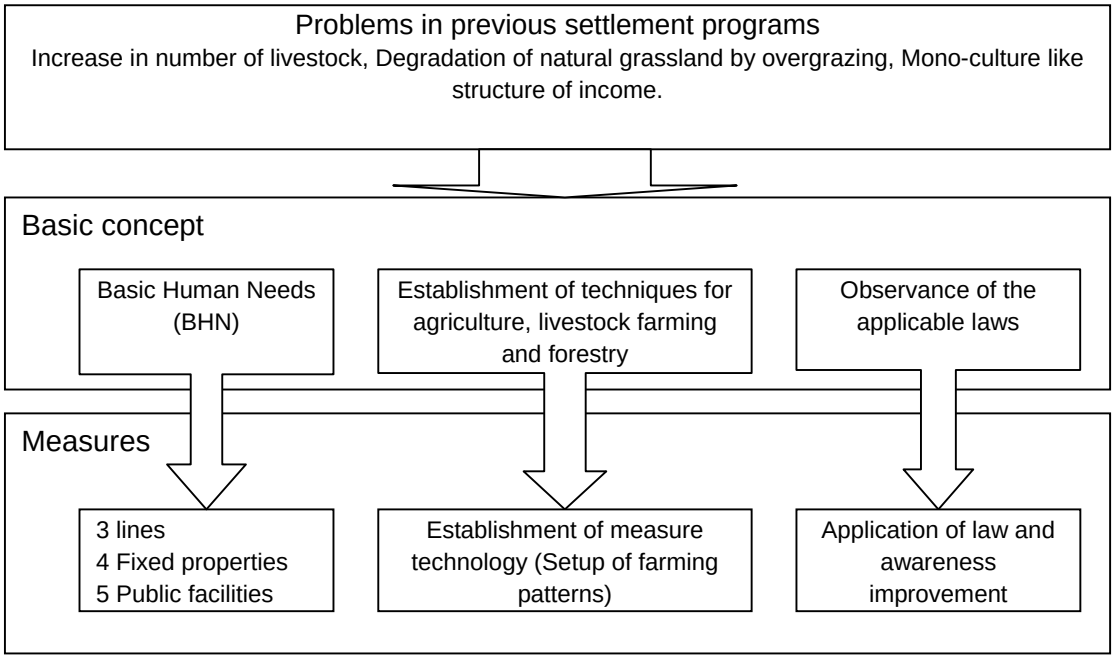
2.1 Concept of measures for prevention of desertification

To control the natural grasslands degradation caused by overgrazing in the Altay Area, creation of infrastructure to support settled agro-pastoralists' livelihood, and management of stable production activities such as self-sufficient winter feed production and diversification of incomes in the settlements, are both necessary. This will help restoration of vegetation in spring, autumn and winter pastures, which will lead to prevention of desertification.

Therefore to develop sustainable agriculture, livestock farming and forestry based on settlement of agro-pastoralists, while taking into consideration the problems under previous settlement programs such as growth in the number of livestock, overgrazing and a mono-culture income structure, for the verification study on prevention of desertification we formulated a basic concept for creation of the infrastructure (BHN, Basic Human Needs) for lives in the settlements, establishment of techniques for agriculture, livestock farming and forestry and observance of the applicable laws for regulation of overgrazing and tree felling, as shown in the figure below. We then implemented measures based on this concept.

The content verified by this verification study on prevention of desertification was the development of techniques to engage in sustainable agriculture, livestock farming and forestry. These techniques consisted of production and field management techniques, such as "self sufficient production of winter feed" and "conservation and management of farmland," and guidance techniques such as "organized activities" for spreading these techniques. These techniques also reduce the loads on natural grasslands, and secure a source of income for agro-pastoralists as an alternative to increasing the number of livestock.

Furthermore, construction of the infrastructure for basic human needs (BHN) by local government agencies and other entities and observance of related laws by agro-pastoralists also are requisites for smoothly promoting this concept.



2.2 Pillars of the basic concept

2.2.1 Infrastructure construction (Basic Human Needs, BHN)

To achieve stable production and lives through settlement, daily lives must be improved based on construction of the necessary infrastructure. As shown in the following table, the organizations implementing the settlement project in the Altay Area are creating the so-called “3 Lines, 4 Fixed Properties and 5 Public Facilities.” Of these, agro-pastoralists must build a house and livestock shed using their own funds, with assistance (materials for building) from the local government.

3 Lines	Roads, service water, electricity
4 Fixed Properties	Houses, sheds, feed production fields, protective forests
5 Public Facilities	Hospitals (clinics), schools, shops, public halls, extension training and technical centers

2.2.2 Establishment of agriculture, livestock farming and forestry techniques

In order to establish the agriculture, livestock farming and forestry techniques by which sustainable farming activities can be conducted without an increase in the number of livestock after settlement, the following contents were confirmed in the verification study on prevention of desertification, and techniques were developed.

Classification	Contents	Method
Production techniques Field management techniques	Self sufficient winter feed production	Forage production
	Income diversification	Cash crop production
	Livestock feeding improvement	Decentralization of sheep breeding, fattening of sheep, year-round feeding of cows
	Farmland conservation and management	Decision on irrigation plan
		Farmland reclamation
		Construction of windbreak forest belts
	Farming improvement	Improvement in farming awareness
Extension and guidance	Farming guidance	Acquisition of farming technology
	Organized activity based on improved awareness	Joint use of machinery
		Cooperative marketing of products
		Establishment of a water management association

Establishing farming patterns is an effective means for employing the agriculture, livestock farming and forestry techniques established to achieve prevention of desertification. The workforce and management capabilities of the settled agro-pastoralists must be considered when setting up such patterns. In the verification study on prevention of desertification, the following three patterns were established. The effect of each pattern in mitigating loads on natural grasslands (the effect contributing to desertification prevention) can be estimated based on the crop cultivation area in the fields (refer to the following table).

	Livestock farming type I	Livestock farming type II	Diversified farming type (livestock farming and agriculture)
(1) Contents of management	Breeding / sale of sheep	Breeding / fattening of sheep, feeding of cows	Combined livestock farming and agriculture
(2) Improvements	Out-of-season breeding of sheep	Silage, fattening of sheep, feeding of cows	Production and sale of cash crops
(3) Land use	Alfalfa	Alfalfa, maize	Alfalfa, maize, soybeans, vegetables
(4) Load mitigation effect on natural grassland (spring, autumn, winter pasture)	Can expect load mitigation of 1 sheep for 180 days per 1 Mu of alfalfa production	Can expect load mitigation of 2 sheep for 180 days per 1 Mu of maize production	Will obtain income equivalent to 2 sheep per 1 Mu of soybean production and sale (Can expect load mitigation of 2 sheep for 180 days = equivalent to reduction of 2 sheep)

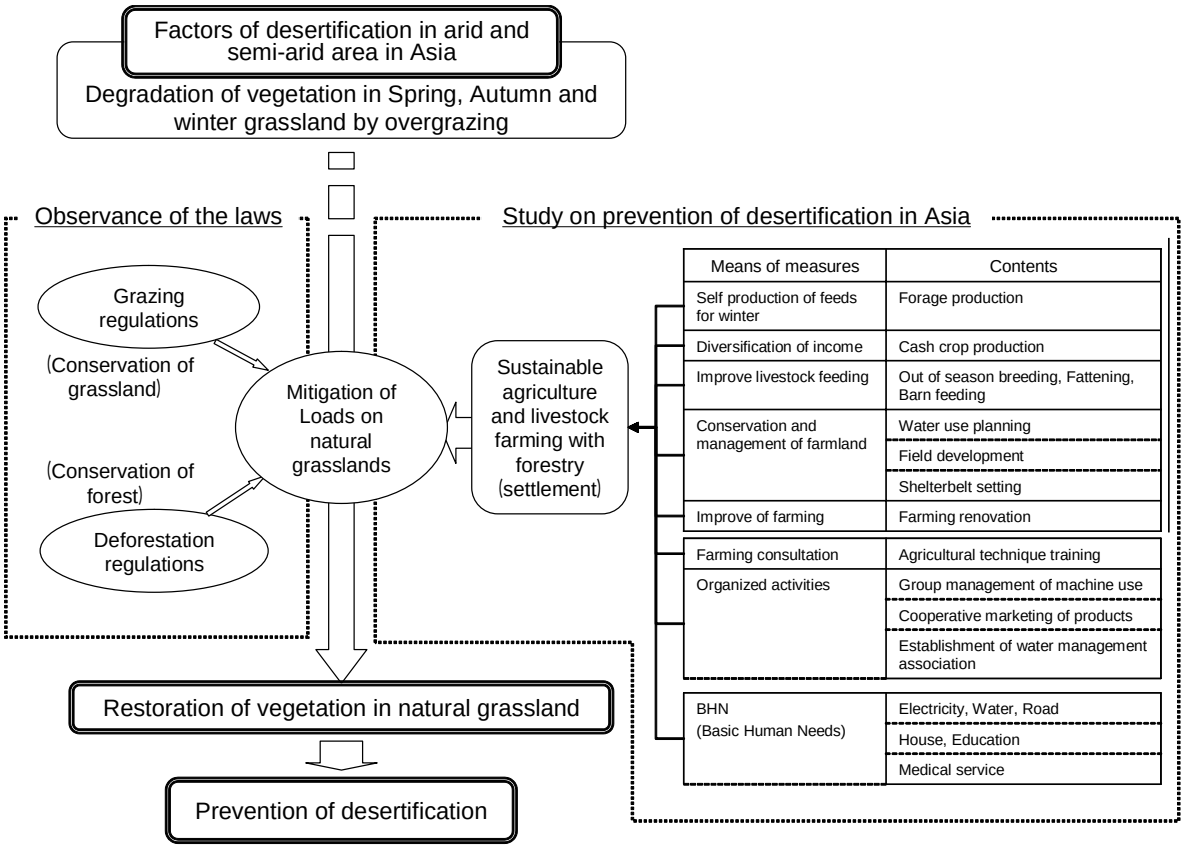
Feeding duration in settlements: 180 days, 1 Mu = 667m^2

2.2.3 Observance of laws

Observance of the legal system is a prerequisite for controlling overgrazing and destructive timber cutting. While laws apply to the entire country, in actual application laws are applied with meticulous detail in accordance with rules that are prescribed corresponding to actual local conditions. Therefore, both appropriate application of laws and enhanced awareness of legal compliance are important.

2.3 Basic concept

The following figure shows the basic concept described so far.



Chapter 3 Manual on Prevention of Desertification in Arid and Semi-arid Areas in Asia

3.1 Objective

This policy manual has been compiled for the purpose of contributing to sustainable agricultural and rural community development, by providing the information necessary for technicians who are responsible for preparation and implementation of measures for prevention of desertification. The goal is to establish measures for prevention of desertification in regions where desertification is progressing as a result of human factors such as overgrazing in addition to natural causes.

Areas where this manual will be applied are assumed to be arid and semi-arid areas in Asia where nomad settlement programs will be carried out and where irrigation agriculture is feasible.

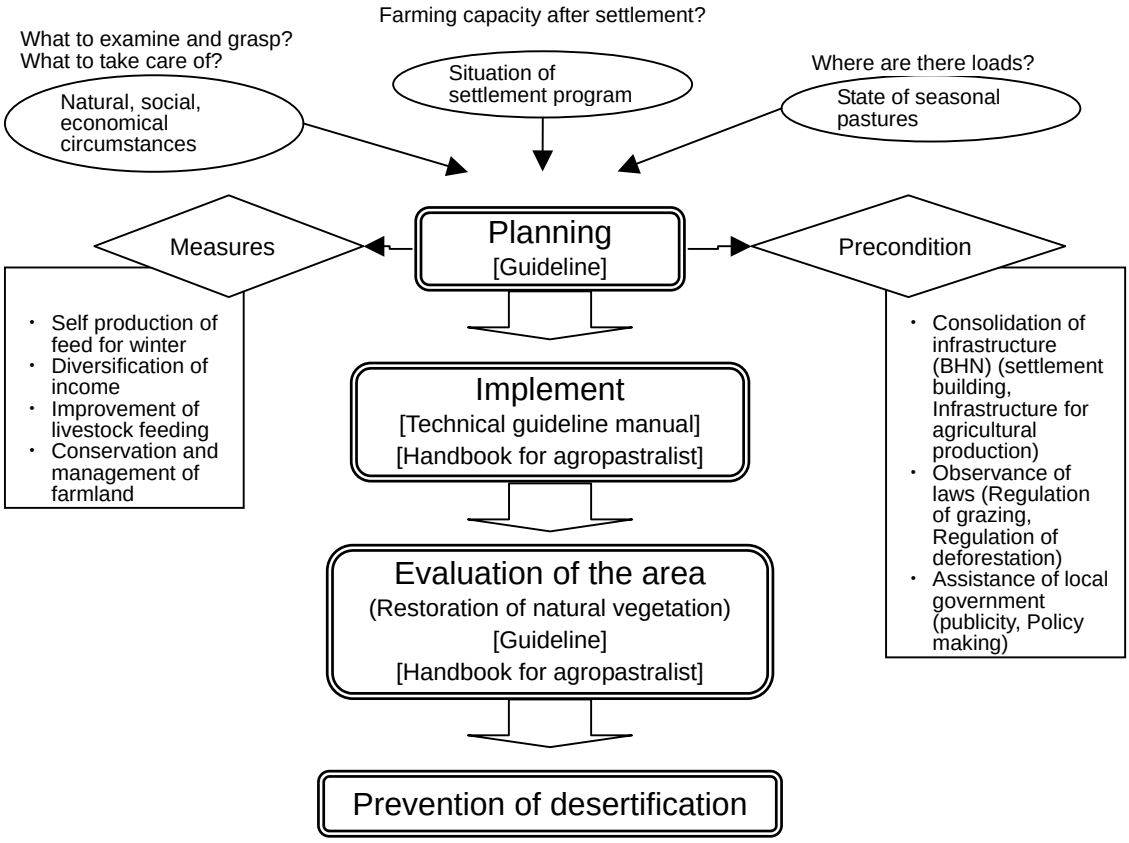
We hope the manual also will be utilized by international organization or NGOs undertaking similar programs.

3.2 Structure

The Manual on Prevention of Desertification in Arid and Semi-arid Areas in Asia is divided into three parts consisting of the Guidelines, a Technical Guide Manual and a Handbook for Agro-pastoralists, which can be applied separately depending on the needs of individuals using the manual.

3.2.1 Role of each component of this policy manual

The following figure shows the role of each component of the Manual on Prevention of Desertification in Arid and Semi-arid Areas in Asia at each work stage. The Guidelines should be used mainly when preparing plans, while the Technical Guide Manual and the Handbook for Agro-pastoralists should be used when implementing and managing plans. The Guidelines and Handbook for Agro-pastoralists can be used when conducting land evaluations for restoration of vegetation on natural grasslands.


Farming capacity after settlement?
What to examine and grasp?
What to take care of?
Natural, social, economical circumstances
Situation of settlement program
Where are there loads?
State of seasonal pastures
Measures
Planning
[Guideline]
Precondition
・ Self production of feed for winter
・ Diversification of income
・ Improvement of livestock feeding
・ Conservation and management of farmland
Implement
[Technical guideline manual]
[Handbook for agropastralist]
・ Consolidation of infrastructure (BHN) (settlement building, Infrastructure for agricultural production)
・ Observance of laws (Regulation of grazing, Regulation of deforestation)
・ Assistance of local government (publicity, Policy making)
Evaluation of the area
(Restoration of natural vegetation)
[Guideline]
[Handbook for agropastralist]
Prevention of desertification

3.2.2 Procedures and points for practical use of the Manual on Prevention of Desertification

The procedures and points for practical use of this Manual are as follows.

Component	Procedures and points for practical use
Guidelines	1. Procedure for practical use Utilize as guidance for planning measures for prevention of desertification. 2. Users Technicians in charge of planning and execution of measures for prevention of desertification 3. Points ・Comprehensively explains matters concerning situations and problems to be understood before planning (eco-environmental, sociological and economical conditions of an area, settlement program circumstances and seasonal pastures for pasturage, issues concerning the programs and pastures). ・Not only a general outline, but guidelines containing examples in the Altay Area. ・Both environmental preservation of an area and stable farming activities in settlements are considered. That is, the Guidelines are not merely for projects for settlement but illustrate measures to enable control of spring, autumn and winter pastures through production in settlements and stabilization of livelihood, and address rehabilitation of natural grasslands and large-scale prevention of desertification (considers the dual aspects of environment and settlers' lives). 4. Structure Chapter 1 Structure of the Guidelines Chapter 2 Main Points for Designing a Plan Chapter 3 Procedure for Designing a Plan Chapter 4 Introduction to Verification Case Studies by Japan Green Resources Agency (J-Green) Chapter 5 Reference Data The flow from planning to execution is as follows. ・Survey of present conditions ・Extraction of problems ・Selection of the project area ・Survey of water, other resources ・Clarification of measures ・Application of techniques on agriculture, livestock farming and forestry ・Execution of the project ・Area evaluation

Component	Procedures and points for practical use
Technical Manual	1. Procedures for practical use Utilize as a technical instruction book when providing farming guidance to settled agro-pastoralists. 2. Users Local technicians who provide farming guidance to settled agro-pastoralists 3. Points ・Establishes farming patterns that enable farming management in accordance with the management skills of settled agro-pastoralists and the natural grasslands situation (balance dual aspects of environment and settlers' lives). ・Explains production techniques and field management techniques for improvement of yields and income from farming activities in the settlement, in order to secure winter feed and diversify income. ・Describes means to improve each agro-pastoralist's farming techniques and the effectiveness of organized activities. ・Is highly adaptable for many situations because it summarizes both newly developed techniques as well as local techniques. 4. Structure Chapter 1 Setup of Farming Patterns Fundamental thinking for setup of farming patterns Introduction to farming patterns Chapter 2 Production Technique Activities in the settlement Livestock farming type I Livestock farming type II Multiple farming (livestock farming and agriculture) type Chapter 3 Field Management Techniques Matters to consider for reclamation of fields on degraded land Water use for maintenance and improvement of production Windbreak forest belts for land conservation Field management calendar Chapter 4 Organized Activities Farming guidance Organized activities Organization and management of a water users association

Component	Procedures and points for practical use
Handbook for Agro-pastoralists	1. Procedures for practical use This is a booklet designed to enable settled agro-pastoralists to conduct farming activities for themselves. 2. Users Settled agro-pastoralists. To be used effectively, guidance provided by local technicians will be necessary. 3. Points ・Briefly explains points concerning farming and other activities. ・Uses numerous illustrations to visualize the contents for easier understanding. ・Prepared in monochrome to facilitate printing and wider use. ・Produced as separate volumes, making it easy to carry to work sites. 4. Structure [Environment] ・Aims at agriculture and livestock farming that protect natural grasslands ・Aims at environmentally-friendly farming [Livestock farming type I, II] ・Guidance on herbage cultivation and hay processing ・Guidance on forage crop cultivation and silage processing ・Summer mating and winter lambing of sheep ・Fattening of sheep ・Cow milking method [Multiple farming (agriculture and livestock farming) type] ・Guidance on soybean cultivation ・Guidance on oil sunflower cultivation ・Guidance on kitchen gardens [Field management techniques] ・Efficient irrigation procedure (Preparation before planting) ・Efficient irrigation procedure (Irrigation work after planting) ・Windbreak forest belt management procedure [Life in the settlements] ・Farming management ・Towards realization of life with enhanced roles for women

Volume 2 Guidelines

Chapter 1 Structure of the Guidelines

These Guidelines have been compiled on the assumption they will be used primarily as a guidance manual for designing plans concerning measures for prevention of desertification. As used here, plans concerning measures for prevention of desertification are plans that will be achieved through settlement of agro-pastoralists. Such plans will be implemented with the expectation of achieving vegetation recovery in winter pastures by engaging in stabilized production and lifestyles, after changes to farming patterns and income structures, including diversification of income by means such as creation of a basis for production of feed and other materials, production of feed during winter, improvement of livestock feeding and production of cash crops, based on providing for basic human needs in settlements.

Chapter 2 and the remaining chapters of these Guidelines are organized as follows:

Chapter 2: Main Points for Designing a Plan

Separately describes by item the matters to be used as the main points, in accordance with "Fig. 1.1 Flow from preparation of a plan for measures for prevention of desertification to implementation".

Chapter 3: Procedure for Designing a Plan

This provides greater detail on “Chapter 2: Main Points for Designing a Plan,” and describes matters that must be studied and points that should be considered when preparing a plan for measures for prevention of desertification.

In particular, this chapter describes the matters that should be prepared concerning “3.1 Survey of present conditions” and “3.2 Extraction of subjects” for each item, which are important when preparing a plan.

Chapter 4: Introduction to Verification Case Studies by J-Green

This chapter describes the concrete contents of the survey procedure explained in detail in Chapter 3, based on the results of the verification study on prevention of desertification in the Altay Administrative Office Area, Xinjiang Uygur Autonomous Region, conducted by J-Green to achieve development of sustainable agriculture and livestock farming with forestry that solves the problems created by traditional settlement projects.

Chapter 5: Reference Data

This chapter describes the reference data and social and economic survey

procedures for the case studies in the verification study on prevention of desertification introduced in Chapter 4.

These Guidelines follow the flow shown in Fig. 1.1; subjects are extracted based on the study of present conditions in the target area, project implementation areas are selected based on the results of an analysis of various information and data and the results of coordination with the organizations concerned, and after measures have been clarified, useful means for prevention of desertification are evaluated and a plan prepared. The project is then executed based on the plan.

By developing sustainable agriculture and livestock farming with forestry in the settlements, the ability to accommodate livestock in the settlements will be improved and the number of livestock grazed in spring, autumn and winter pastures can be reduced.

Because this approach will have a substantial affect on natural grasslands and nomadic grazing techniques, when implementing measures for prevention of desertification through settlement projects it is important to quantitatively understand and evaluate the effects from the project, based on a sufficient projection of these changes beforehand.

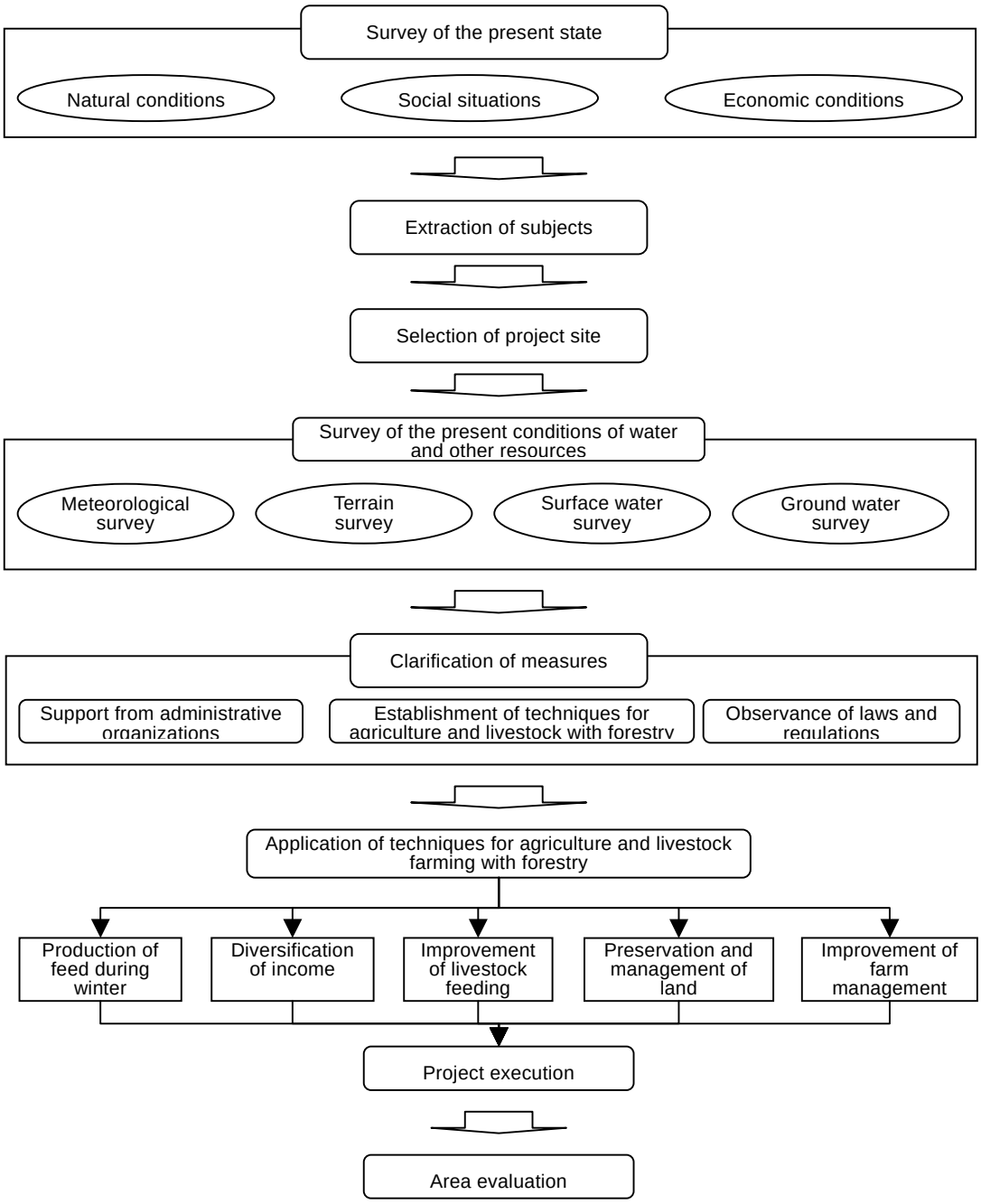


Fig. 1.1 Flow from preparation to implementation of a plan for measures for prevention of desertification

In addition, proper guidance for agro-pastoralists by local technicians will be needed to implement, carry out and manage sustainable agriculture and livestock farming with forestry in settlements. Use these Guidelines after referring to the Technical Guide Manual concerning the methods for technical guidance and other topics.

Chapter 2 Main Points for Designing a Plan

2.1 Survey of present conditions

The natural conditions, social situation and economic conditions of an area that will serve as the basic data needed for consideration of various measures are understood through a survey of present conditions.

Item	Main points	Means to obtain
Natural conditions	・ Is the land suitable for implementation of a settlement project? ・ What affect will climatic conditions have on implementation or management? ・ Can water resources required for production and life in the settlement (water for agricultural use and drinking water) be ensured? ・ What forms do land use patterns take in the area?	Statistical materials, survey/observational data, existing reference literature, etc.
Social situation	・ What influence have social conditions such as population, ethnic groups and history had on the area? ・ What activities are government agencies or the autonomous organizations of the area taking to promote settlement projects and the spread of agriculture and livestock farming with forestry? ・ What are the conditions of language use and the literacy level?	Statistical materials, information collected from local government, existing reference literature, etc.
Economic conditions	・ How are industrial trends in the area changing? ・ Based on the agro-pastoralists' economic conditions, where should the economic level (objective) be set? ・ What is the situation concerning markets for the agricultural and livestock products of the area, what are the distribution conditions and quantities, etc.?	Statistical materials, survey data, information collected from local government, existing literature, etc.

* Because the social situation and economic conditions change continually, it is important to attempt to collect suitable information and data.

2.2 Extraction of subjects

Understand the main factors among the natural conditions, the social situation and economic conditions that have caused desertification, and analyze how these are entwined with the current social and economic system, then extract subjects.

2.3 Selection of the project area

When selecting the project area, determine a suitable area based on the problems in the subject area, in addition to analyzing the data on natural conditions, social situation and economic conditions.

2.4 Survey of present conditions of water and other resources

In the survey of present conditions of water and other resources, implement a survey of the following matters, in addition to accurately understanding the purpose, site conditions and other factors concerning irrigation facilities, in order to obtain the basic data required to select the routes and locations of canals, determine the type of construction, decide on the design and construction method for each facility and manage the facilities in the future.

Items	Main points
Meteorological survey	・ What volume of water resources is collected in the target area watershed? What is the relationship between rainfall and the surface water and groundwater?
Terrain survey	・ Judging from geographical features, where are the watershed boundaries, what are the conditions of river canals and old river canals, what is the extent of the flood plain, are there natural levees, etc.?
Surface water survey	・ What is the quantity of river water or lake water, and what is the form of the outflow?
Ground water survey	・ What is the distribution of the aquifer, condition of bedrock fissures, etc.? Can good drinking water be ensured?

2.5 Clarification of measures

When preparing a plan, first compile a framework that defines the overall orientation of the plan after evaluating basic policies for the measures, based on adequate consideration of the natural conditions, social situation and economic conditions as understood until now and problems in the subject area, then clarify the details of the measures.

Items	Main points
Definition of framework	・ Prepare a framework that defines the overall orientation while coordinating with related organizations and being consistent with other related concept and plans.
Definition of objectives	・ Clarify the objectives, and define the scope of application, target years, results and indicators for the measures, in order to turn the basic plan into specific goals.
Observance of laws and regulations	・ Understand the laws, regulations and other rules concerning the regulation of overgrazing and deforestation, which will be indispensable to prevention of desertification.
Support from administrative organizations	・ To achieve development of agriculture and livestock farming with forestry, understand the details such as financial support currently provided in the area, support for diffusion of farming techniques, etc.

2.6 Application of techniques for agriculture and livestock farming with forestry

Agriculture and livestock farming with forestry techniques must be established as

techniques that agro-pastoralists can use in the settlements. Position these techniques as the means to implement measures for prevention of desertification, and compile them as a package, by appropriately combining the separate techniques for each means, considered from the standpoint of ease of use. Also summarize the matters that will be important for linking the application of these agriculture and livestock farming with forestry techniques to project execution.

Items	Main points
Production of feed during winter	・ Adopt an approach to reduce to the extent possible the use of natural grasslands on which loads have been added, through self-supporting production of feed during winter.
Diversification of income	・ Seek use of techniques that make it possible to shift the income structure away from a structure centered on livestock farming, and stabilize farm management through diversification of income based on production of cash crops.
Improvement of livestock feeding	・ To improve livestock farming management, promote livestock feeding improvements including introduction of animal improvements and superior breeds, diversification of sheep breeding and sales periods, fattening of the sheep and feeding of cows.
Preservation and management of land	・ To maintain and improve sustainable productivity of fields, implement measures such as appropriate rules for water use and creation of windbreak forest belts, and work to preserve and manage fields.
Improvement of farm management	・ To engage in sustainable agricultural production, prepare a farm management plan according to local land uses, farming patterns and management goals, and provide guidance linked to the implementation, instruction and diffusion of techniques based on the plan.

2.7 Area evaluation

A plan can be expected to improve accommodation of livestock in settlements and reduce the number of livestock pastured to spring, autumn and winter pastures, and this can be assumed to produce substantial changes to natural grasslands and techniques for nomadic grazing. Such changes should be understood sufficiently in advance, and the project results understood and evaluated quantitatively.

Items	Main points
Impact on natural grasslands	・ Understand the extent to which the load on natural grasslands has been mitigated, and whether natural grassland vegetation has recovered.
Impact on nomadic grazing	・ Because the extent to which agro-pastoralists depend on natural grasslands for feeding will decrease and the style of nomadic grazing also will change when feed production is performed in settlements, understand what affect settlements will have on the nomadic grazing system.

Chapter 3 Procedure for Designing a Plan

This chapter explains topics such as matters that must be included in surveys and points to take into consideration when designing a plan for measures for prevention of desertification.

The plan for measures for prevention of desertification discussed here is a plan that was designed with the goal of mitigating the load on natural grasslands produced by developing sustainable agriculture and livestock farming with forestry by agro-pastoralists, based on problems with settlement projects implemented in the past in the Altay Administrative Office Area in Xinjiang Uygur Autonomous Region.

Specifically, the plan is expected to achieve vegetation recovery in winter pastures, and become a useful measure for prevention of desertification, by reducing the grazing period that produces grassland degradation through efforts to diversify income by means such as creation of a basis for production of feed and other materials, production of feed during winter, livestock feeding improvements and production of cash crops, based on providing for basic human needs in settlements. By establishing farming patterns that take into consideration agro-pastoralists' labor and management capabilities, the plan also is useful for prevention of desertification.

Individuals responsible for designing and implementing plans for measures for prevention of desertification should familiarize themselves with the details of the matters explained in this chapter prior to designing and implement plans for measures for prevention of desertification. These matters also should be considered when teaching and disseminating plans to local peoples such as agro-pastoralists.

3.1 Survey of present conditions

When designing a plan for measures for prevention of desertification, it is important to understand the natural conditions, social situation and economic conditions of the area and evaluate the plan by adequately considering these factors. Plans must be designed to be harmonious with the area, based on an analysis of the situation. A survey of present conditions is the most basic survey required to extract subjects, based on the natural conditions, social situation and economic conditions of the area. These data also can be used as basic data for selecting a project area and evaluating measures.

When reviewing data, the normal approach is to first understand data on general conditions, based on a review of reference literature on the area, then study more detailed data through field surveys and interviews with the parties concerned. To understand these data, please refer to Chapter 5 Reference Data for the social and economic survey methodologies frequently used in field surveys.

3.1.1 Natural conditions

The natural conditions are the most basic data on an area such as the location, geographical features and climate of the natural location, and the existing quantities and distribution of natural resources such as land and water, that are used when selecting a project area and designing the outline of a plan for farm field development.

(1) Location, geographical features, geology, soil

To design a plan for field development, review the general situation of the area using statistical materials, observational data from past surveys and existing literature, then study conditions such as the terrain, geographical features and soil in the project area. In addition, decide the scope of the project area and orientation of the plan by drawing on these results.

○ Matters that should be summarized	
・ Economic position (Roads, transport, markets) ・ Geographical features, altitude, inclination, main rivers ・ Geology	・ Vegetation (Kinds, extent of cover, grass production volume) ・ Soil ・ Physical properties (particle form and structure, ground water level, topsoil thickness) ・ Chemical properties (pH, humus, N, P, K, Cl)

(2) Weather and water resources

To review matters concerning topics such as water resources, and investigate issues such as the effects weather conditions will have on the project's execution, operation and management, review the data on temperature, precipitation, humidity, evaporation volume, wind velocity, water levels of rivers and lakes and the groundwater level, by reviewing statistical materials, observational data from prior surveys and existing reference literature. This will enable you to understand the affect rainstorms, aridity and other weather conditions will have on the project and farming in the future, and enable you to consider in advance the measures that should be taken in those later phases.

○Matters that should be summarized	
・ Climate zones ・ Temperatures (Average, maximum, minimum) ・ Precipitation ・ Amount of evaporation	・ Non-frost periods (Average, longest, shortest) ・ Daylight hours ・ Affect of weather project execution, operation and management

(3) Forms of land use

Conduct a survey of present land use patterns in the area, and consider how the land can be used when executing the project based on the current conditions.

Considering the fact that livestock farming generally is the main industry in arid and semi-arid areas in Asia, understanding matters such as the current conditions of land use for natural grasslands, agriculture and forestry based on the main industry trends is vitally important.

In addition, if nomadic grazing is being practiced widely in the area, it is desirable to understand the range and routes of migration as a part of natural land use, because the natural grasslands are used over a wide range for grazing.

This approach is an excellent way to develop a good understanding of the many ways in which land use forms are deeply related to the structure of industry in the area, and understand how the land has been used in the area in relation to industry in the area.

○ Matters that should be summarized	
・ Natural grasslands uses ・ Agricultural uses	・ Forestry uses

3.1.2 Social situation

The social situation in an area, including ethnic group composition, population and customs, will have a major affect when conducting activities such as the use, management and dissemination of various techniques, and a survey of these factors must be conducted in advance. Such a survey will enable you to perform studies and other activities aimed at an approach that gives adequate consideration to factors such as the position of local peoples (ethnic, racial groups), the situation concerning languages used and local government entities.

(1) Population and households

To study the orientation for promotion of agriculture and livestock farming through the population trends in the area, study the population or household trend and the trends in the population ratio by age in the area, and analyze the future outlook.

The trend in population or the number of households is greatly affected by family patterns (large family or nuclear family) in an area. In particular, the number of households also can be changed significantly by the type of family pattern by which nomadic peoples will migrate under the settlement project. Moreover, the trend of the population ratio by age will be affected not only by the individuals who will be responsible for agriculture and livestock farming in the future, but also by the projected consumption trend, change of eating habits and other factors. Because these factors can also greatly affect the form of farm management by agro-pastoralists, analyzing the future outlook in terms of population and households is extremely important.

○ Matters that should be summarized	
・ Trend of population and households, change of family patterns ・ Trend of population ratio by age	・ Future outlook projected from trends in the matters shown at left

(2) History, ethnic groups and religion

Study the history of the peoples in the area, and the changes in ethnic or racial composition and change in population by ethnic group, based on the historical background of peoples (ethnic groups) residing in the area. It is especially important to give sufficient thought to implementing plans in a manner that will not have a negative influence among ethnic groups, by taking into consideration the ethnic relationships among peoples when disseminating techniques in an area.

Moreover, it is desirable to understand the religious beliefs in the area and the relationships of cooperation among adherents of different religions, because of the need to proceed by adequately considering the religious policies of the government, differences of adherence to religion by various groups and similar concerns when designing, implementing, managing and disseminating a plan for prevention of desertification.

○ Matters that should be summarized	
・ Ethnic or racial history ・ Status of employment in industry by ethnic or racial group	・ Land use condition by ethnic or racial group ・ Religious beliefs, relationships of cooperation among adherents of different religions in the area

(3) Administrative organizations

Because the cooperation and support of government organizations will be indispensable for designing, implementing, managing and disseminating a plan, it is important to understand the administrative organizations in the area. This will entail cooperating with the organization serving as the contact point, or coordinating with the various related organizations that will engage in activities such as planning, implementation, operation and management and dissemination of techniques in the field, when receiving the results of studies and during project implementation.

○ Matters that should be summarized	
・ Administrative organization chart ・ Organizations serving as contact points for project implementation	・ Organizations engaged in planning, implementation, operation and management ・ Organizations engaged in the dissemination of techniques in the field

(4) Conditions at autonomous organizations in an area

Because it will be important to cooperate with the organizations that provide

guidance and support to agro-pastoralists, and implement various activities through voluntary participation by agro-pastoralists when disseminating techniques to them, it is desirable to understand which organizations are providing guidance and support for residents in the area and the circumstances of their activities. The settlements used as a base of production and life for agro-pastoralists in a settlement project will be newly constructed, or formed by making use of existing villages, and understanding the activities of organizations that perform voluntary activities around the area, and using this information for later reference, is helpful particularly when a new village will be constructed, because the settlers will have no record of actual results from settlement activities and will have to start from the beginning.

○ Matters that should be summarized	
・ Structure, systems and roles of local or municipal organizations	・ Activities of the local and municipal organizations

(5) Languages and literacy

1）Languages of the area

In order to exchange information with agro-pastoralists in the field and disseminate techniques to them, it is necessary to understand the languages normally used in the area. This means understanding the languages used by local people in the area, including the local government organizations and area residents. It also is important to consider what type of letters the area settlers used to express those languages when the languages have changed historically or politically.

○ Matters that should be summarized	
・ Languages used by local government ・ Languages used by residents	・ Changes in languages accompanying social transitions

2）Literacy

As with languages, it is necessary to understand literacy conditions among the agro-pastoralists in order to exchange information in the field and disseminate techniques to them. In particular, it is important to consider what method to use to explain the program to local people when implementing, operating and managing the project and disseminating techniques in the field. Such information also can serve as a reference when investigating whether the substantial use of text when preparing explanatory materials and other information will be an obstacle to understanding, or whether to create visual materials using tables, charts and other techniques.

○ Matters that should be summarized	
・ Educational system in the area ・ Literacy conditions by age in the area	・ Outlook for school attendance and literacy rate as a result of settlement

(6) Status of infrastructure construction

To design a plan for measures for prevention of desertification in conjunction with a settlement project, it is necessary to understand the extent to which infrastructure has been prepared as a foundation for production and daily lives. Infrastructure construction conditions also will greatly affect the production and living environments. This means understanding current conditions and the outlook for infrastructure such as roads and basic utilities.

In addition, there are several housing alternatives, such as dispersed housing and collective housing. Especially when a new settlement will be constructed, giving adequate consideration to conditions at the site is also important. When facilities such as basic utilities that should be newly constructed are being considered, it is important to coordinate with the government bureaus concerned, and to the extent possible work to secure the budget and increase the level of services, after understanding the conditions of access to neighboring towns and markets and the status of existing facilities construction (including basic services) in the surrounding area.

○ Matters that should be summarized
・ Status and outlook of road construction in the surrounding area ・ Status and outlook of basic utilities construction in the surrounding area

3.1.3 Economic conditions

Economic conditions are one important indicator for considering what level to set as a future objective, based on present living conditions of the local people and the economic level.

Therefore, review the various data on the economic conditions, using reference literature and interviews, and use this as basic data when studying economic indicators (goals).

(1) Industry in the area

To analyze the trends for major industries in the area, it is important to survey labor force composition by industry, volume of production, production trends and other indicators in an area. When performing the survey, to review the trends for industries in the area, and understand and compile data on issues such as the conditions of production by main industries, the structure of individuals engaged in industry, agriculture and livestock farming, consumption trends and future plans for the area.

○ Matters that should be summarized	
・ Trends for industries in the area ・ Review and compilation of data by industry	・ Conditions of production ・ Structure of individuals engaged in industry, agriculture and livestock farming ・ Consumption trends ・ Future plans for the area

(2) Farmers' economy

To consider objectives (indicators) agro-pastoralists should seek to achieve in the future, based on their lives and economic level at the present point in time, it is important to perform a survey concerning conditions such as the current living conditions, income and expenditures, savings, and property and assets of the nomadic people. Classify the survey results by stratum (size) and compare them for characteristics such as management, and consider the level at which to set the objectives agro-pastoralists should seek to achieve after settlement.

○ Matters that should be summarized	
1) Name 2) Number and make-up of family members 3) Family workers and persons engaged in pasturing 4) Form of pasturing (annual cycle) 5) Conditions of natural grasslands use 6) Typical daily work cycle（Head of household and wife） 7) Livestock feeding conditions (Sale, death, self-consumption, calving, donation, etc.) 8) Circumstances for ensuring winter feed 9) Cash income (livestock sales, non-farming income)	10) Details of cash expenditures (Main expenditures per year) 11) Volume of resource consumption for living 12) Selling conditions (Selling periods, buyers, sale locations) 13) Ownership of properties 14) Housing conditions 15) Conditions of daily life 16) Relations with other agro-pastoralists 17) Family illnesses 18) Hopes and opinions for settlement

(3) Present farming conditions

In order to investigate the desirable form of future farming and set up farming patterns, it is necessary to understand present farming conditions. To use the farming patterns in the project area as a reference, perform a survey of the standard farming patterns and agricultural income in the area.

○ Matters that should be summarized	
・ Type and number of feeding livestock	・ Type of crops and production area

(4) Distribution and marketing

Understanding the market and distribution conditions in the area, and selling through an organized system that is beneficial for agro-pastoralists while evaluating selling periods, is extremely important for achieving farming improvements. Perform a survey of the market conditions in the area, the present conditions for distribution from the production areas to consumption areas and the distribution quantities. When conducting a survey, it is important to plan selling strategies, after making an adequate survey by product.

1）Market survey

To study products and selling periods that will be beneficial for agro-pastoralists in the area, perform a survey concerning products handled in the markets, quantities handled, prices and similar market conditions. Analyzing favorable selling periods based on the results is especially important for planning selling strategies.

○ Matters that should be summarized
・ Consumption trends by product, changes in retail market prices

2）Distribution survey

To investigate a selling system that will be beneficial for agro-pastoralists, perform a survey of issues such as distribution routes, means of transport, transport time, transport costs and distribution quantities.

When addressing issues such as favorable selling conditions, issues such as the distribution circumstances in the area and merchants' typical purchasing patterns must be considered and the possibilities sufficiently understood, and adequately understanding the conditions for distribution of livestock products in the area is important.

○ Matters that should be summarized
・ Distribution routes, means of transportation, transportation costs and distribution quantities, by product

3.2 Extraction of subjects

When considering measures for prevention of desertification, it is extremely important to analyze what kind of issues have become problems, as well as what factors have become the primary causes of desertification.

It is critical to understand the main factors among natural conditions or social and economic activities that are causing desertification, and analyze how these are intertwined with the existing socioeconomic system. For example, overgrazing typically is cited as a main factor, but the question of how nomadic grazing as currently practiced encourages overgrazing must be analyzed. In this manual, production of animal feed products in fields based on settlement is taken as a premise, to aim at mitigation of the load on natural grasslands through development of sustainable agriculture and livestock farming with forestry based upon the application of a grazing system grounded in the local area and in production of feed on developed fields through settlement. Therefore when considering future measures, it is also important to sort through the issues noted in settlement projects implemented in the area in the past, or in agriculture production activities on area farmland.

○ Matters that should be summarized
・ Factors among natural conditions and social and economic activities that have caused desertification ・ Relationship between those factors and current social and economic activities ・ Extraction of subjects　(Pasturing, management by nomadic people, agricultural production activities in settlements, settlement project issues, etc.)

3.3 Selection of the project area

If possible, analyze the data on natural conditions, the social situation and economic conditions that were obtained through the field survey when selecting the project area, and decide an appropriate area based on the area issues identified. One procedure that can be used when narrowing down the potential sites from several selected candidates is to establish a set of evaluation items and criteria as shown in Table 3.3, and select the site after assigning points and making a comparative evaluation of the total scores for each candidate site.

In addition, although the evaluation criteria should be set after a suitable examination according to the actual conditions of the area and other considerations, the measures for prevention of desertification aimed at mitigation of the load on natural grasslands through feed production on developed fields based on settlement also must take into consideration from the beginning whether it is possible to ensure the water resources required for agriculture and livestock-farming and daily lives, as well as transportation conditions, salt accumulation in fields and similar concerns. The residents' cooperation also is needed when promoting a project while receiving local resident involvement. It is important to also consider such issues when establishing the evaluation criteria.

Table 3.3 Evaluation procedure for project implementation candidate areas

Evaluation item	Evaluation criteria				Remarks
	A	B	C	D	
Affect on desertification	High	Medium	Low	None	State of desertification, including wind erosion, accumulation of salt
Accumulation of salinity	Heavy	Medium	Light	None	Accumulation or potential for accumulation of salinity
Ability to secure water resources	Easy	Possible	Difficult	Impossible	Usable quantity and possibility of distribution
Participation by local people	Easy	Possible	Difficult	Impossible	Cooperation of local people
Access to transportation	Good	Medium	Bad	Difficult	Convenience of activities

3.3.1 Influence on desertification

Normally judged and evaluated from circumstances such as the distribution of vegetation in the area.

3.3.2 Accumulation of salinity

Evaluate whether accumulation of salinity is already occurring in the area, and project and evaluate the probability that accumulation of salinity will occur in the future as a result of irrigation, based on the geographical features, soil and other conditions of the area.

3.3.3 Ability to secure water resources

Judge and evaluate whether the use and development of water resources required for agriculture and livestock farming and for daily life are feasible.

Even when regarded as areas where implementation of a project is necessary, areas should be excluded from eligibility as a project implementation site when the affect of desertification would be serious and securing the water resources would be difficult.

3.3.4 Participation by local people

Local resident participation is indispensable for implementing sustainable agriculture and livestock farming with forestry in an area. When considering implementing a project, evaluate whether the stakeholders in the area can be expected to undertake the project with the intention to participate actively. Moreover, if possible, perform a peripheral survey to evaluate whether the cooperation of agro-pastoralists can be obtained, then take steps to increase the likelihood of participation.

3.3.5 Access to transportation

Judge and evaluate whether a road network from the town center to the area considered for settlement development has been built. If roads have not been built at that point in time, but construction can be expected based on implementation of the project, this can be taken into consideration to evaluate this factor more positively.

3.3.6 Comprehensive evaluation

Assign points based on the evaluated results for each item, and decide on an area after making a comparative evaluation of the total score for each site. Furthermore, because the feasibility of a project can be expected to decline when there are items that are difficult or impossible to evaluate, it is preferable to select an area from among those that can be evaluated or judged as easily as possible and where the need for measures for prevention of desertification is high.

3.4 Survey of water and other resources

In arid and semi-arid regions not only in Asia but in every country in the world, the tight supply-demand situation for water resources generally is a limiting factor for every type of production activity. This means it is important to first understand local conditions, then properly plan and design facilities to ensure they can be used easily by agro-pastoralists living in the area, when building water use facilities.

A survey of water and other resources is implemented for the purpose of accurately understanding the purposes and site conditions of irrigation facilities, and to obtain the basic data necessary to select canal routes, determine the type of construction, decide the designs and construction methods for facilities and manage the facilities in the future.

3.4.1 Survey plan

When building irrigation canals, the most common approach is to first decide a framework for the survey, then scrutinize the details at each step, taking into consideration the planning, surveying, design and construction phases.

Depending on the progress of a survey, irrigation canal surveys themselves will differ in terms of survey items, survey scope, survey policies, survey contents and survey accuracy. Therefore when performing a survey it is important to formulate an adequate survey plan for these items, and carry out the survey based on the master plan.

Irrigation canal surveys include surveys required for planning, design, construction, maintenance and management and other purposes.

Moreover, as the survey contents, surveys can include surveys to collect data and take interviews, study routes, provide a field survey, perform measurements, field tests or field observation, conduct laboratory tests, make observations during trial construction and after construction, and provide supplementary research.

Furthermore, when selecting canal routes and conducting surveys for design and construction, surveys must be implemented by taking into consideration not only technical issues but also the broad social effects and restrictions. In addition, because of the long time required from commencement of the survey until construction, surveys should be conducted from time to time during each phase.

In this manual, we have classified surveys into planning surveys, full design surveys, construction surveys and supplementary surveys, as shown in Fig. 3.4.1.1, to match the order of project implementation. Surveys such as meteorological or geographical surveys, which require decisions on specific design and construction plans, are undertaken mainly to understand natural conditions, site conditions or other issues.

The site surveys discussed here are surveys implemented to understand the endowment form, available quantity and potential usable quantity of water resources;

the survey results form the fundamental data for performing various analyses or preparing plans. A list of site surveys of water and other resources is shown in Table 3.4.1.1.

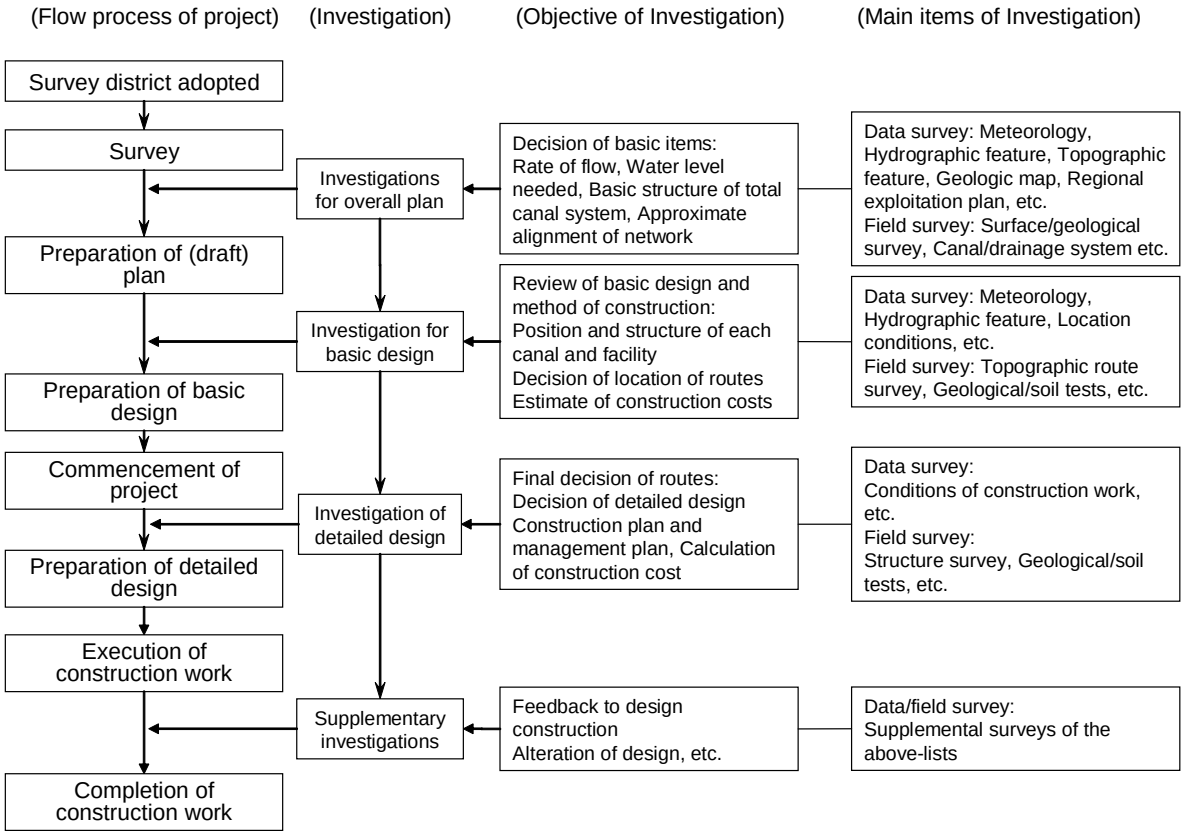


Fig. 3.4.1.1 Contents of survey according to project flow

Table 3.4.1.1 List of surveys for condition of water and other resources

	Survey item	Purpose of survey	Survey period	
			planning	overall design
Meteorological survey	Rainfall	Runoff analysis, water balance analysis	○	○
	amount of evaporation	Evaporation assumptions	△	○
	Temperature, humidity, wind velocity, hours of sunlight, amount of sunlight, air pressure	Evaporation assumptions	△	○
Geographical survey	Terrain survey		○	○
	Preparation of detailed geographic maps	Facilities planning and design	△	○
	Remote sensing	Understand land use conditions, interpretation of large-scale geologic structures	△	
Surface water survey	Water level	Runoff analysis, water balance analysis, assumptions for periods when water can be used	○	
	River flow	Calculation of river flow	○	○
	Water quality	Decision on suitability for water use	○	○
Ground water survey	Survey of geology	Understand condition of geological structures, distribution of aquifer	○	
	groundwater level	Assumptions on direction of groundwater movement, determination of depth	○	
	water quality	Decision of suitability for water use, assumptions on groundwater sources	○	○

○: Survey that should be implemented △: Survey that is implemented according to need

3.4.2 Meteorological Survey

Conduct meteorological surveys to investigate the extent to which water resources are captured in the area watershed and the relationship between rainfall and surface and groundwater.

Implement the meteorological surveys continually in each phase, from the planning survey through overall detailed design survey, and use the results to decide the fundamental conditions preparation of the comprehensive execution design plan and construction implementation plan. Data should be reconfirmed at the construction implementation survey stage, in order to prepare the hydraulics designs, structure designs, construction plans and management plans for the facilities. Because considerable time may be needed to proceed from the planning stage to the design and construction phase, the latest supplementary data must be collected depending on circumstances.

Normally a large evaporimeter with a 120cm diameter is used to measure evaporation. In arid areas with strong winds, however, measurement is difficult

because sand is deposited in the evaporimeter, and the water cannot be exchanged frequently because of the large quantity of water required.

While use of a small evaporimeter (20cm diameter) is easy to manage, errors are said to be significant because the size of water surface is small.

3.4.3 Geographical survey

Conduct a geographical survey to collect data concerning terrain and geography in the planning area and prepare topographic maps. For rivers, information that can be gleaned from reading the terrain includes the watershed boundaries, river canals and old river canals, breadth of the flood plain and natural levees. Using the collected materials to revise existing topographic maps to match the project area can be sufficient, but if no materials exist topographic maps will have be prepared based on field surveys and interviews. When preparing topographic maps, gather existing materials and proceed by first creating rough maps (1:50,000) and then proceeding to detailed maps (1:10,000).

3.4.4 Surface water survey

Conduct a surface water survey to understand the quantity of water in rivers and lakes and form of water flow. In particular, the purpose of a river survey is to understand the forms of rivers and their conditions, and the results of the survey can be used for a runoff analysis and water-balance analysis, and for the designs of irrigation facility structures.

3.4.5 Groundwater survey

For the groundwater survey, perform a study to understand geographic features and geology, and use the results to clarify the distribution conditions of the aquifers acting as vessels for holding groundwater. The groundwater level survey can be conducted in conjunction with studying the aquifer distribution. A simple survey procedure is to measure water levels in existing wells.

It is also necessary to understand the fissures in the bedrock and the distribution of water in fissures that exist in fault fracture zones. Techniques such as interpretation of aerial photographs, surface exploration and physical exploration are used for such surveys of geographical features and geology.

Because groundwater frequently is supplied as drinking water, it is important to secure good quality groundwater. This means it is necessary to conduct a water quality survey and confirm whether the water quality is suitable for this purpose.

In addition, when standards concerning the water quality of water for drinking and irrigation have been set in the country where the settlement projects will be carried out, these standards must be followed.

3.5 Clarification of measures

When considering specific agriculture and livestock farming with forestry techniques for a plan for measures for prevention of desertification, it is necessary to clarify the contents of measures, and important to compile a basic framework after investigating the basic policy and direction of the measures, based on sufficient consideration of the natural, social and economic conditions and area issues as understood through the efforts up to this point. In these measures for prevention of desertification, it is important to consider production of feed crops based on settlement and a pastoral system that does not place a load on natural grasslands as a whole, reflecting the objectives of production of feed crops on fields reclaimed through settlement and mitigating the burden on natural grasslands based on development of sustainable agriculture and livestock farming with forestry through the use of a nomadic grazing system rooted in the area.

When specifying the basic framework, it also is desirable to clarify and make a list of the objectives to be achieved and the details of the activities to realize the goals.

3.5.1 Establishment of the basic framework

The basic framework is the long-term vision that looks 10 to 20 year into the future and prescribes the overall orientation. It is important to formulate the vision in cooperation with the relevant organizations that will have jurisdiction over the project, while coordinating details with other concepts and plans concerning the future of the area.

3.5.2 Establishing objectives

To turn the basic framework into specific details, it is necessary to clarify the objectives to be achieved and the details of the activities to realize the goals, based on the fundamental policies. When establishing the objectives, it is critically important to set the scope of the target area, the year of each objective, the results and indicators, and clarify the framework.

(1) Scope of target area

When setting the scope of the target area, it is necessary to understand present conditions that will become limiting factors, including the geographic location, existence of natural resources and living conditions of the agro-pastoralists. In conjunction with the scope of the target area, at this point it also is necessary to study which of the peoples living in the area to include.

(2) Year of the objectives

When formulating a plan, decide the time period for project implementation and the

timeframe required to achieve the goals. For the project implementation period, set the years of the objectives by taking into consideration the time needed to build the infrastructure and the time period during which agro-pastoralists will continue their activities while continually operating and managing the infrastructure.

When setting the implementation period, it is critically important to pay attention to the accounting (budget) fiscal year and size of the budget that can be appropriated to surveys and the project, and the status of progress of other related projects in the area.

(3) Results

Results are the items to be attained through implementation of the various activities to achieve the objectives. When setting results, it is important to check the feasibility by taking into consideration factors such as area farming conditions, current technical level, and future execution, operation and management.

(4) Establishing indicators

Indicators are numerical targets or degrees to measure the extent to which results and objectives have been attained. By establishing indicators, the objectives achieved can be verified and proven more objectively. When establishing indicators it is best to use quantitative data to the extent possible.

(5) External conditions

External conditions are an indispensable requirement for implementing a project efficiently in line with a plan and achieving the project's purposes, but they cannot be controlled during the project, and it is uncertain whether they can be fulfilled. Because external conditions can become obstacles to achievement of activities and objectives, it is important to monitor them regularly.

When external conditions that can have a negative influence on the project exist, it also is necessary to consider changes to the project details. Because a project's success cannot be anticipated if the project details cannot be altered, it is important to attempt to alter the project details to avoid such external conditions.

3.5.3 Observance of laws

Observance of laws is indispensable when promoting measures for prevention of desertification. Desertification is caused by not only by extreme natural factors but is caused by human factors as well, such as overgrazing and deforestation, and it is important to investigate laws, ordinances, regulations and other provisions concerning natural resources (land, water), agriculture and livestock farming with forestry and the environment relevant to overgrazing or deforestation regulations, and to understand

what regulations or management have been implemented in the area. Furthermore, along with understanding the status of observance of such legal systems, when desertification is not being prevented because measures have not been implemented, it is necessary to suggest to governing organizations actions such as enactment of the relevant laws and regulations and establishment of a system to encourage observance of laws.

(1) Legal system concerning natural resources and the environment

1）Legal system concerning land resources management

If land resources are not managed appropriately, the probability land will be further degraded is high. Therefore protecting and managing land appropriately is critically important for using land resources in perpetuity. Particularly in arid and semi-arid areas where inappropriate land management is a cause of desertification, proper use and management of land resources according to defined uses is required.

Therefore when preparing a plan and implementing a project, it is necessary to understand the legal system concerning land resources protection and management and adopt measures that comply with the legal system.

2）Legal system concerning water resources

Water resources are indispensable for pursuing stable agriculture and lives in arid and semi-arid areas. Therefore when preparing a plan and implementing a project, it is very important to understand matters that should be observed for the development and use of water resources, to enable local residents to ensure water for agriculture and daily needs. It is also important to combine this with an understanding of the legal system concerning issues such as water quality, and understand in advance the standards that must be met, such as those for drinking water.

3）Legal system concerning agriculture and livestock farming with forestry

Implementing sustainable farming activities for agro-pastoralists calls for promoting agriculture and livestock farming with forestry in harmony with the environment. To develop sustainable agriculture and livestock farming with forestry, it is very important to understand not only the orientation of agricultural promotion but also the provisions concerning ecosystem and environmental protection under the legal system related to agriculture and livestock farming with forestry, and consider how to develop these industries in harmony with the environment in the future.

4）Legal system concerning the environment

When implementing a plan or project, adequate consideration must be given to the ecosystem and environment. Many countries recently have introduced systems to

evaluate the ecological and environmental impact of projects (environmental assessment systems). Therefore when preparing plans or implementing a project, it is important to understand the environmental assessment system, as well as matters that should be observed to protect the ecosystem and environment, and implement projects in harmony with the environment.

(2) Role of proclamations in local governments

In some instances, it is necessary to establish detailed numerical objectives according to actual local conditions in order to achieve goals set by the central government. Some local governments draft and publish proclamations conforming to local circumstances, based on central government laws and regulations. It is important to understand these proclamations and also understand, through means such as interviews, what instructions local governments provide in their jurisdictional area. The extent of the local government's legal binding force to ensure effectiveness of its proclamations should also be researched.

3.5.4 Support of government organizations

It is important to plan and execute a project with an understanding of the support systems responsible for measures for prevention of desertification (settlement projects, etc.) at the national and local government levels, and the cooperation of government offices responsible for planning, execution and dissemination activities related to agriculture and livestock farming with forestry in the area. This means it is necessary to understand the support systems in the country or local area and the systems for dissemination of agriculture and livestock farming with forestry.

The primary means considered as a support system to promote development of sustainable agriculture and livestock farming with forestry by settlement are financial subsidies and support for the dissemination of farming techniques to agro-pastoralists. This section describes settlement projects and systems for the dissemination of agriculture and livestock farming with forestry techniques that are representative of such support.

(1) Settlement projects

1）Views on settlement projects for prevention of desertification

Past settlement projects have been implemented for the purpose of enhancing productivity or improving education and medical services for agro-pastoralists, through construction of infrastructure in the settlement area that forms the center of the agro-pastoralists' lives and production activities.

Examples of the infrastructure critical for settlement include, in addition to housing, the sheds or fields for rearing livestock or agricultural production, roads to make

transportation more convenient, and basic services such as service water and electricity that are indispensable for daily life and facilities such as clinics, schools and shops. Once these have been built and stable farming and daily life have been developed, not only will the issue of overgrazing on natural grasslands have been solved, the purposes of settlement will have been achieved because access to education and medical services will be easier and lives will have been improved.

Even though agro-pastoralists have been settled, however, this does not mean they will totally abandon nomadic grazing and feed all of their livestock in the settlement area year-round, because the concept adopted is to manage sustainable livestock farming in harmony with the natural environment, while using the traditional nomadic grazing system in conjunction with livestock farming in the settlement. Therefore it is important to implement settlement projects to enable agro-pastoralists to conduct agriculture and livestock farming with forestry to feed their livestock in the settlement sheds during spring, autumn and winter, while continuing traditional pasturing without placing a load on natural grasslands (in summer when grass is plentiful, etc.). Furthermore, when irrigation facilities, windbreak forest belts and other necessities are inadequate or not managed properly because of inadequate funds or technical problems, settlers' production activities will not support their lives as smoothly as in the past and their future as settled farmers will be disrupted, and it is important to consider these issues adequately when preparing a plan or implementing a project.

2）Proposing a settlement project to contribute to prevention of desertification

To mitigate the load on natural grasslands and promote development of stable livestock farming in the future, nomadic peoples must be able to produce feed required for their livestock and supply this to their animals in a settlement. This will control overgrazing on natural grasslands that are being degraded (especially spring, autumn and winter pasturing when grass is scant), and mitigate the load.

In Xinjiang Uygur Autonomous Region, we have been able to conduct research for settlement of nomadic people and construction of base areas (fields) for production of feed from such a viewpoint, and proposed measures for improving the past style of livestock farming, which is dependent only on natural grasslands, by feeding livestock in settlement areas and engaging in sustainable livestock farming in harmony with the natural environment while continuing to use traditional nomadic grazing. We have proposed this not with the thought that if nomadic peoples could just have housing in order to settle, this would be sufficient. Rather it is a concrete measure to comprehensively establish production conditions to ensure foodstuffs and feed, create living conditions to enable people and livestock to stably use clean drinking water, and provide social services such as education, medical services and technical support. These are referred to as the "3 lines, 4 fixed properties and 5 public facilities," which

the government is implementing to move nomadic peoples to settlement projects.

The verification study on prevention of desertification highlighted the importance of establishing a pattern of pasturing livestock on natural grasslands in summer and feeding at settlement sheds in spring, autumn and winter, by producing feed grass and food crops for self-sufficiency on fields properly equipped with irrigation facilities. It also pointed out the need to consider an appropriate scale of management based on the management capabilities of nomadic peoples. Assuming livestock feeding for 20 sheep per capita (about 100 sheep per household for a five-person family), a trial calculation shows annual per capita net income of about 2,000 to 3,000 yuan can be earned by engaging in proper feeding with established techniques and selling the lambs born during the year.

(2) System for dissemination of agriculture and livestock farming with forestry

In China, organizations responsible for technical support in the field have been established in local governments. There also are agencies such as farming technique extension stations, forestry management stations and agricultural economy stations in town offices serving as entities in charge of direct instruction for farmers and agro-pastoralists. These organizations provide a contact point for instruction in various techniques to farmers and agro-pastoralists living in the town.

In some situations, depending on the area or technology sector, these organizations are located at a higher government level in a city or province. When working to disseminate established techniques, it is important to implement the efforts after gaining the cooperation of the technical staff working at these organizations. Adequate consideration also must be given to whether these organizations have the necessary budget, manpower and techniques for dissemination guidance and related activities.

3.6 Application of techniques for agriculture and livestock farming with forestry

When specifying the basic framework/concept, the details of agriculture and livestock farming with forestry techniques based on government organization support must be considered. These techniques include not only techniques necessary for production and management to develop sustainable agriculture and livestock farming with forestry by agro-pastoralists, but methods related to instruction for diffusion of the techniques as well. Sustainable farming activities can be developed by utilizing these techniques as a package.

Application of the following techniques is effective for developing sustainable agriculture and livestock farming with forestry by agro-pastoralists that takes into consideration mitigation of the load on natural grasslands as a measure for prevention of desertification, as well as the effects of settlement projects implemented in the past.

Self-sufficient production of feed during winter	Establish pasturing systems so settlers will not move herds to pastures in spring, autumn and winter
Improvement of livestock feeding	Investigate advantageous selling periods based on off-season breeding and fattening techniques
Diversification of income	Introduce production of cash crops that will not cause an increase of livestock
Preservation and management of fields	Thoroughly implement proper water and windbreak forest belt management
Improvement of farming	Achieve farm management in accordance with direction of farming and goals for the area

Agriculture, livestock farming and forestry techniques must be established as techniques agro-pastoralists can practice in settlements. In terms of convenience, it is very useful to position the above five items as the means to implement measures for prevention of desertification, and appropriately combine agriculture and livestock farming with forestry techniques with individual techniques for each means.

To achieve the measures for prevention of desertification, it also is important to use indicators to determine whether these means can be used effectively in farming activities. Establishing farming patterns that demonstrate the orientation of farming management is another method of using indicators.

Finally, it also is important to summarize the matters to be considered when executing a project using such agriculture and livestock farming with forestry techniques.

3.6.1 Self-sufficient production of feed during winter

It is important to guide agro-pastoralists in the direction of sharply curtailing uses that place a load on natural grasslands, through self-production of feed during winter, by helping them acquire feed cultivation and processing techniques. Thus for production of feed during winter, it is vital to appropriately support the selection, cultivation, cutting and processing of feed based on meteorological conditions in the area, in order to ensure a large quantity of high-quality, palatable winter feed. Moreover, from the viewpoint of using silage effectively and efficiently during winter feeding especially, it is useful to undertake measures such as changing the type of livestock (from sheep to cows) and fattening of livestock.

In addition, settlers' own labor or farm machinery is necessary for self-sufficient production of feed in winter. Efforts to lower production costs, by means such as government support and joint use of machinery, are important because introducing equipment for each individual is expensive.

3.6.2 Diversification of income

Diversification of income through production of cash crops enables agro-pastoralists to stabilize their management, because they can shift from an income structure dependent on livestock sales. Because this is linked to controlling the number of livestock as well, diversification of income can be expected to mitigate the loads on natural grasslands.

Ensuring and enhancing income from sales of products is essential for producing cash crops. This means it is first necessary to select crops by considering the ability to convert them to cash and suitability for cultivation. Criteria on suitability for cultivation include the length of the growing period and ease of management.

Agro-pastoralists must be able to earn more income, even if only a little, by enhancing yields and quality by cultivation. Other cultivation issues include water management and fertilizing practices, and efforts should be made to utilize methods and techniques suitable in the area.

3.6.3 Improvement of livestock farming

The tendency of many agro-pastoralists is to increase the number of livestock corresponding to the increase in winter feed supply after settlement. To control this increase in the number of livestock, it is necessary to enhance livestock management. Measures include introducing improved livestock or superior breeds, promoting changes such as diversification into sheep breeding and different selling periods, guidance for calving and rearing of cows, and appropriately preventing and treating diseases.

Such measures are premised on local procurement of the required materials, labor

and other inputs to the extent possible. Nevertheless, it also is necessary to consider improvements that will enable agro-pastoralists to engage in sustainable farming activities provided a certain level of initial investment has been made. In that case, it is important to establish details that can be accepted and practiced steadily by local governments and agro-pastoralists.

3.6.4 Preservation and management of fields

Preservation and management of fields is an important means of continually maintaining and enhancing productivity. Methods to establish rules for proper water use through preparation of a water use plan, and to protect fields by creating windbreak forest belts, are used as measures.

(1) Preparation of a water use plan

In arid and semi-arid regions, not only in Asia but in every country in the world, the tight supply-demand situation for water resources generally is a limiting factor for every type of production activity. Therefore when building water use facilities, it is important to first understand local conditions, then properly plan facilities to ensure they can be used easily by agro-pastoralists living in the area.

Moreover, when water resources have been developed, it is necessary to prepare a water use plan that clarifies the purposes and methods of use, and establish proper water use rules, and take steps to build the proper facilities and implement sustainable management.

Obtaining the active participation of agro-pastoralists also is important for efficient water use, and for planning effective use of limited water resources. Generally, agricultural irrigation projects in developing countries are regarded as national projects, because agro-pastoralists lack adequate understanding of the need to manage and operate irrigation facilities themselves. It is important to address both economic development and preservation of the area's environment through irrigation, and this means consideration must also be given to forming a new concept that encompasses participation by agro-pastoralists as well.

(2) Setting up windbreak forest belts

Windbreak forest belts demonstrate a number of effects. In addition to preventing farmland erosion and movement of surface soil by wind, they promote crop growth through their evaporation control effect by weakening wind, increasing humidity and restricting the increase in temperature. When placed near housing, they make life more comfortable by providing shade lowering inside temperature. Thus establishing windbreak forest belts in arid and semi-arid area is useful for protecting fields and homes from dry, heavy winds and forming comfortable lives and a better agricultural

environment for agro-pastoralists.

It is important for governments and local residents to work together to construct windbreak forest belts to protect agriculture and rural community development. Until now, however, the typical approach has been for a government agency to prepare a plan and distribute seedlings, then leave future management entirely to local residents. As a result, windbreak forest belts frequently are not well maintained.

To cultivate windbreak forest belts that will continue to be managed properly, government organizations must provide appropriate instruction, and foster a correct awareness of the roles of windbreak forest belts and encourage voluntary management on the part of local residents. Moreover, the functions of windbreak forest belts will be demonstrated and maintained continually if both government and residents work together to create a coherent system for building windbreak forest belts, from preparation of a plan to production of seedlings, planting and management.

3.6.5 Farming improvement

For settled agro-pastoralists to engage in sustainable production activities in settlements, farming management improvements based on farm management guidance from related local instructional organizations are indispensable. New efforts involving cultivation in particular require techniques unfamiliar to agro-pastoralists, ranging from production to sales.

Thus it is important to prepare a farming plan in accordance with the orientation for farming in the area, local land use, farming patterns and management objectives, then implement techniques, provide guidance and disseminate technologies based on the plan.

Furthermore, when attempting to improve farming management, trial calculations to verify whether management on the basis of farming patterns using appropriate techniques can be useful. The ability of the agro-pastoralists to achieve the objectives must be taken into consideration, and trial calculations are extremely important for determining whether management by agro-pastoralists is sustainable.

3.7 Project execution

Execute a project after establishing a specific plan for measures for prevention of desertification. This section describes matters concerning construction of irrigation facilities and settlements.

This section also discusses the need for a construction schedule management, in order to implement the project in accordance with the plan.

3.7.1 Irrigation facilities

Irrigation facilities consist of water discharge facilities such as open canals, pipes, drops and chutes and supplementary construction such as division works.

Selection of the type of construction means choosing the most appropriate discharge facilities for the canal forms and routes that can be assumed to sufficiently demonstrate the functions as an entire irrigation canal system. This selection must be made with adequate consideration given to structure safety and economic viability, the topography along the canal routes and various social conditions, including land use conditions along the canals.

In particular, discharge facilities represent the main components of the entire irrigation canal system, and the quality of such facilities will affect the functions of the canal system. Therefore the quality of the facilities must be adequately investigated, because this will greatly influence construction costs. In addition, the decision concerning the type of construction for discharge facilities must be made by keeping in mind the location and scale of supplementary construction such as division works, because these have a close relationship with the discharge facilities.

(1) Open canals

a. Open canals are broadly classified into retaining wall canals, lining canals and non-lining canals. Select the appropriate type after a comparative study encompassing factors such as the purpose of the open canals, facility safety, social limiting factors, construction costs and maintenance costs.

b. Compared with pipes, open canals generally are more advantageous in terms of hydraulics, and are also advantageous from an economical standpoint if cutting and banking for both alternatives are equal.

c. Long cutting and banking is disadvantageous in terms of safety and economy, and to the extent possible should be avoided.

d. Non-lining canals are adopted frequently for drainage canals where prevention of water leakage normally is not taken into consideration and there are no concerns about erosion and scouring. Moreover, where terrain and slopes are comparatively steep, non-lining canals can be the best option for water canals where erosion and scouring can be assumed, if the canal gradient is lessened by drop or chute

construction.

e. Lining canals are canals with a gentle gradient that are lined with thin covering materials to stabilize the canal slope surfaces and smooth stop-water or canal surfaces, using natural soil materials. In contrast, retaining wall canals are canals formed with walls supported by internal and external water pressure on the water canal side and soil pressure on the reverse side. Both lining canals and retaining wall canals are forms adopted for purposes such as preventing leaks and reducing the cross section, and can be properly used depending on site conditions.

(2) Pipes

a. In arid and semi-arid areas, pipes are a better form of construction in terms of preventing leaks and evaporation.

b. Because the construction expense is 2 to 3 times the cost of open canals, however, and construction expense will increase even further when the ground is poor, to the extent possible a route through good soil should be selected and the construction should cover the shortest distance.

c. Pipes should not pass through faults, fracture zones and soft ground if possible, but if passing through such areas cannot be avoided, countermeasures must be considered during construction.

d. In inflow sections, in terms of maintenance measures will be necessary to prevent accumulation of earth and sand in the pipes.

(3) Drops and chutes

a. When canal slopes are steep on the whole, flow velocity will be faster and, depending on the materials used for the canal surfaces, the surfaces will be subject to erosion or scouring. The location of drop facilities, the type of construction and other factors should be investigated by comparative study, taking into consideration the canal surface materials and scouring or erosion flow velocity.

b. When the geographical gradient is comparatively steep, the slope of bottom in canals is determined by a comparative study that combines the limit of velocity based on the canal structure or materials and modification of the gradient using drop facilities. When flow in the canal is maximized, the surface flow will become unstable.

c. Because the gradient of canals will be comparatively steep, when drainage will be into rivers the slope of bottom in canals must be modified in the plan for drainage, through appropriate placement of drops or chutes and work to ensure the overall safety and economy of the canals.

d. When placing drops near residential areas, the affect of vibration, noise and spray

must be considered.

3.7.2 Schedule management

(1) Objective of schedule management

The objective of schedule management is to implement and control the procedural plan during the defined term of construction. Managing and controlling the progress of the project is important because the quality and cost will greatly affect project progress.

(2) Schedule management procedure

The schedule management procedure is divided into planning, execution, evaluation and response steps.

To control a project so it proceeds according to the plan as much as possible, projects are executed based on scheduling charts, with the facts of the project's progress recorded regularly at daily, weekly or monthly intervals, and checked by comparing planned work and implemented work to evaluate how construction is proceeding vis-à-vis the plan,.

When actual work deviates substantial from the plan, however, there is a problem with either the plan or the system of execution and it is necessary to modify the plan and take corrective measures.

After modifying the plan and taking corrective measures, implement the planning, execution, evaluation and response steps based on the revised scheduling charts.

The typical schedule management procedure is described below.

a. Planning stage: To create a construction plan, a daily work plan for each separate operation and a schedule chart for determining the order of operations are prepared based on the basic policies, including the construction procedures and order of construction suitable for the area. In this situation, the plans for use of labor, materials and equipment and machinery must be given adequate consideration. Moreover, in addition to the overall construction schedule described above, when preparing the plans it is necessary to prepare sub-construction schedules for steps that are especially important for the overall construction, and control these steps strictly, because this will promote smooth progress for the overall construction.
b. Execution stage: Instruction and supervision are provided while arranging and working out plans for labor, materials and equipment and machinery in accordance with the construction plan daily work plan and work procedure.
c. Evaluation stage: Record the status of work progress, and control progress by comparing actual results with the plan.
d. Response stage: When work progress is behind schedule or there are other

problems, make improvements to operations, take corrective measures such as accelerating construction or, depending on the situation, prepare new plans by modifying the work schedule in terms of feasibility.

3.7.3 Settlement construction

(1) Settlement construction methods

There are several construction methods for settlements, with the most common being dispersed housing and collective housing. The most appropriate type must be selected according to area site conditions. The merits and demerits of their types are as follows:

a. Dispersed housing: Under this method, houses and sheds are arranged in a belt-shaped settlement along a main road or along the main or secondary canals. This alternative is advantageous for producing crops, and also is convenient, because fields generally are constructed in vicinity of the housing. The disadvantage is cost, because electricity lines and water pipes must be extended further. Access to facilities is also difficult, because agro-pastoralists' homes are dispersed and no core area is created.
b. Collective housing: This method is used to construct a community by gathering together an average of 40 to 50 agro-pastoralist households. This enables efficient supply of electricity and water, and is advantageous for production and living because structures such as school, shops, clinics and stations for instruction and dissemination of techniques can be built in center of the area. On the other hand, the drawback is the large amount of funds required for construction.

(2) Facilities that should be developed for a settlement project

The minimum infrastructure necessary for living in the form of housing and sheds must be constructed in order for agro-pastoralists to make a living. The "3 lines" for water, roads and electricity also must be built.

a. Water: Safe drinking water for human beings and livestock must be secured.
b. Roads: Roads linking the settlement to the local government, and roads within the settlement, must be construct or improved.
c. Electricity: Electric power for production and living in the settlement must be secured. Forms of electric power supply can include small hydraulic power generation, wind power generation and solar energy generation.
d. Other: After a settlement has been built, clinics, schools, shops, a community center and a station for instruction and dissemination of techniques must be constructed.

(3) Matters to note when constructing a settlement

Matters that should be considered when constructing a settlement are described below. When standards concerning the following matters has been set in countries that have decided to undertake a settlement project, such standards should be followed.

a. Planned project execution: After preparing an overall plan that considers how large a settlement must be constructed based on the number of nomadic people in the area for the settlement project, divide the project into several phases and execute them consecutively, depending on factors such as budget.

b. Ensuring greenbelts: When constructing housing, sheds, windbreak forest belts and infrastructure such as roads, greenbelts covering a certain amount of area should be ensured if possible, taking the environment into consideration.

c. Ensuring housing lot width: When deciding the size of housing lots, it is desirable to ensure a certain amount of width to enable settlers to do gardening. (in Xinjiang Uygur Autonomous Region, an area of around 0.2 ha is appropriate). Moreover, the land for each lot should be separated into a housing area (house) and a production area (shed and feeding space). Sheds should be located downwind from houses..

d. Ensuring house width: It is desirable to ensure a house area of at least 15 square meters per household, depending on the ability of the agro-pastoralists.

e. Shed area: Sheds should be designed based on the area of land dedicated to livestock, and when determining the area it is important to take into consideration room for movement of livestock. An area of 150 to 200m^2 per household is appropriate. Standards for building stables are 5 m^2 per head of large livestock (cows, horses, camels), 1.3 m2 per head of small livestock (sheep, goats).

f. Ensuring field width: Ensure the field width required to cultivate feed during winter and cash crops. When setting field width, calculate the winter feed quantity required per head by taking into consideration the quantity given to feeding livestock and number of feeding days during winter, then make a trial calculation of the necessary production area based on the number of livestock and feed yields. If possible, create a plan to distribute the fields suitably to each agro-pastoralist. Ensuring about 50 to 100 mu (around 3.4 ha to 6.7 ha) per household would be appropriate.

3.8 Area evaluation

By promoting development of sustainable agriculture and livestock farming with forestry on settlements, the capacity to raise livestock on settlements should improve and the amount of livestock pastured to spring, autumn and winter pastures can be reduced. Because this will lead to a significant change in natural grasslands and nomadic pasturing as a result, when deciding to implement measures for prevention of desertification through a settlement project it is important to predict these changes sufficiently in advance and quantitatively understand and evaluate the effects from the project.

3.8.1 Affects on natural grasslands

The effects settlement activities will have on a target area must be understood and linked to the prevention of desertification. This means it is necessary to understand the extent to which a project will mitigate the loads on natural grasslands, and the extent to which natural grasslands vegetation will recover.

3.8.2 Affects on the nomadic pasturing system

Nomadic pasturing is a form of livestock farming in which nomadic people move with their livestock in order to obtain water and natural grass. Nomadic peoples in the People's Republic of China, Mongolia and Central Asia raise sheep, goats, cows, horses and camels, the so-called five main livestock, with variations in the number of each type of livestock depending on environmental conditions of the area. Livestock feeding depends almost entirely on natural grasslands. Therefore changes in the number of livestock substantially affects vegetation. If feed can be produced by settlement, dependence on natural grasslands will decline and the nomadic pasturing style also will change. Therefore the role of settlements must be firmly positioned within the nomadic pasturing system.

Chapter 4 Introduction to Verification Case Studies by Japan Green Resource Agency (J-Green)

This section describes the concrete survey details of the method explained in detail in Chapter 3, using the actual example of the study on measures for prevention of desertification conducted by J-Green in the Altay Administrative Offices Area, Xinjiang Uygur Autonomous Region to achieve sustainable development of agriculture and livestock farming with forestry that solved the issues raised by settlement projects implemented in the past.

4.1 Survey of present conditions

Deserts in the People's Republic of China are distributed across an extensive area, including Xinjiang Uygur Autonomous Region, Gansu Province, Qinghai Province, the Nei Mongol Autonomous Region and the Ningxia Autonomous Region. Of these, J-Green selected Xinjiang Uygur Autonomous Region as the project area because of advancing desertification caused by wind and sand damage resulting from meteorology and geographical causes, and the marked desertification resulting from overgrazing and improper irrigation in the area.

Other reasons J-Green selected the Altay Administrative Office Area of Xinjiang Uygur Autonomous Region were the fact the Altay area is a natural grasslands (nomadic pasturing) livestock farming area typical of northwestern China, and the fact overgrazing from nomadic pasturing is the main cause of desertification and degradation of natural grasslands in spring, autumn and winter when grassland vegetation is scarce is quite marked.

In a field survey, we studied the natural conditions, social situation and economic conditions in the Altay Administrative Office Area by means such as existing reference literature, field observations and interviews. We also were able to easily understand the data at the autonomous region, administrative area city and county levels by using statistical almanacs, which China publishes annually to compile prior year survey results. In addition, we reviewed data at the town and village level through interviews at the local government organizations concerned.

Finally, we prepared a plan for measures for prevention of desertification that adequately considered present conditions, and appropriately reflected the survey results in the extraction of subjects, selection of the target area, clarification of measures and decisions concerning agriculture and livestock farming with forestry system techniques.

4.1.1 Natural conditions

(1) Location and area

The Altay Administrative Office Area is located in the northernmost part of Xinjiang Uygur Autonomous Region, and borders on the Republic of Kazakhstan in the west, the Russian Federation in the north and Mongolia in the east. The region also borders on Changji Hui Autonomous Prefecture in the south and Ili Kazak Autonomous Prefecture in the west. The Altay Administrative Office Area covers an area of 117,000 km^2, accounting for 7.2% of the area in Xinjiang Uygur Autonomous Region.

(2) Topography

The geographical features in the Altay Administrative Office Area are roughly divided into mountains, plains and desert. The northern and southwestern areas include the Altay Mountains range and Saul Mountains. The central part has the Ertix valley, and an old alluvial plateau between the Ertix River and Ulungur River. To the south of the Ulungur River lies the flat rolling terrain of the northern Junggar Basin, which spreads out to the central part of the Grubantunggut Desert.

The overall topography of the area is higher in the northwest, and lower toward the southeast.

Mountainous areas cover 38,000 km^2, accounting for 32.4% of the total area of approximately 117,000 km^2. Hilly terrain and plateaus in river basins cover 26,000 km^2, accounting for about 22.2% of the total area, and rocky, sandy soils covering 41,500 km^2 and deserts covering 11,500 km^2 make up the remaining 35.49% and 9.82%, respectively, of the total area.

(3) Meteorology

Although the Altay Administrative Office Area is far from the ocean and has a dry climate, humidity from the Arctic Ocean can enter the region because the mountains in the northwest are comparatively low and have many passes through which wind can pass. This humid air rises along the Altay Mountains range running in a northwest direction. As the height of the area rises from the Grubantunggut Desert toward the Altay Mountains, the climate in turn is extremely arid, arid, semi-arid, humid and semi-humid.

Because of its high latitude, the area is dry with strong winds in spring, and characterized by a short summer and a long, hard winter season. Annual rainfall is between 95 to 650 mm, and distributed so there is heavy annual rainfall in the north and very little rainfall in the south. As one moves from west to east, the annual rainfall is less. Annual rainfall in the central high mountains is 600 mm, with the amount of rain declining as height above sea level decreases. The annual rainfall in the north of the Junggar Basin is just 100 mm. Winter rainfall in the mountainous area accounts for

30% of total annual rainfall of the area, and annual evaporation volume of 1,472 to 2,178 mm is much greater than annual rainfall.

The annual mean temperature is around 3 to 4°C. Yearly daylight time is 2,250 to 3,100 hours, and accumulated temperature of 10°C or higher is around 2,500 to 3,000°C. The number of non-frost days is 120 to 140 days on the plains, and only 90 days in the mountainous areas.

(4) Soil

The Altay Administrative Office Area has hilly wasteland between the northern mountains and southern deserts, and a variety of soil types have been formed because natural conditions differ extremely. Distribution of soil types is subject to height above sea level. For the area as a whole, 21.3% of all soil has organic matter content of 3% or higher, 41.7% of all soil has 1-3% organic content and 37% of the soil has less than 1% organic content.

(5) Water resources

After the Ili Area, the Altay Administrative Office Area has the second most abundant water resources in Xinjiang Uygur Autonomous Region. Rivers carrying snowmelt originating in the Altay Mountains course through the region.

In all there are 56 long and short rivers in the area, with annual flow volume of 13.37 billion m^3. According to their hydrology, these rivers can be divided into the Ertix River system, the Ulungur River system and the Jeminay valley system. In addition, there are eight lakes in the mountainous areas and five lakes in the plains.

Five rivers have annual flow volume greater than one billion m^3; volume is estimated at 4.2 billion m^3 in the Burqin River, 2.1 billion m^3 in the Haba River, 1.8 billion m^3 in the Kara-Ertix River, 1.5 billion m^3 in the Ke-Ertix River and 1.07 billion m^3 in the Ulungur River. Usable ground water in the entire area is estimated to be 0.25 billion m^3.

(6) Land use forms

To understand land use forms based on trends in the main industries in the area, we studied current conditions concerning land use by means such as site reconnaissance and interviews.

Based on these results, it was evident that soil improvements and irrigation through measures such as agricultural field development would be necessary when providing land for agriculture and livestock farming with forestry, and that these must be implemented by taking land conditions into consideration when developing fields as a foundation for production for settlement projects. Moreover, livestock farming based on nomadic pasturing using the natural grasslands is carried on widely throughout the area, as shown in Table 4.1.1. We therefore decided to investigate measures for

prevention of desertification aimed at the development of sustainable agriculture and livestock farming with forestry using the nomadic pasturing system and production of feed on developed fields through settlement.

Table 4.1.1 Land use area in the Altay Administrative Office Area (2003)

Unit: thousand ha, %

Administrative Area	Arable Lands (farmland)	Pastures	Forests	Construction land	Unused land
11,780	179	9,637	1,056	40	860
(100)	(1.5)	(81.9)	(9.0)	(0.3)	(7.3)

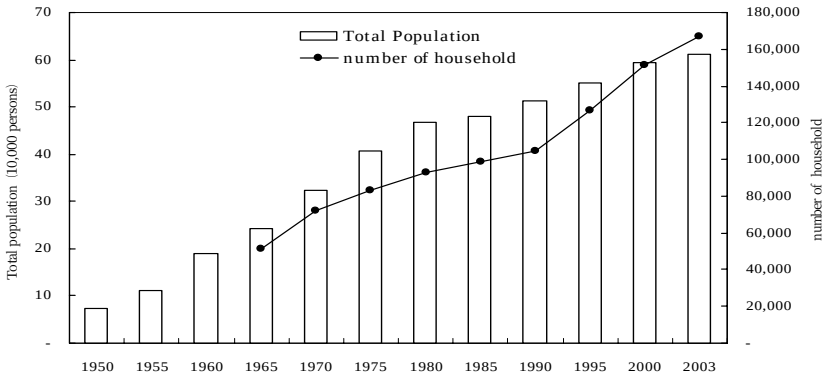
Data: Altay Statistical Yearbook (2004)

4.1.2 Social situation

(1) Population and households

To study the orientation for promotion of agriculture and livestock farming in the future through factors such as the change in area population, we analyzed population-related data (population trend and change in age composition) using statistical data for the Xinjiang Uygur Autonomous Region and Altay Administrative Office Area.

According to the relationship between the change in population and the number of households in the Altay Administrative Office Area (Fig. 4.1.2.1), growth in the area population over a 50-year period was remarkable, increasing 8.2 times over a period of approximately 50 years, from 74,500 people in 1949 to 612,600 in 2003, but more recently the population growth rate has slowed. On the other hand, the trend for growth in number of households has been higher than that of population, and can be regarded as the effect of an ongoing shift towards nuclear families.



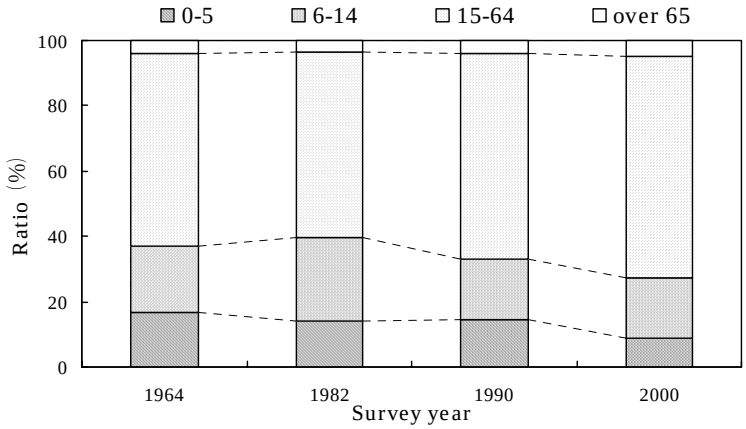
Data: Altay Statistical Yearbook (2004)

Fig. 4.1.2.1 Relationship between change in population and number of households in the Altay Area

There are two patterns in the settlement of nomadic peoples in the Altay Area. One is the pattern in which households of nomadic peoples that had moved as a group in the past have settled altogether at one time, while the other is one in which a son of a large family has settled. In the survey area, many cases in which a large family's son was chosen as a settler can be found, and this tendency is thought to be linked to the increase in the number of households (Refer to the Chapter 5 Reference Materials concerning settlement patterns created based on genealogy) .

The change in population ratio by age is shown in Fig. 4.1.2.2; although slight, signs of a declining birth rate and aging of the population have begun to appear. Although it is believed this declining birth rate and aging population will not progress rapidly in the future, it is necessary to pay attention to this change.

Such trends will have a certain influence on prospective consumption trends, changes in eating habits and other behavior, and must be considered adequately when studying the orientation for promotion of agriculture and livestock farming in the future.



Data: Altay Statistical Yearbook (2004)

Figure 4.1.2.2 Change in population ratio by age in the Altay Area

(2) History, ethnic groups and religion

It is important to understand industrial employment conditions and land use conditions by ethnic group in an area, based on historical relationships among the peoples (ethnic groups) living in the area. We studied the history surrounding the ethnic groups in the area, ethnic composition and change in population by ethnic composition.

When we examine the ethnic composition of the Xinjiang Uygur Autonomous Region (Table 4.1.2.1), the Uygurs who represent this autonomous region account for 46% of the entire population, followed by the Han, who are about 40% of the population. On the other hand, in the Altay Administrative Office Area, the Kazak who

live mainly by nomadic pasturing and livestock farming account for the half of the population, followed by Han, who account for around 44%.

Table 4.1.2.1 Population and ethnic composition in the Xinjiang Area (2003)

Unit: Person (%)

Division	Total	Ethnic group composition				
		Han	Uygur	Kazak	Hui	Others
Xinjiang Uygur Autonomous Region	19,339,500 (100.0)	7,711,014 (39.9)	8,823,476 (45.6)	1,352,125 (7.0)	866,653 (4.5)	586,232 (3.0)
Altay Administrative Office Area	612,628 (100.0)	266,498 (43.5)	10,374 (1.7)	302,793 (49.4)	21,000 (3.4)	11,963 (2.0)

Data: Xinjiang Statistical Yearbook (2004)

Generally the Uygur had engaged in farming in the oasis areas, while the Kazak had from long ago pursued nomadic pasturing. As the settlement of nomadic peoples progressed in the second half of the 20th century, however, many Kazak came to live in settlements and today are engaged in farming. Numerous Han also are engaged in farming in the area, many of whom engage in highly productive cultivation using good farming techniques.

Based on these survey results, we addressed the project while taking into consideration the mutual relationships among these ethnic groups.

Table 4.1.2.2 Change in total population and population by ethnic composition in the Altay Area

Unit: Person

Year	population				
	Total	Han	Uygur	Kazak	Hui
1949	5.6				
1963	20.1	7.0	0.6	11.4	0.5
1970	32.3	15.6	0.7	14.3	1.1
1980	46.8	23.1	0.9	20.4	1.6
1990	51.2	21.6	1.0	25.8	1.7
2000	59.4	25.9	1.0	29.3	2.0
2003	61.3	26.6	1.0	30.3	2.1

Data: Altay Statistical Yearbook (2004)

We also studied the circumstances concerning religious beliefs in the area, because we believed it was necessary to sufficiently consider the government's religious policy and the differences in adherence to religion among the ethnic groups.

With the exception of ethnic groups such as the Han, Mongolians and Xibe, almost all people in Altai Administrative Office Area practice Islam. Generally, Muslims follow the custom of praying at a mosque, but the Uygur and the Hui have mosques based on their respective institutions and traditions, and a unique Islamic culture fostered

among the ethnic groups has taken root. Because the influence of Islamic culture has affected eating habits as well, with food lifestyles being based on mutton and beef, we were careful to prepare a plan for farming development based on livestock farming of sheep or cows.

(3) Administrative organs

Because government cooperation and support is indispensable for preparing a plan of measures for prevention of desertification and implementing, managing and disseminating the plan in the field, we reviewed the administrative organs of the area.

As shown in Figure 4.1.2.3, in China local government organs are placed in every administrative unit (Region, Autonomous Region, direct city, prefecture, city and town as well as local people's convention). As the local government, these organs are responsible for administration of activities such as the economy, education, science and culture in the area, based on the authority provided by law.

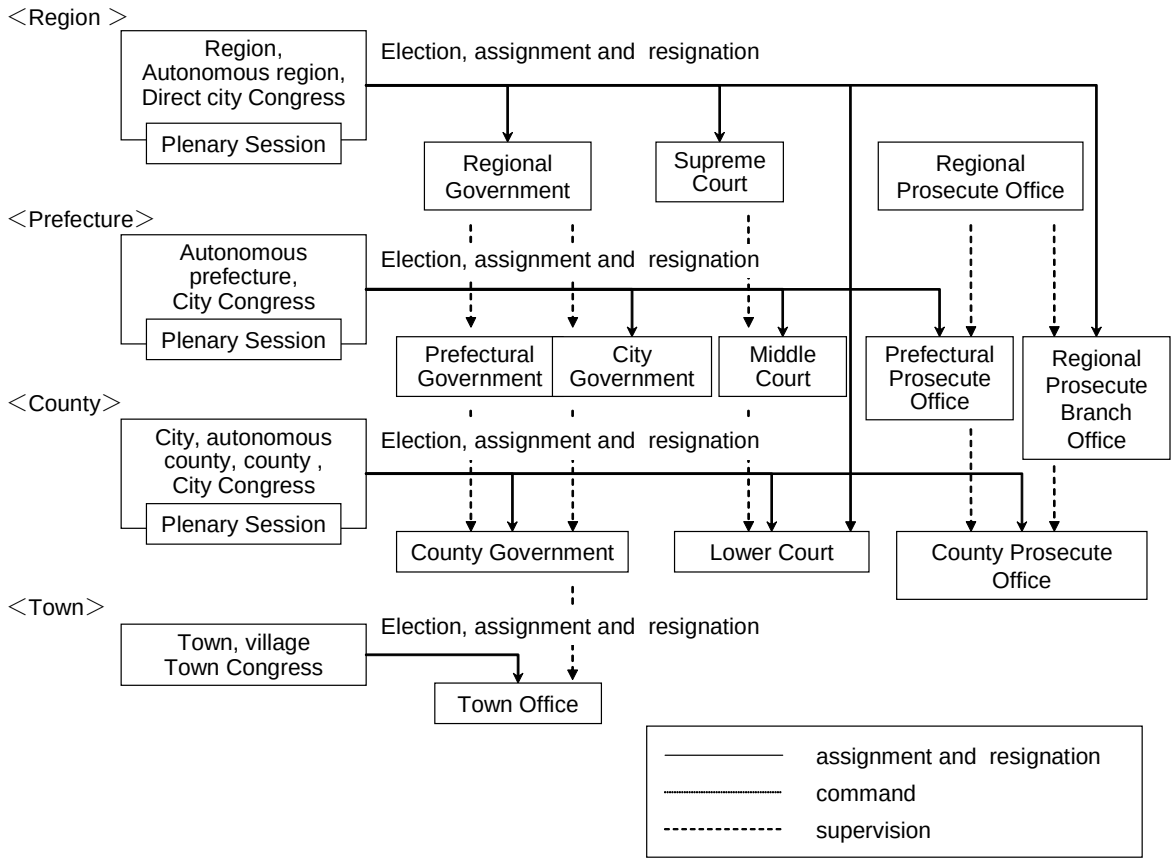


Fig. 4.1.2.3 Local administrative organs in China

(4) Autonomous organizations in an area

Because we believed it is important when disseminating techniques to agro-pastoralists to cooperate with organizations providing local instruction and support, and to implement activities with the voluntary participation of local peoples,

we studied the situation and activities of the organizations providing instruction and support to the local people of the area.

In China, the administrative village is the unit at the “Town” level, which is the lowest administrative unit. Administrative villages are not given authority, and are positioned as organizations (rural communities) for gathering local people’s opinions. Positions like village leader, sub-leader, secretary, cashier, manager of women’s meeting and so on are established, and individuals are elected locally for a set term and autonomous activities implemented by them.

(5) Languages and literacy

1) Language of the area

In order to exchange information with agro-pastoralists in the field and disseminate techniques to them, it is necessary to understand the languages the people in the area normally use. Therefore we studied the languages used locally by the concerned individuals at government organizations and agro-pastoralists.

In the Altay Administrative Office Area, the Han reside mainly in the urban areas, where Chinese is used widely, and nearly all individuals working in the governments use Chinese. When communicating with agro-pastoralists, individuals will use the languages spoken by the people of the area if necessary.

On the other hand, the languages agro-pastoralists speak are centered on the Kazak language. The Kazak language was written in Arabic until the second half of the 19th century, after which the Roman alphabet was used briefly, but today it is again written in Arabic. Some agro-pastoralists also write using the alphabet. As this illustrates, it is necessary to understand the circumstances of language use, taking into consideration the transitions in languages accompanying social reforms.

2) Literacy

Understanding literacy conditions as well as the languages is necessary in order to discuss information with the local people and disseminate techniques to them. We therefore studied the literacy situation in the area.

When nomadic peoples continue a nomadic pasturing lifestyle, their enrollment rate at schools tends to be low, and their illiteracy rate high, because they have fewer opportunities to receive an education.

(6) Infrastructure construction circumstances

To prepare a plan for measures for prevention of desertification accompanying a settlement project, the extent to which the infrastructure that will serve as a foundation for production and livelihoods is in place must be understood. The status of infrastructure construction can greatly affect production and living environments,

however, so it is important to prepare a plan properly, by obtaining the government's support. Therefore we studied the conditions and prospects of infrastructure construction in the area.

Under the settlement project in the Altay Administrative Office Area, the local government will build the infrastructure (the set of 3 Lines, 4 Fixed properties and 5 Public facilities) beginning with basic services, with agro-pastoralists taking responsibility for certain aspects. A base for agro-pastoralists' production and lives will be created through this project, and measures taken to promote income growth through increased production, agro-pastoralist education, medical services and alleviation of poverty.

Shop in the settlement

Elementary school newly-constructed in the settlement

○The "Set of 3 Lines, 4 Fixed properties and 5 Public facilities" to be built under the settlement project

3 Lines　Roads, service water and electricity

4 Fixed properties

Housing, sheds, fields for feeds and windbreak forest belts

5 Public facilities

Clinics, schools, shops, community centers and centers for instruction and dissemination of techniques

4.1.3 Economic conditions

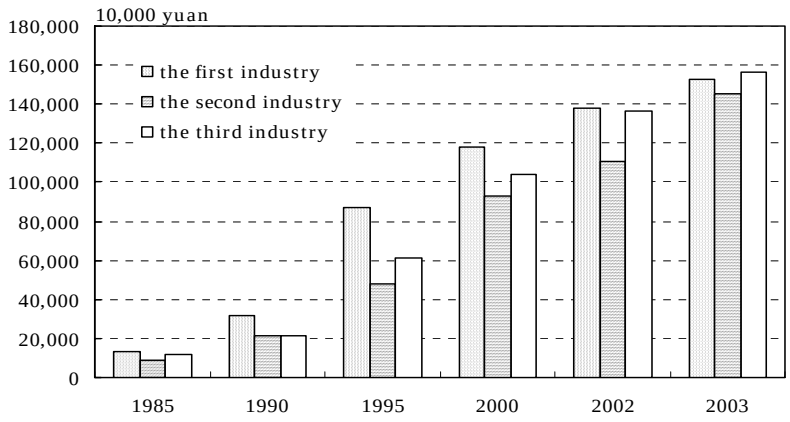
Economic conditions are one important indicator when considering the level at which to set future objectives based on current living conditions and economic levels of the people in an area. In the survey of measures for prevention of desertification we studied data of economic conditions, using reference literature and interviews, to consider the economic indicators (purposes) for agro-pastoralists. In the same survey, we used these data mainly to investigate farming management improvements.

(1) Industry of the area

To analyze the trends for major industries in the area, we studied the employed population by industry, production volume and production trends for the area. Industry structure is closely related to land use patterns, and in the Altay Administrative Office Area, the industry structure is primarily livestock farming on the basis of pastures. Therefore in the verification study on prevention of desertification, we considered measures to prevent desertification aimed at development of sustainable agriculture and livestock farming with forestry based on production of feed on the fields in settlements and use of the nomadic pasturing system rooted in the area.

1) Area industry trends

As shown in Fig. 4.1.3.1, Gross Domestic Product in the Altay Administrative Office Area has increased rapidly since 1990. Although primary industry accounts for a large percentage of production and is positioned as the most important industry in the area, the percentage of tertiary industry also shows a positive trend. As shown in Table 4.1.3.1, agriculture, livestock farming and other industries (forestry, fisheries) account for 38%, 54% and 8%, respectively, of the primary industry in the Altay Administrative Office Area, and livestock farming is positioned as the most important industry.



Data: Altay Statistical Yearbook (2004)

Fig. 4.1.3.1 Change in Gross Domestic Product by industry in the Altay Area

Table 4.1.3.1 Gross product of primary industry production (2003)

Unit: 10,000 yuan (%)

Division	Gross product value	Breakdown				
		Agriculture	Livestock farming	Forestry	Fisheries	Others
Xinjiang Uygur Autonomous Region	6,883,187 (100.0)	4,827,597 (70.1)	1,619,823 (23.5)	136,936 (2.0)	32,065 (0.5)	266,766 (3.9)
Altay Area	209,950 (100.0)	78,986 (37.6)	112,383 (53.6)	8,678 (4.1)	2,453 (1.2)	7,450 (3.5)

Data: Xinjiang Statistical Yearbook (2004)

2) Agriculture, livestock farming and forestry

To prepare a plan for measures for prevention of desertification combined effectively with livestock farming and agriculture, we identified conditions and issues centered on livestock farming and agriculture, which are positioned as important industries in the Altay Administrative Office Area, in conjunction with the future outlook prepared by the government. We also studied combinations of different kinds of livestock and crop production on the fields based on the data, clarified measures details and implemented measures on agriculture and livestock farming with forestry techniques.

(a) Livestock farming

We implemented a survey concerning the composition of individuals in charge of livestock farming, livestock production and changes in consumption, then performed an analysis and studied measures concerning present livestock feeding conditions.

a) Livestock farming population

Livestock farming is an important industry in the Altay Administrative Office Area. The number of households of individuals in charge of livestock farming and the livestock farming population account for over 30% of the total (Table 4.1.3.2).

Table 4.1.3.2 Number of livestock farming households and population as a percentage of households and population in the Altay Area (2003)

Unit: household, person, %

	Number of households			Population		
	Total	Livestock farming	%	Total	Livestock farming	%
Altay Area	55,506	18,617	33.5	258,911	95,528	36.9

Data: Xinjiang Statistical Yearbook (2004)

b) Number of head of livestock raised and quantity of meat consumption

As shown in Figure 4.1.3.2, the number of sheep raised has increased rapidly since the early 1980s, against the backdrop of an increase in meat consumption as a result of factors such as population growth and changing eating habits. Until the first half of the 1980s, up to 70% of all meat production was dependent on sheep.

Data: Xinjiang Statistical Yearbook (2004)

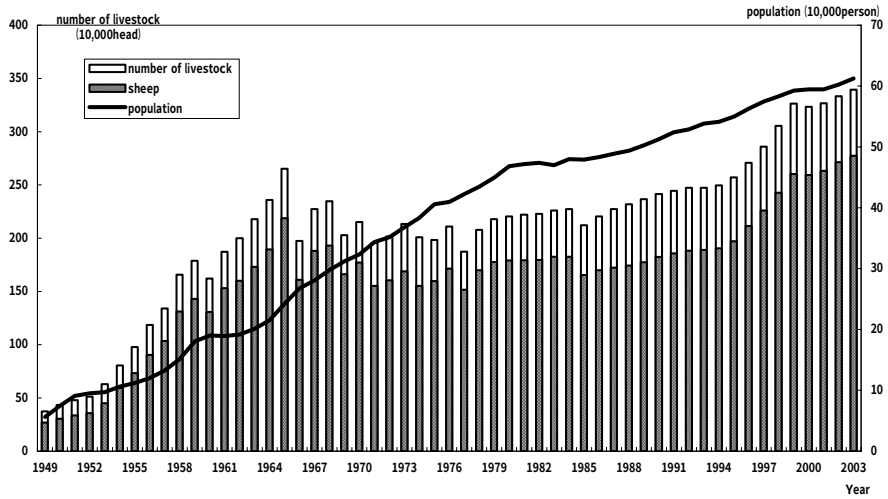
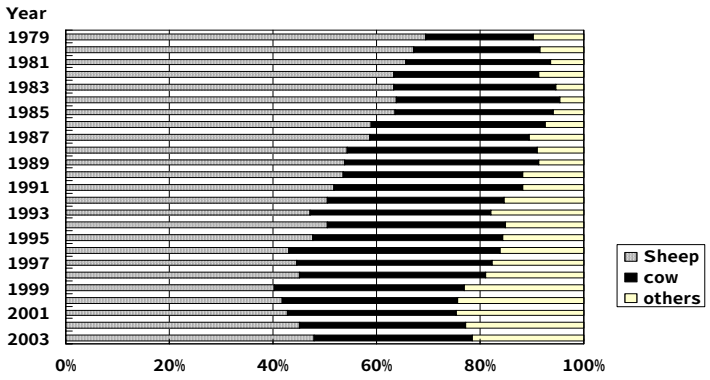


Fig. 4.1.3.2 Change in population and number of livestock in the Altay Area

Since the mid-1980s, the percentage of cows has increased relatively (Fig. 4.1.3.3) and milk production has increased rapidly (Table 4.1.3.3). Signs conforming with the government policy to shift from small livestock such as sheep to large livestock such as cows can continue to be seen.



Data: Altay Statistical Yearbook (2004)

Fig. 4.1.3.3 Change in volume of livestock production in the Altay Area

Table 4.1.3.3 Change in volume of milk production

Year	1978	1980	1985	1990	1995	2000	2001	2002	2003
Milk production (1,000tons)	10.7	13.3	22.1	41.7	48.0	66.3	67.4	69.9	80.8

Data: Altay Statistical Yearbook (2004)

c) Livestock farming development plan

In the Altay Administrative Office Area, which seeks to promote area development based on livestock farming, the municipal and provincial governments have prepared plans for development of the livestock industry and set long-term goals projecting 15 years into the future. According to the “2020 Plan for Livestock Farming in Altay City” (Table 4.1.3.4), the government plans to decrease the number of livestock by 30% from 860,000 head in 2004, the highest level, to 620,000 in 2020, while increasing the production volume of meat, milk and other products through breed improvement and disease prevention measures.

Table 4.1.3.4 Livestock Farming and Economic Development Plan in Altay City (2005-2020)

items	unit	Year		
		2004	2010	2020
Highest number of livestock	10,000 heads	86	62	62
Number of livestock at end of year	10,000 heads	61	49	44
meat production	tons	13,343	15,260	17,860
milk production	tons	31,886	76,886	—
egg production	tons	498	543	—

In past plans, the government promoted economic development for livestock farming based on increasing the number of livestock reared. In light of problems such as the decline in feed production and degradation of natural grasslands caused by overgrazing, however, and its awareness of the danger of being unable to forecast sound development in the future if livestock farming along the lines of past plans is continued, for the 2020 Plan the government set goals for economic development of livestock farming that take ecology into consideration.

(b) Agriculture

We implemented a survey concerning irrigation farming conditions, changes in agricultural production and prospects for promotion of agriculture, and studied the varieties of crops and cultivation structure for fields.

a) Field area

Because annual rainfall on the plains in the Altay Area is less than 200mm, irrigation is indispensable for farming or growing wind and sand break forest belts.

As shown in Table 4.1.3.5, the average area of fields in the Altay administrative Office Area is about 127,000 ha, of which paddy field and irrigation field area together is about 122,000 ha, accounting for 96% of the total.

Table 4.1.3.5 Irrigation field conditions (2001)

Place	Cultivated area (ha)	Breakdown (ha,(%))					
		Paddy field		Irrigation field		Non-irrigated field	
Xinjiang	3,439,320	68,640	(2.0)	3,159,570	(91.9)	211,110	(6.1)
Altay Area	127,010	40	(0.0)	122,290	(96.3)	4,680	(3.7)

Data: Xinjiang Statistical Yearbook

b) Sowing area and production volume

The total sowing area in 2003 in the Altay Administrative Office Area was 105,000 ha, as shown in Table 4.1.3.6. Alfalfa accounted for around 40%, cereals and legumes 20% each and oil crops 12%, respectively.

Table 4.1.3.6 Sowing area and production volume by crop in the Altay Area (2003)

Items	Sowing area (thousand ha)	(%)	Production (t)	Yield (kg/ha)
Crop sowing area	105.31	100.0%		
1. Food crops	43.37	41.2%	203,817	4,699
(1) Cereals	22.54	21.4%	143,752	6,378
a. Wheat	12.65	12.0%	55,215	4,365
b. Maize	9.55	9.1%	87,628	9,176
(2) Legumes	20.83	19.8%	60,065	2,884
Soybeans	13.37	12.7%	40,787	3,051
2. Oil crops	12.99	12.3%	30,966	2,384
Sunflower seeds	12.99	12.3%	30,966	2,384
3. Vegetables and melons	2.17	2.1%		
4. Others	46.78	44.4%		
a. Alfalfa	38.68	36.7%	273,210	7,063
b. Other feeds	3.14	3.0%		

Data: Xinjiang Statistical Yearbook

Looking at the change in crop production volume (Table 4.1.3.7), wheat and oil crops such as corn and sunflower seeds have long been cultivated in the Altay Area.

After peaking at 151,000t in 1997, wheat production has shown a declining trend. On the other hand, production of corn and vegetables has increased rapidly since 1990 because of progress in opening newly-developed farmland in line with promotion of the WFP (World Food Programme) Project 2817 and settlement projects by China's government.

Table 4.1.3.7 Annual change in crop production volumes in the Altay Area

Unit: tons

Year	Cereal production				Oil crops	Vegetables
	Total	Major cereals				
		Wheat	Corn	Legumes		
1980	80,452	71,384	5,586	282	3,354	15,335
1990	127,056	106,241	13,693	-	8,853	21,860
1995	162,672	102,132	27,652	13,291	16,385	17,034
2000	211,610	113,621	56,103	40,355	32,670	32,529
2001	223,594	86,192	70,308	65,533	19,050	42,558
2002	207,837	69,936	77,311	59,668	17,689	34,029
2003	203,817	55,215	87,628	60,065	30,966	31,389

Data: Xinjiang Statistical Yearbook

c) Agricultural development plans

In the 2015 Agricultural Development Plan for the Altay Area, which shows desired agricultural production, the government plans to increase crop production area by approximately 1.4 times over a 15-year period from 2001 through 2015, and roughly double total food production during the same term (Table 4.1.3.8). In particular, the government expects an increase in production of 2.5 times over the 15-year period, with the main emphasis on production of vegetables.

Table 4.1.3.8 2015 Agricultural Development Plan for the Altay Area

	Crop sowing area 10,000mu	Food production 10,000t	Oil crop production 10,000t	Vegetable production 10,000t	Total production Million yuan
2001	175	23.5	4.18	10.5	71.0
2002	185	25.3	4.65	10.8	75.5
2003	195	26.9	4.75	11.3	81.0
2004	200	28.8	4.85	12.0	84.0
2005	208	32.5	4.95	12.5	90.0
2010	225	38.9	5.05	16.0	140.0
2015	240	46.1	5.25	25.7	210.0
Average annual growth rate	4.36	7.5	9.95	6.77	6.4

(c) Forestry

To consider the position of forestry in the plan for measures for prevention of desertification, we implemented a survey concerning forest resources, afforestation conditions and management of windbreak forest belts in the area, and studied current conditions and issues.

a) Forest resources conditions

Forestry in the Xinjiang Uygur Autonomous Region is positioned with an emphasis on environment protection more than the economy. The same tendency to focus on afforestation for the purpose of nurturing protective forests can be noted in the Altay Administrative Office Area as well. As shown in Table 4.1.3.9, no promotion of forestry to produce timber has been implemented in the Altay Area, and afforestation has been carried out to create protective wind and sand break forest belts or for field protection. Although natural forests in the area were logged in the past, after the start of natural forest belt protection projects in 1988 the volume of logging was restricted, and recently the cutting of natural forest trees has been prohibited entirely.

Table 4.1.3.9 Afforestation conditions by use (2003)

Unit: ha (%)

Items	Total	type of use				
		timbers	economy	Prevention	charcoal	special use
Xinjiang Uygur	286,433	10,742	41,473	232,064	2,120	34
Autonomous Region	(100.0)	(3.8)	(14.5)	(81.0)	(0.7)	(0.0)
Altay Area	22,981	-	-	22,981	-	-
	(100.0)	(0.0)	(0.0)	(100.0)	(0.0)	(0.0)

Data: Xinjiang Statistical Yearbook

Classification of forests (evergreen) in China according to use

Type	Details
Forests for timber	Forests, trees and bamboo trees for production of timber
Forests for economy	Trees for production of fruit, vegetable oil, industrial materials and medicines
Prevention forests	Forests, trees and shrubs for cultivation of water resources, water and land conservation, wind and sand breaks, field and pasture protection, levees and road protection
Forests for charcoal	Trees for production of fuel
Forests for special use	Forests for national defense, environmental protection, research and nature reserves

b) Afforestation conditions

In China, afforestation is viewed as an activity to be conducted by citizens for landscape preservation such as greening in urban areas, and for ecological preservation as a means of returning farmland to forests or grassland and setting up windbreak forest belts, based on the Forest Law. Generally, the construction of windbreak forest belts also is implemented through compulsory activities by residents in the spring and autumn. The scope of projects and number of trees are assigned by the local governments, and instructions for completing preparation of rice field ridges, digging, planting and initial irrigation after planting by the end of each construction phase are given by the government organizations responsible for forestry (Village Forestry Control Station). Production of seedlings for afforestation is handled by the government organization responsible for forestry or private companies that sell seedlings, and strict controls are implemented for prevention of destructive logging and nature conservation. As an afforestation problem, the structure of tree stands is said to be too simple because many of the trees are poplars and oleaster, and the possibility of such stands suffering extensive damage during outbreaks of harmful insects has been pointed out. The reason a diverse variety of seedlings is not being produced is thought to be a bias toward production of seedling types that grow quickly in the early stages and are easy to manage.

c) Windbreak forest belt management conditions

Because no windbreak forest belt management other than irrigation has been implemented, many unhealthy windbreak forest belts can be seen.

Establishing a production system that can provide a variety of seedlings in an area, and enhancing managers' awareness concerning the roles of windbreak forest belts, are important considerations for building functional and sustainable windbreak forest belts. In the measures for prevention of desertification, we sought to enlighten residents on the importance of windbreak management through training and instruction for agro-pastoralists.

(2) Farmers' economy

To consider the purposes (indicators) the agro-pastoralists who will be settled should aim for in the future, based on their present lives and economic level, we implemented a survey concerning the agro-pastoralists' living conditions at the present point in time, and conditions such as their income and expenses, savings and property. We then classified the survey results by stratum (by scale), and arranged the management factors as show in Table 4.1.3.10.

Table 4.1.3.10 Management conditions of nomadic people in Alahake Town, Altay City, Altay Area (25 households)

		Large-scale management (over 100 heads) (7 households)	Mean-scale management (50～60heads) (6 households)	Maen of Total (25 households)	
Age of Chief (age)		51	31	33	Mean
Number of composition of a family ①		5	4	4	〃
Number of persons who are engaged in livestock farming (persons)		3	2	2	〃
Breakdown: Man (persons)		2	1	1	〃
Number of livestock (summer) (heads)	Sheep	110	32	69	〃
	Goats	19	12	14	〃
	Cows	20	10	14	〃
	Horses	10	4	7	〃
	Camels	5	1	3	〃
	Total	164	59	107	〃
Number of livestock for sales (Total) (heads)		30	14	21	〃
Number of livestock for self-consumption (Total) (heads)		8	4	6	〃
Balance-Sheet (yuan)	Gross income ②	16,911	6,187	11,821	〃
	Expence of farming ③	2,410	1,050	1,782	〃
	Net income ④=②+③	14,501	5,137	10,039	〃
	Net income per capita ④/①	2,900	1,284	2,510	〃

Data: Results of a survey concerning the management conditions of nomadic peoples

(3) Current farming conditions

To investigate the desired future form of farming and establish farming patterns, it is necessary to understand current farming conditions. For the verification study on prevention of desertification as well, we implemented a survey concerning standard farming patterns in the area and agricultural income, for use as a reference when studying farming patterns in the project implementation area.

At present, the nomadic peoples make their living by livestock farming, and earn nearly all of their income by selling livestock. On the other hand, in the farming by agro-pastoralists who are settled nearby, many individuals are engaged in multiple activities combining agriculture and livestock farming, producing crops such as wheat, soybeans and sunflower seeds on their fields, in addition to feed. Because they are able to cultivate crops on their fields by settling, many agro-pastoralists cultivate feed crops according to the number of head of livestock, and earn money by using their remaining fields to cultivate cash crops such as soybeans and sunflower seeds. Based on this finding, when setting the farming pattern at the project implementation site we studied farming patterns that combine agriculture and livestock as the basic farming model.

(4) Distribution and marketing

To study issues such as selling periods and selling systems that are beneficial for agro-pastoralists, we performed a survey on topics such as market conditions in the area, current distribution conditions from production areas to consumption areas and distribution volumes.

Based on the results, we considered strategies to sell mutton from winter through the spring when prices are comparatively higher, using techniques for winter lambing and fattening, and introducing cash crops centered on soybeans, for which stable prices can be expected, and sunflower for self-sufficiency in oil.

1) Market survey

To study issues such as farm livestock products and selling periods that are beneficial for agro-pastoralists, we performed a survey on topics such as items handled in the market, the quantities handled and prices. We used the resulting data when investigating the time for selling sheep, crop selection and similar issues.

For mutton consumption trends and changes in retail prices by month, the quantity of mutton consumed in a year is high during “Shunsetu” (the lunar New Year, from the end of January to early February) and at the end of September for the Han, and during the “sacrifice festival” (December 7-10 in the Muslim calendar) and 70 days before the “sacrifice festival” for the Uygur and the Kazak, and many people eat mutton during the winter. Therefore the retail sales price of mutton in the markets tends to be highest in January and February. The wholesale price of sheep sold to merchants at wholesale prices by agro-pastoralists generally tracks the trend in the sales price of mutton. Because nomadic peoples all sell sheep to merchants in the fall, however, selling is not advantageous for them in terms of price. It became clear that to solve this problem, it is necessary to establish a system technically and organizationally that will enable them to sell sheep during the period from winter to spring, when prices are higher.

Moreover, for soybeans shopkeepers purchase from intermediaries and supply the soybeans to separate markets. The market retail price in the soybean market is around 4 to 5 yuan per kilogram (a retailer’s profit is 0.2 to 0.3 yuan per kilogram), and generally changes stably.

Sunflower seeds are not supplied in large quantities to markets, because they mainly are used for home consumption.

2) Distribution survey

To study an organized selling system that will be beneficial for agro-pastoralists, we investigated the distribution routes, means of transportation, transport time, transport costs and distribution quantities through interviews with individuals responsible for these functions in the markets or related government organizations. In the verification study on prevention of desertification, we performed a survey focusing on distribution conditions around Altay City for sheep, soybeans and sunflower seeds, which occupy an important position in agro-pastoralist farming, and studied strategies for distribution of these items. This survey clarified it is possible to sell sheep favorably through cooperative marketing, and verified it would be advantageous for agro-pastoralists to

implement cooperative marketing. (The verified details are available in “4.2.4 Cooperative Marketing of Products” in the Technical Guide Manual).

(a) Mutton

Many agro-pastoralists sell sheep to wholesalers who drive in from areas such as Urumqi City, Changji City and southern Xinjiang. Recently, however, some individuals have procured their own trucks and transport their sheep themselves to sell in the Urumqi and Changji markets.

Generally the method wholesalers use to buy sheep is negotiated transactions with agro-pastoralists. To control distribution expenses (sheep carriage and penning costs), when wholesalers purchase sheep they buy sheep until a truck is fully. If agro-pastoralists are to create an advantageous market, these distribution costs must be adequately considered when borrowing trucks and selling in markets themselves.

(b) Soybeans

Soybeans are used mainly as an ingredient for tofu, soybean-oil, soy milk, seasonings such as soy sauce and condensed soybeans, and are transported to processing and manufacturing plants or collected by merchants and sold in shops.

Agro-pastoralists separate harvested soybeans from the pods, pack them and sell the soybeans to merchants after negotiating terms. The sales price to merchants is about 3 yuan per kilogram. Moreover, currently there are no instances of cooperative collection and shipment of soybeans in Alahake Town and Jiayilema Town, which are located in the area where we implemented the study. This is because the fluctuation in soybean market retail prices during a year is quite small, and prices are comparatively stable, and even if sellers were to attempt to diversify their selling periods or ensure sales volume this would not result in advantageous sale prices.

(c) Sunflower seeds

Most agro-pastoralists have the processing plant in the town where they live crush their sunflower seeds for oil for home consumption, and sell the remainder to merchants. There are some small family-run factories for crushing seeds in towns (Alahake Town has three or four); they can crush about 1 kg of oil from 2.5-3.0 kg of sunflower seeds at a processing fee of 2 jiao per kg (1 yuan = 10 jiao).

4.2 Extraction of subjects

In order to pursue measures for prevention of desertification, it is very important to understand what factors are issues in the area, and analyze the main factors causing desertification, while also taking into consideration the conditions of the pasturing system currently used.

Several causes of desertification in the Altay Administrative Area can be noted, including inferior natural conditions such as dryness and little rainfall, overgrazing or deforestation accompanying population growth and unplanned use of water resources. Of these, overgrazing has become an especially serious problem. Therefore in the verification study on prevention of desertification, we investigated the causes of desertification and studied how the nomadic pasturing system has been managed. Based on the findings, we extracted subjects concerning settlement projects implemented in the area in the past, and considered the orientation for measures for prevention of desertification, while analyzing issues related to pasturing and farming activities on the settlement.

4.2.1 Causes of overgrazing

Because the nomadic people engage mainly in livestock farming, the sale of sheep and other livestock is their principal means to increase income. Therefore the income of nomadic peoples is dependent on the number of livestock sold, and for many nomadic people there is a strong tendency to increase their livestock as a means of ensuring their income.

In addition to the trend of increasing livestock in response to the upturn in mutton consumption demand in recent years, the number of livestock reared in the area also has grown annually because farmers who cannot make a living from crop production income alone have increased livestock (mainly sheep) as a means of raising their income. As farmers have become able to ensure feed during winter, there has been a strong tendency to increase herds.

Moreover, nomadic peoples tend to increase their herds by a pattern of endowing livestock when new families are formed by sons and daughters through marriage, for example, and raising new animals to supplement the decrease of their own herds.

The livestock supply and demand trend, the unavoidable need to earn income from livestock sales based on farming management and local practices and customs all promote growth in the number of livestock in the area, and together with the fact nomadic pasturing is being continued on a scale that exceeds the vegetation on natural grasslands, have become the main causes of overgrazing.

4.2.2 Present nomadic grazing system

In the Altay Administrative Office Area, a nomadic grazing system under which nomadic people move to seasonal natural grasslands each season to make use of differences in vegetation according to altitude and weather has been adopted. Generally, nomadic families with an average of six members will make a living by moving, together with feeding livestock, over a distance of about 500km during a year, changing natural grasslands by season to spring, summer, autumn and winter pastures. Their housing is a yurt, in which they live mainly from spring to autumn and which requires more than 40 days each year to assemble or take down. On the other hand, many have homes built of sun-dried bricks, where they live during winter pasture and await the arrival of spring.

Natural conditions in each seasonal pasture differ, and fluctuations will be seen in the weight of livestock (sheep) during movement among pastures because of variations in the types and quality of natural grass and quantity of grass available. Particularly in autumn when many nomadic people sell their sheep, the weight of sheep tends to drop temporarily; the cause is thought to be a decrease in the amount of feeding as herds are moved to autumn pastures, where the quantity of grass is less. Thus nomadic pasturing in this area is greatly susceptible to natural conditions. Moreover, in the Altay Area, sheep occupy an important position among livestock as property and a source of income and energy for nomadic people.

Yurts in summer pasture

Houses in winter pasture

With several generations sharing quarters in a yurt, nomadic people live without privacy, using candles for illumination. Conventions of city and rural village living have penetrated in their lifestyle, however, and as a result of contact with agro-pastoralists who have adopted a more comfortable lifestyle through settlement, many are eager to settle. Because many nomadic people produce crops on the fields they've received after settlement, and the need for agro-pastoralists to redirect their family labor capacity to agricultural production, many have adopted entrusted feeding as an agro-pastoralist system that enables them to engage in both agriculture and livestock farming while staying in the settlement, leaving the feeding of their livestock to their family, relatives or others during the spring to autumn period.

As settlement has progressed in recent years, traditional nomadic pasturing system and the agriculture and livestock farming system have been maintained together.

4.2.3 Extraction of issues

(1) Pasturing-related issues

The increase in number of livestock, overgrazing on natural grasslands (especially spring, autumn and winter pastures) and agro-pastoralist management concerns can be cited as pasturing issues to be addressed throughout a year.

1) Increase in number of livestock

Agro-pastoralists manage their activities around livestock farming. The increase in number of livestock (especially sheep) has been strengthened as the sale of sheep and other livestock has become the primary means of increasing income, and a means of raising the income of farmers who are having difficulty maintaining their standard of living solely from the increase in demand for mutton in recent years or their income from cash crops.

Moreover, most settled agro-pastoralists produce winter feed required for raising livestock on their fields, such as alfalfa and corn, and decide crop cultivation area based on the quantities required for feeding, taking into consideration the number of their livestock, and the cultivated area of feeds like alfalfa tends to correspond to the number of livestock. As they enhance their wealth and management abilities, many agro-pastoralists tend to increase livestock in order to earn as much as possible, so there is a concern that feed production in settlements might be promoting an increase in the number of livestock through increased income.

Taking steps to promote income diversification through cultivation of cash crops is critical to eliminate such concerns. It also is important to establish system to investigate farming-related technical support and sales strategies, and create support systems that will not increase livestock, centered on government measures. Such efforts will also make it possible to diversify risks against livestock deaths from causes such as abnormal weather.

2) Overgrazing on natural grasslands (spring, autumn and winter pastures)

With the exception of summer pastures where normally rainfall is relatively plentiful (natural grasslands at high altitude in the Altay Mountains), overgrazing condition are found on spring, autumn and winter pastures near the plains, where natural grasslands are used for nomadic grazing and grass recovery is weak because of limited rainfall, because the pasturing pressure accompanying growth in the number of livestock exceeds the natural grasslands' recuperative capacity. Therefore in parts of areas like the Saul Mountains (winter pasture), efforts already have been taken to

restrict the number of livestock that can enter the area, and alleviate overgrazing and conserve natural grasslands. Although the number of feeding livestock declines temporarily when many nomadic people sell sheep in autumn, the absolute number of livestock in the area is thought to be increasing because of the tendency for nomadic peoples to increase their livestock. Moreover, because settled agro-pastoralists can feed livestock beyond the capacity of the sheds on a settlement through the practice of entrusted feeding, the tendency to increase the number of livestock is thought to have intensified among agro-pastoralists as well.

Thus the need has grown not only to restore natural grasslands on winter pastures, where the extent of degradation caused by overgrazing is serious, but to properly conserve natural grasslands on spring and autumn pastures, where grazing capacity has been reduced by overgrazing as well.

3) Issues concerning management by nomadic people

Although nomadic people are aware of the degradation of natural grasslands, they tend to aim at increasing their livestock because earnings from the sale of livestock (sheep) have become the principal means of enhancing income and consumption demand for mutton has grown rapidly with the change of eating habits.

Nomadic grazing also faces the risk of weather disaster. Heavy snows in particular can kill many livestock. Nevertheless, because current management techniques do not offer a means to ensure income other than selling livestock, and management risk also is high because weather disaster and other risks cannot be addressed, today it is difficult to restrict the number of livestock substantially.

4) Other issues

Although sheep normally give birth from early to late April in spring pastures, grazing capacity is very low because this is before sprouting. Therefore to preserve pastures, nomads cannot remain in spring pasture for long. This means it is important to adequately ensure feed during winter and promote feeding on the settlement, to enable nomads to delay entering spring pasture.

(2) Issues related to agricultural production activities in the settlements

1) Production of feed in settlements

To increase the number of sheep, which nomads rely on heavily as a source of income for their nomadic lifestyle, securing feed during winter is extremely important. Agro-pastoralists' feed production is centered on alfalfa, which is especially tough against aridity and can be raised with little irrigation water, and is comparatively easy to cultivate even for nomads with little cultivation experience. As shown in Table 4.2.3.1, cultivation volume and production have been increasing annually.

Table 4.2.3.1 Artificial grasslands and feed production volume in the Altay Area

Unit: ha, kg/ha

Year	1990		1995		2000		2001	
	Area	Output	Area	Output	Area	Output	Area	Output
Artificial grassland area	31,473		37,090		42,320		46,023	
Alfalfa	28,880	4,500	32,270	4,000	35,860	6,155	37,633	7,166
Corn	2,593	5,280	4,820	5,736	6,460	8,684	8,390	8,379

Data: Materials compiled by the Altay Area Animal Husbandry Bureau

Because fertilizer reduction or suitable irrigation are not provided, however, for the first year or two after the start of cultivation yields have been low (first year yield of 100 to 200 kg per mu (1,500kg to 3,000kg per ha) versus the target yield of 500kg per mu (7,500kg per ha), and sufficient winter feed cannot be ensured. Therefore many agro-pastoralists continue to use natural grassland grazing in winter pastures and areas like the Saul Mountains, and little progress has been made in mitigating the load on natural grasslands through settlement. Although alfalfa cultivation becomes the main activity several years after settlement, most agro-pastoralists cultivate other crops in addition to alfalfa when renewing the alfalfa in four to five years. In one village in Altay City, settlers initially cultivated only alfalfa and began to cultivate other crops after five or six years, and today melons are being cultivated on the same area as alfalfa.

On the other hand, although expansion of production of corns also is expected from the standpoint of improvement of feed efficiency or land productivity, very little is cultivated in villages because of the time and effort required compared with alfalfa. In order to cultivate corn, organic fertilizers are required. Other issues include production of silage, the cost of construction for silos required for storage, and securing workers for harvesting, grinding and packing. Although this situation continues for some time after settlement, once feed production begins in earnest agro-pastoralists tend to increase of livestock as winter feed, which had been a limiting factor, is produced in surplus. Therefore although it is important to expand feed production as much as possible, it is even more important to promote diversification of income, which will make it possible to control the increase in the number of feeding livestock. Finally, in the settlements it is necessary to teach management that does not specialize in the sale of livestock, while cultivating feed crops and simultaneously providing other technical support.

2) Irrigation in settlements

In the Altai Administrative Office Area, agro-pastoralists do not actively implement water management, and water is allocated even if not needed for irrigation, so

awareness of water conservation is low and individuals tend to engage in redundant irrigation. This is thought to reflect the fact water management is provided by government authorities, and the awareness that agro-pastoralists should engage in efficient irrigation has not spread.

Moreover, although the government also is responsible for repair of basic irrigation facilities, maintenance tends to be delayed because of budget and personnel shortages. To improve these circumstances it will be necessary for water users themselves to think about saving water and implementing effective irrigation, while also continuing to receive government guidance and support, and also necessary to implement irrigation facilities management properly and efficiently.

3) Afforestation activity in settlements

(a) Afforestation

Because the structure of windbreak forest belts on settlements is simple and the variety of trees is not diversified, often being only poplar and oleaster, windbreak forest belts are susceptible to damage from swarms of harmful insects and efforts are needed to promote diversification of tree varieties, including species local to the area. If diversified windbreak forest belts can be created, large-scale damage to the extent of crop production being disrupted can be avoided, even assuming insect damage is widespread. The fact seedling production of diverse tree species is not being carried out can be cited as background to the single species afforestation used in the Altay Administrative Office Area. In seedling production a bias towards tree species that grow quickly in early years and are simple to manage can be noted, and seedling production of indigenous varieties and drought-tolerant species is only being implemented on an experimental basis by a limited number of organizations. As a result, for afforestation for ecological and environmental conservation, seedlings are transported to a site from extremely distant locations, which cannot be deemed suitable in terms of the area ecosystem. A more suitable approach would be to create windbreak forest belts coherently in the local area, from production of seedlings to planting. To create functional and sustainable windbreak forest belts in the settlements, it will be necessary to establish a system for coherent production from seedlings to planting that will make it possible to supply seedlings of diverse species.

(b) Windbreak forest belt management

Many unhealthy windbreak forest belts can be seen because very little management is being provided other than irrigation. In numerous cases trees are growing vertically because of dense planting, and have become extremely unstable, and sound growth by proper thinning should be promoted in order to prevent damage from wind. Windbreak forest belts left unmanaged after trees have died also can be seen, and

especially when farmlands have been abandoned, windbreak forest belts also have been abandoned and are dying. This situation is thought to be due to a lack of knowledge among settlers concerning windbreak forest belt management, which makes it necessary to cultivate a sense of ownership and appropriate, sustainable windbreak forest belt management at the individual or community level.

(3) Issues related to settlement projects

Although settlement projects have been implemented in the Altay Administrative Office Area, the management conditions of agro-pastoralists who have been settled, and problems after settlement, have been noted as issues.

1) Settlement projects summary

In the Altay Administrative Office Area, settlement projects have been implemented by the government and approximately 80% of the nomadic peoples have been settled (Table 4.2.3.2). There are few cases of agro-pastoralists cultivating pasturing grasses in the settlements or on farmland by themselves.

Table 4.2.3.2 Settlement conditions in the Altay Area

Year	Number of nomad homes (Houses)	Number of settlers (Houses)	Ratio (%)	Nomad population (Persons)	Settler population (Persons)	Ratio (%)	Total number of livestock (1,000 head)	Sheep (1,000 head)
1990	17,468	6,216	35.6	114,661	31,080	27.1	2,415	1,621
1995	22,451	9,887	44.0	125,521	49,390	39.3	2,571	1,702
2000	23,540	17,685	75.1	129,226	88,425	68.4	3,234	2,306
2001	24,426	18,773	76.9	135,039	99,715	73.8	3,266	2,235
2002	25,011	20,227	80.9	130,863	125,055	95.6	3,333.5	2,714.5
2003	26,310	22,054	83.8	135,817	131,550	96.9	3,394.2	2,773.1

(a) Settlement project by the WFP (World Food Programme)

The WFP China 2817 Project was implemented as a pilot project for settlement project for agro-pastoralists in the Altay Area from 1988 to 1997, using the food aid under the World Food Programme (WFP).

Through this project 32,000 ha of irrigated fields were developed, with 20,000 ha used as artificial grasslands planted with alfalfa and the remaining area utilized for forests, roads, irrigation canals, land for facilities and other purposes. As a result, 6,100 households have been settled, equivalent to 15% of the Kazaks in the Altay Area, and income created for more than 32,000 agro-pastoralists.

Although the FAO and UNDP implemented specialized techniques for feed production, irrigation and water management, for other purposes local techniques

were used. In this project, agro-pastoralists constructed houses and sheds in the fields distributed on the settlement, and a settlement composed of around 100 houses in a belt pattern (dispersed housing) was formed. As a result, construction of the infrastructure for daily living is said to be inadequate or inconvenient to use.

(b) Settlement project by the Chinese government

After the WFP project, a settlement project that improved the issues highlighted by the WFP China 2817 Project was implemented in the Altay Administrative Office Area by the Chinese government. Artificial grasslands covering 46,000 ha were developed in 2001, on which farming is being conducted. In this project, collective housing was adopted for the settlement format, and the “3 lines, 4 fixed properties and 5 facilities” package was constructed efficiently.

(c) Considerations

In settlement projects in the past, the distribution of fields to agro-pastoralists frequently was decided based on the number of livestock owned and family labor capability. Therefore a large gap is found in distribution areas depending on the settlement project, with 160 mu per household in the case of Burqin County and 60 to 120 mu per household in Aweitan Town in Altay under the WFP China 2817 Project, and 22 to 40 mu per household in Chibar in Habahe County and 37 to 100 mu per household in Jiayilema Town under the settlement project of the Chinese government. In other projects as well in which fields were distributed based on the projected future increase in number of livestock and family labor capabilities, a large differential is found, with the area per household ranging from 60 to 120 mu. Agro-pastoralists’ income from agriculture and standard of living are generally proportional to the size of their fields, so the size of fields managed significantly affects agro-pastoralists’ farm management.

2) Farm management conditions for settled agro-pastoralists

In a settlement project, some agro-pastoralists manage their fields mainly for livestock farming for sheep and other animals, just as they did before settlement, while others seek to manage their agro-pastoral activities centered on the cultivation of cash crops (by entrusting livestock farming to others). Typically, agro-pastoralists who had many head of livestock before settlement will tend to manage their activities around income from livestock sales after settlement as well, and almost no individuals abandon the rearing of livestock entirely to devote themselves exclusively to agriculture.

Agro-pastoralists who produce crops on their fields have adopted a style of

entrusting feeding, by which they entrust their livestock to a family member, relatives or others from spring until autumn. In addition to cultivation of feed crops, they raise wheat, soybeans, flower beans and sunflowers for oil, either for home use or for sale, and the proportion of income from livestock sales and crop sales varies for each agro-pastoralist.

3) Issues after settlement

Compared to before settlement, living conditions for agro-pastoralists have been improved remarkably. Nevertheless, some agro-pastoralists cannot produce a sufficient volume of crops for feeding and must use winter pastures as they did in the past, because of the differences that occurred in the allocation of field area per household in past settlement projects.

Considering the low income structure of farming that makes it difficult to live on the income from sales of agricultural products alone, the heavy dependence of agro-pastoralists on livestock such as sheep and other factors, farming by agro-pastoralists after settlement tends to aim strongly at farming centered on livestock, with first priority on ensuring winter feed. As a result, there is concern this has created conditions that have increased the number of feeding livestock after settlement and intensified overgrazing of natural grasslands, without halting grassland degradation. Should such conditions continue, the sustainability of livestock farming itself, which is the main industry in the area, will be lost, and agro-pastoralists' lives may be affected as well. To improve this situation, it will be important to focus on management of a "composite livestock and agricultural farming model" that introduces highly profitable cash crops, while receiving technical support from the government and continuing feed production in the fields as the main activity, and consider measures aimed at alleviation of management risk.

4.3 Selection of the study site

After conducting a survey of present conditions and extracting subjects, we implemented field surveys in six candidate areas of the Altay administrative Office Area, based on the method for evaluation of proposed areas shown in Table below.

The six candidate areas where we implemented the surveys are all hilly areas, river plains and nearby wastelands. We selected the candidate areas to serve as model fields. As a result, we evaluated the candidate areas by ranking them (Evaluation criteria A, B, C and D); the candidate areas given an “A” for three or more classifications were the Alahake site in Altay City and Kerdala site in Habahe County, and ultimately we selected these two sites as locations for model fields.

Classification		Evaluation criteria				Remarks
		A	B	C	D	
I	Incidence of desertification	High	Medium	Low	None	State of desertification including erosion by wind, accumulation of salinity
II	Accumulation of salinity	Heavy	Medium	Light	None	Appearance or potential of accumulation salinity
III	Assurance of water resources	Easy	Possible	Difficult	Impossible	Quantity available for use and possibility of distribution
IV	Participation by local people	Easy	Possible	Difficult	Impossible	Cooperation of local people
V	Transportation access	Good	Medium	Bad	Difficult	Convenience of activities

Table 4.3.1 Evaluation of candidate sites for implementation

Candidate site		Evaluation classification					Remarks
		I	II	III	IV	V	
1	Site A	A	B	B	A	C	River bank hills, sand hills in parts
2	Site B	B	B	B	A	A	Hills, next to existing project site
3	Alahake site	A	B	A	A	A	Hills with steep slopes, farm reclamation has been implemented nearby
4	Site D	A	B	C	A	B	Hills, sand hill in parts
5	Kerdala site	B	A	A	A	B	Plain of former river, with existing irrigation canals
6	Site F	B	B	A	A	B	Hills, project being implemented

Table 4.3.2 Features of model field candidate sites

Classification	Alahake site in Altay City (in Alahake town)	Kerdala site in Habahe County (in Jiayilema town)
Terrain	Hill with steep slope at foot of mountain	Plain at junction of rivers
Soil	Rocky soil (Gobi)	Gobi and sand
Vegetation	Minimal, some shrubs	Natural grasslands, shrubs
Use	Not being used	For pasturing (spring, autumn) For cultivation (feeds, cereals)
State of desertification	Natural desert (Gobi)	Damage from wind, sand
Assurance of water resources	New development (Intake, Irrigation canals)	Deteriorated simple irrigation facilities
Agro-pastoralists	Newly settled nomadic people Some agricultural villages nearby	Settled or semi-settled agro-pastoralists

4.4 Surveys of present conditions of water and other resources

Because it is necessary to clarify the present hydrological, geological and soil conditions and obtain basic data for farm and field design when preparing a plan for creation of model fields, we conducted surveys of the present condition of water and resources at the Alahake site in Altay City and Kerdala site in Habahe County. The details and results of the surveys are shown below.

4.4.1 Details of surveys

Details of the surveys at the Alahake site in Altay City and Kerdala site in Habahe County are shown in Table 4.4.1.

Table 4.4.1 Details of surveys concerning water resources.

	Alahake site	Kerdala site
Field survey (Scale drawing: 1 / 10,000)	8km^2 (Area)	8km^2 (Area)
Hydrology, geological cross section (Scale drawing: 1/2,000)	24km (6 sections)	24km (6 sections)
Physical probe (Electric probe)	80 points	80 points
Boring survey	4 holes (L=177m)	4 holes (L=177m)
Set up tubes (Boring survey)	4 holes (L=177m)	4 holes (L=177m)
Trial excavation (Geology, soil section survey)	80 holes	80 holes
Deep wells (digging for survey)	10 holes	10 holes
Soil analysis	50 points×3 sets	50 points×3 sets
Soil permeability test (Permeability)	32 points	32 points
Test of pouring water in holes for boring for survey	19 sets (4 holes)	19 sets (4 holes)
Water quality analysis of ground water	14 sets	14 sets
Soil sieve test	20 sets	20 sets

4.4.2 Results of the surveys

(1) Alahake site

1) General condition

The Alahake site is located about 60 km southwest from the center of Altay City on the east side of the Alahake River; the area on the north side of National Route No. 217 is a diluvial plain rising gradually to a steep range of hills in the south. The altitude is 530-536m.

The planned site for the model fields has enough sunshine, and annual hours of sunlight are 2,825 - 2,960 hours. The annual average temperature is 5.4°C; the highest recorded temperature is 39.1°C, the lowest recorded temperature is -45.7°C

and the frostless period is 158 days. The four seasons are distinct, with cold winters and hot summers. The spring temperature rise is unstable, winds are frequent and there are many days with sand storms. When autumn arrives the temperature drops rapidly. Annual precipitation is 218mm, and irrigation is required. The volume of evaporation is large, with maximum annual evaporation volume of 2,272mm.

The area around the planned fields is convenient to transportation, communication and electricity facilities, and the distance to National Route No. 217 is about 5km and the distance to the Alahake Town Office is 10km.

2) Water resources

In Alahake Town, the Alahake River flows south from its source in the Altay Mountains where it is fed by snow melt, through a watershed area of 500 square kilometers, with annual flow volume of 67 million m^3. Tiberei Dam, which was built on the lower reach of the river, is a gravity-type concrete dam with total water storage capacity of 26 million cubic meters and a storage area of 5,000 mu (333ha); the dam is the multipurpose dam, serving mainly for irrigation but also for flood prevention and supplying water for cultivation of marine products. Construction of Tiberei Dam has further stabilized the river flow volume on Alahake River and contributes to city water supply.

3) Soil

The soils in the model fields consist of russet-colored soil containing calcium and sandy soil, both influenced by natural conditions during the formation process. The soil source materials are alluvial deposits originating from the components of egg-shaped gravel sands.

The source of the brown lime soil (russet brown calcium soil) is the diluvium of the Quaternary layer, with mudstone of the Tertiary layer beneath this.

Although soil salt concentration is 0.04-0.26% and the soil is classified as non-chlorinated ground at most of the points surveyed, there were points classified as weakly chlorinated ground (carbonic acid and sulfate type) at 0.31-0.83%. The soil pH is low, with little soil nourishment of various kinds except potassium, and organic matter at 3-7g/kg also is minimal.

4) Hydrology and Geology

The planned model fields are fan-like lands with steep slopes spreading in front of a fault displacement forming rocky cliffs devoid of vegetation.

The thickness of the Quaternary layer diluvium is 30-80m, with sandy soil from 0-2m below the surface (some wind-blown sandstone, but mainly rocky soils), and rough sandy soil up to 2-3m thick.

The groundwater level is deep, at 18-40m below the surface. The thickness of an aquifer is 12-45m, and groundwater volume is limited. In addition, an impermeable stratum forms the upper part of the Tertiary layer, at a depth of 30-80m from the surface.

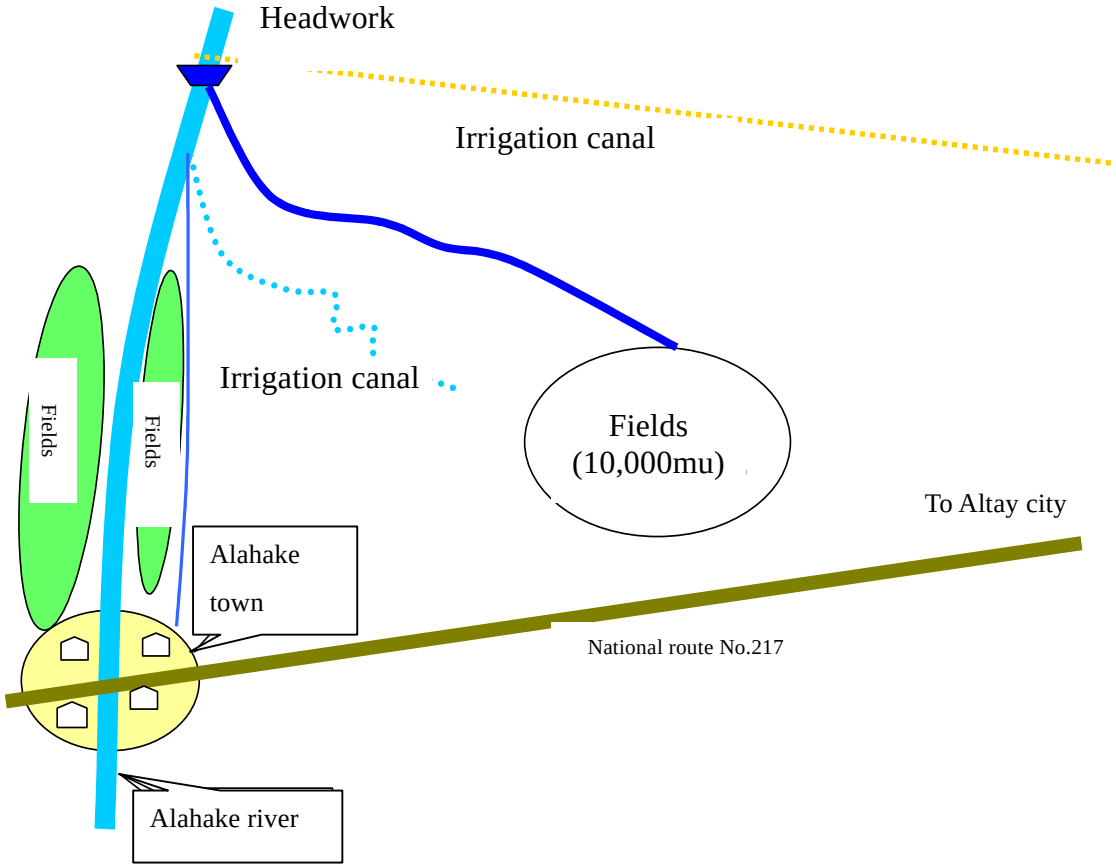


Fig. 4.4.2.1 Sketch of the Alahake site

(2) Kerdala site

1) General conditions

The Kerdala site is located in the southwest of Habahe County, at a straight-line distance of approximately 15km from the county center and altitude of 455-460m, and has flat, sand and gravel soil in the former river plain at the confluence of the Haba River and Ertix River.

The planned model fields receive adequate sunshine, and annual hours of sunlight are 2,950 hours. The annual average temperature is 4.0°C; the highest recorded temperature is 39.4°C, the lowest recorded temperature is -50.1°C and the frostless period is 145 days. The four seasons are distinct, with cold winters and hot summers. Like the Alahake site, the spring temperature rise is unstable, with frequent winds and many days with sand storms. Autumn brings a sharp drop in temperature. Annual precipitation is 178mm, and irrigation is required. The volume of evaporation is large,

with maximum annual evaporation volume of 2,072mm.

Under the influence of the constricting geographical features of the Ertix River, winds are strong throughout the year and average wind velocity is 4.5m/sec, with wind velocity of 17-21 m/sec or higher on about 60 days per year, primarily in April - May and November - January.

Transportation, communication and electricity facilities have not been built near the planned fields.

2) Water resources

The water resources for the Kerdala site will be water carried by the Kemur irrigation canal from the Haba River. The length of Kemur irrigation canal is 27km, and the planned model fields are located at the end of the canal. Because farmlands covering about 8,000 mu have already been plotted in the upper part of the planned model fields, and the canal is in a deteriorated state and is leaking water in some locations, we were concerned that very minimal quantities would be supplied as city water to the fields, but the various water resources-related problems were solved by construction of canals to take water directly from the Haba River.

3) Soil

The characteristic features of the soil in the planned fields are classified into alluvial soil of the Quaternary layer and wind-blown sandstone. The fields are located on the north bank of the Ertix River, belonging to the typical continental dry climate of a northern temperate zone. Like the Alahake site, the soil source materials are alluvial deposits originating from the components of egg-shaped gravel sands. The area around the Kerdala site frequently has northwest-oriented strong winds, and large quantities of sand granules are carried in from the outside of the area.

Soil salt concentration is 0.06 - 0.08%, and the soil is classified as non-chlorinated ground. The soil pH is within a range of 7.2-7.4, with little soil nourishment of various kinds except potassium, and organic matter also is minimal at 2-5g /kg.

4) Hydrology and Geology

The thickness of the alluvial layer is 6-25m. From 0-0.5m the surface cover is egg-shaped gravel beds, and egg-shaped grit is locally distributed to depths of 0.5-15m. Medium-size rough sand is contained in the gravel at depths up to 15-25m.

The groundwater level is 8-10m below the surface. The thickness of an aquifer is 2.5-15m, and groundwater pumping is possible. In addition, an impermeable stratum forms the upper part of the Tertiary layer, at a depth of 6-25m from the surface. The groundwater does not contain salt and is usable for both irrigation and drinking.

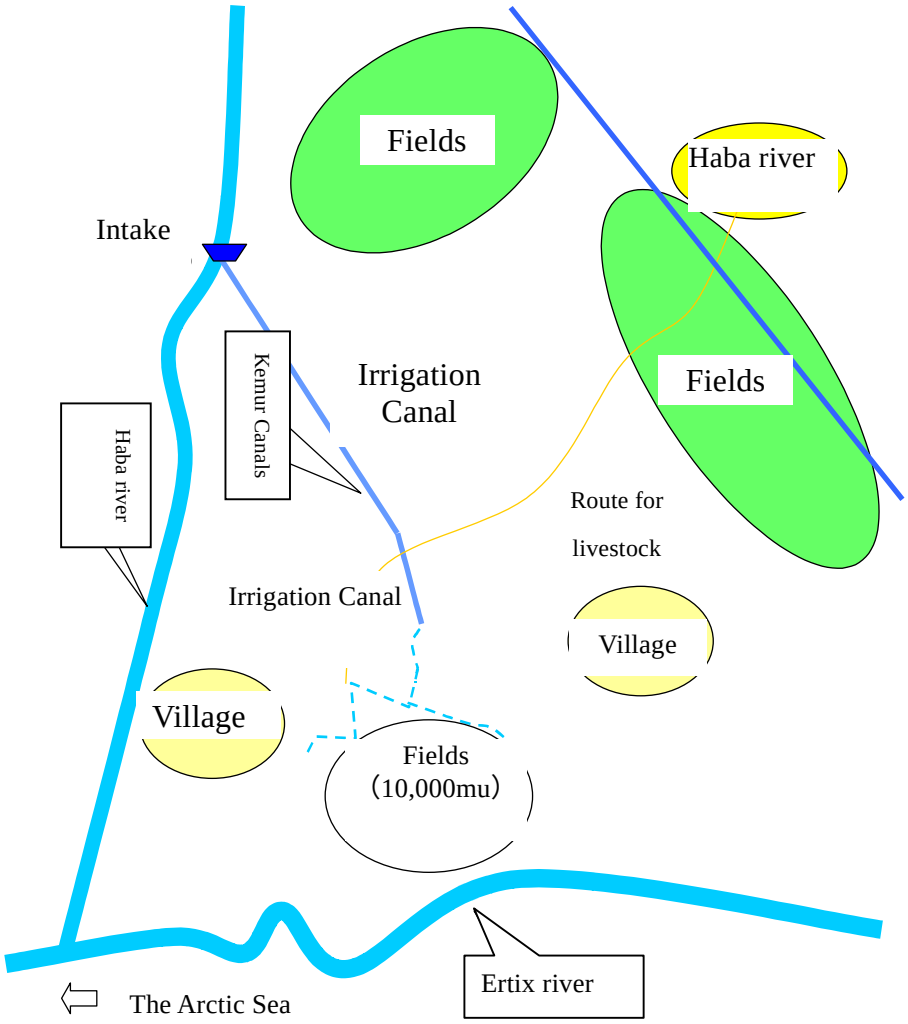


Fig. 4.4.2.2 Sketch of the Kerdala site

Table 4.4.2 List of results of water resources survey

Indicators	Alahake site, Altay City	Kerdala site, Habahe County
Economical location (road traffic, market)	National Route No. 217, 45km west of city	Same as the left, 150km west
Terrain, altitude, slope, main river	Alluvial fan of Ertix River and Alahake River, concave basin (bank terethnic group) EL530-536m, slope 1.5-1.6%	Desert on Ertix River bank terethnic group, small semi-fixed hills EL455-460m, slope 0.3-0.4%
Geology	Quaternary layer aggregate soil, gravelly soil, fine sands	Alluvial soil of the Quaternary layer, and mudstone of the Tertiary layer
Vegetation (species, cover density, volume of grass production)	Cover density 10-30% Volume of grass production 20-100kg/mu	Cover density 10-20% Volume of grass production 200-250kg/mu
Soil in model fields	Russet calcium soil (66%), wind-blown sandstone (34%)	Russet calcium soil (52%), wind-blown sandstone (48%)
Physical properties (particle composition, ground water level, surface soil thickness)	Stone inclusions 5-20%, ground water depth 18-40m, surface soil 30-60cm	Stone inclusions 10-64%, ground water depth 8-10m, surface soil 30-150cm
Chemical properties (pH, humus, N, P, K, Cl)	pH 8.1, humus 0.4-1.0%, TN 0.05%, effective phosphoric acid 5-10ppm	pH 7.0-8.3, humus 0.4%, TN 0.02%, effective phosphoric acid 7ppm

4.5 Clarification of measures

In order to clarify the contents of measures for prevention of desertification, in the verification study on prevention of desertification we first considered the framework that sets the basic policies, then clarified the purposes to be achieved and contents of the activities for realizing the goals.

4.5.1 Establishment of framework

The framework is the long-term vision defining the overall orientation. In the verification study on prevention of desertification, we defined the basic policy as “development of sustainable agriculture and livestock farming with forestry by settlement of nomadic people, based on issues at settlement projects implemented in the past,” as shown in Fig. 4.5.1, for the purpose of eliminating the problem of degradation of vegetation by overgrazing in seasonal pastures that is a cause of desertification, and established the framework needed for “mitigation of loads on natural grasslands” to be attained through application of that basic policy.

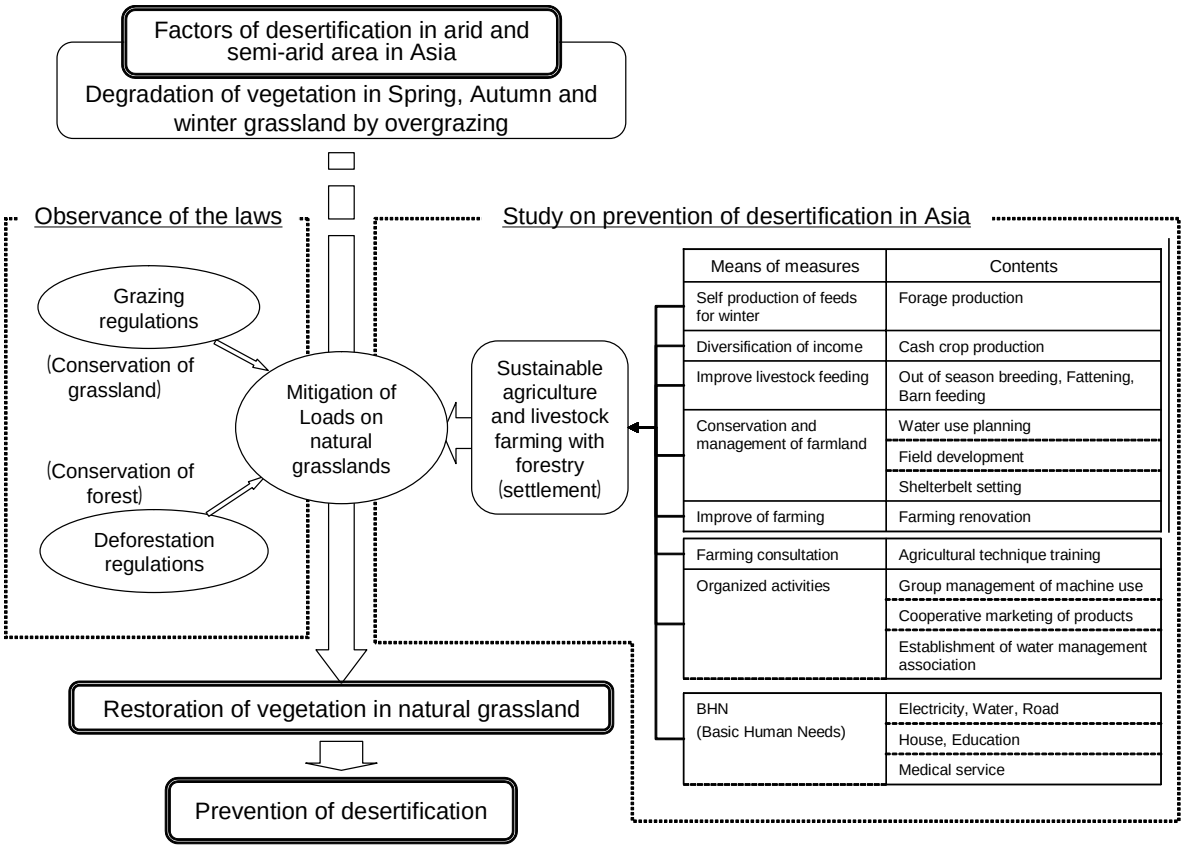


Fig. 4.5.1 Framework for the verification study on prevention of desertification in Asia

4.5.2 Establishment of purpose

Considering the need to clarify the purpose of the measures to be achieved and the details of the activities to realize them in order to embody the framework, in the verification study on prevention of desertification we defined the project scope, target year, outputs and indicators of the purposes.

(1) Project scope

Because it is necessary to understand present conditions such as physical location, existing natural resources and people's livelihoods that will be limiting factors when defining the scope of the purposes, in the verification study on prevention of desertification we defined the project scope (target area) to be Alahake Town (Altay City) and Jiayilema (Habahe County) in the Altay Administrative Office Area after consulting and negotiating with the local governments that will act as the entities implementing the project, taking into consideration the effects of desertification, ability to ensure water resources, participation by local people, outputs to be demonstrated and transportation access.

(2) Target year

Because it is necessary to set the project implementation period and term required to achieve the purposes when preparing a plan, in the verification study on prevention of desertification we set the project implementation period to be five years, assuming the time required for construction of infrastructure and the term for the settlement agro-pastoralists to continue their activities while managing and operating the infrastructure. We then set "establish techniques that will enable agro-pastoralists in the northwestern area of China to manage farming activities through sustainable agriculture and livestock farming through settlement" as the goal.

(3) Outputs

The outputs are the results to be realized in order to attain the purposes, and are achieved through implementation of various activities. In the verification study on prevention of desertification, we established seven outputs, covering feed and cash crop production, planned management of pastures, irrigation and drainage, facilities, maintenance of windbreak forest belts and enhancement of attitudes towards farming, while also considering factors such as farming conditions in the area, the present technical level and future project execution, operations and management.

(4) Indicators

Indicators are standards to measure the degree of achievement. In the verification study on prevention of desertification, we established indicators to show purpose

values and extent of achievement that will enable outputs to be verified more objectively.

(5) External conditions

External conditions can be thought of as factors that can also become an obstacle to achievement of activities and purposes, and it is important to monitor them periodically. In the verification study on prevention of desertification, we implemented the survey while monitoring external conditions such as society, culture, natural environment, economy and technology.

Project management

In recent years, managing projects using tools referred to as a logical framework (log frame) centered on related organizations engaged in international cooperation has become the norm. A log frame is an outline of a plan, and is most distinctive feature is that the course of the project execution details and the outputs is arranged clearly by expressing the project activities details and purposes using a causes-and-effects relationship for “causes” and “outputs.”

For the survey in the Altai Area as well, we prepared a log frame and sought to implement efficient and effective administration of the survey by utilizing proper management of the progress of activities for the purposes, indicators, activities and outputs during the verification study period.

The log frame is shown below.

Survey project target group: Agricultural technicians and agro-pastoralists in northwestern China
Survey target area: Altay Administrative Office Area, Xinjiang Uygur Autonomous Region
Survey implementation period: FY2001 to FY2005 (5 years)

Narrative Summary	Objective Verifiable Indicators
Overall Goal Sustainable rural development is to be developed based on the settlement of agro-pastoralists in arid and semi-arid areas in Asia.	
Project Purpose Establish techniques that will enable agro-pastoralists in the northwestern area of China to manage farming activities through sustainable agriculture and livestock farming through settlement.	・Technical Guide Manual is published. ・Annual income of agro-pastoralists: 3,000, or more yuan/person/year
Outputs 1. The ratio of feed self-sufficiency and earnings through sales of livestock is enhanced. 2. Self-sufficient crops and cash crops are cultivated. 3. Planned management of pastures is implemented by agro-pastoralists. 4. Planned irrigation and drainage are implemented by persons in charge of water management and agro-pastoralists. 5. Construction is implemented taking into consideration local geographical conditions, and maintenance and management of irrigation facilities are implemented by agro-pastoralists. 6. Maintenance and management of windbreak forest belts, from raising seedlings to management or renewal, are implemented by agro-pastoralists. 7. Progress is made in reform of agro-pastoralists' attitudes toward farming.	1. (a) Winter feed for self-sufficiency is produced on the settlement. (b) The ratio of feed self-sufficiency is higher than in surrounding settlements. (c) Periods for shipment of livestock are diversified. 2. (a) Vegetables or cereal crops are cultivated on the settlement. (b) Periods for shipment of crops are diversified. (c) Crop yields are higher than in surrounding settlements 3. (a) Supplementary feed is supplied to pastured livestock. (b) Damage from harmful insects is mitigated. 4. (a) The amount of irrigation water required depending on crop growth conditions is studied by the local governments. (b) Rotational irrigation is implemented. (c) Salt accumulation density in the soil does not deteriorate compared to present conditions. 5. (a) Verification project-related costs are reduced compared to the current plan. (b) Repairs to irrigation canals are implemented regularly. 6. (a) Beds for raising seedlings are used and managed by agro-pastoralists. (b) A survival rate of at least 60% for trees during the process of raising, planting and managing seedlings is ensured. 7. (a) The technical meetings hosted by the local governments or settlements are held. (b) Sales (sheep and vegetables) are implemented using market information.
Activities 1-1. Cultivation of feed products 1-2. Silage processing 1-3. Implementation of off-season breeding (summer mating, winter lambing) 2-1. Implementation of tests for variety selection 2-2. Creation of manuring practices suited to the site 3-1. Systematization of techniques of nomadic pasturing 3-2. Preparation of a plan for pasturing 3-3. Implementation of tests for ecological control of harmful insects and weeds 4-1. Tests of irrigation on the fields 4-2. Creation of a water user's association, instruction in management methods 4-3. Measurement of ground water level 5-1. Construction monitoring and management 5-2. Creation of methods for sand hill construction 5-3. Creation of methods for facilities maintenance and management 6-1. Selection of tree species suited to the area environment 6-2. Tests for raising seedlings of useful tree varieties 7-1. Implementation of workshops, training courses for agro-pastoralists and counterparts meetings 7-2. Market surveys (sheep, vegetables)	

Note: To achieve the survey outputs, purpose and overall goal, the following preconditions and external conditions must be fulfilled.

【Preconditions】	【External conditions】
(a) The project area is located in an arid and semi-arid area. (b) Irrigation agriculture can be implemented. (c) The settlement project is implemented.	(a) Water resources are ensured. (b) Prices for farm products do not fluctuate rapidly. (c) The BHN (infrastructure) will be built. (d) Related laws are enacted. (e) The climate does not change rapidly.

4.5.3 Observance of laws

Observance of laws is indispensable for achieving control of desertification through mitigation of loads on natural grasslands. In particular, creating regulations on pasturing livestock (protection of natural grasslands) and cutting trees (protection of forests) is believed to contribute substantially to mitigation of loads on natural grasslands, and in the verification study on prevention of desertification we studied the laws, ordinances and regulations related to natural resources (land, water), agriculture and livestock farming with forestry and the environment thought to be related significantly to grasslands protection.

As the result, it was clear that regulation and control by the government has been implemented strictly, and in the verification study on prevention of desertification, we provided instructions with regard to efforts to set the number of pastured livestock at a proper level, to which the most attention had been paid, that were aimed at the realization of farming that will contribute to prevention of desertification as well as sustainable agriculture and livestock farming with forestry, based on the Grasslands Law and rules and proclamations (by each government level) based on the law.

The following tables are extracted from "Opinion Concerning Strengthening of Natural Grasslands Management," which the Altai municipal government enacted in February 2005, based on the Grasslands Protection Law and enforcement rules for that law (prepared by Xinjiang Uygur Autonomous Region) and actual conditions in the city.

To promote sustainable development of livestock farming in the city, the government strictly sets a proper number of feeding livestock, area of use and period of use for each seasonal pasture by town. According to the documents, the area of use on natural grasslands in Alahake Town and the proper number of feeding livestock for each seasonal pasture are shown in Table 4.5.3.1. The periods of use are shown in Table 4.5.3.2.

Table 4.5.3.1 Available area and proper number of feeding livestock by seasonal pasture

	Seasonal pasture		
	Spring and Autumn	Summer	Winter
Available area (mu)	544,018	422,637	234,429
Number of feeding livestock (1)	61,820	140,927	90,165
Number of feeding livestock in FY2004 (2)	216,760	216,760	163,312
Excess (number of head that must be reduced) (2) – (1)	–154,940	–75,833	–73,147

Table 4.5.3.2 Period of use by seasonal pasture

Spring pasture	Interim pasture	Summer pasture	Interim pasture	Autumn pasture	Winter pasture
Mar.10 to May 25	May 25 to Jun. 25	Jun. 25 to Sep. 20	Sep. 1 to Oct. 15	Sep. 25 to Nov. 25	Oct. 20 to May 20

【Important matters for use of pastures】

a. Spring pastures

- Must move sheep herds in Saul Mountains (winter pastures) to the valley from March 10 and March 25, and move them together with sheep in the valley to the spring pastures in which they will deliver their lambs before April 10.
- Must move livestock herds in winter pastures in the valley completely off winter pastures and to the spring pastures before May 20.

b. Interim pastures

- Must move livestock herds in the farm area to interim pastures off the farm area before May 25.
- Must move livestock in the livestock farming area to interim pastures from May 25 to June 1.
- Prohibited from leaving any kinds of livestock in winter and spring pastures past the due date.

c. Summer pastures

- Must move livestock to summer pastures from June 25 to July 1, based on actual circumstances. Strictly prohibited from leaving livestock in interim pastures and must extend the stay in summer pastures as long as possible (except under particular circumstances such as weather conditions).
- Must move other livestock except horses to interim pastures after September 10 and horses after September 15, and manage their herds intensively.
- Must move livestock except horses to autumn pastures after September 25 and horses after October 15.

d. Winter pastures

- Must move cows to winter pastures after October 20 and move horses and camels after November 20, and manage their herds intensively.
- Must move sheep to winter pastures after November 25 (except under particular circumstances such as weather conditions).
- Must move sheep to Saul Mountains by December 5. They must not greatly increase the kinds and head of livestock after these have been set by the government.

4.5.4 Government support

Because support systems from government organizations for prevention of desertification (settlement projects, dissemination of techniques, guidance, etc.) is very important when preparing and implementing a plan of measures for prevention of desertification, in the verification study on prevention of desertification we studied the support system (the settlement projects) in the Altay Administrative Office Area and the system for dissemination of agriculture and livestock farming with forestry. As a result of these systems, efforts are being made to establish farming by agro-pastoralists under steady promotion of the settlement projects by the government and technical instruction by local governments, and sustainable agriculture and livestock farming with forestry through settlement is being developed. For measures for prevention of desertification, it is important to address observance of laws and support from local governments on a unified basis in this manner.

(1) The settlement projects

In the Altay Administrative Office Area, settlement projects that view development of the regional economy and anti-poverty measures for minorities as key issues have been implemented, and productivity enhancement, measures to provide education and medical treatment for agro-pastoralists and alleviate poverty and steps to improve the ecological environment are being promoted by building the “3 lines, 4 fixed properties and 5 public facilities” described below on the settlements that provide the infrastructure for agro-pastoralists’ lives and production activities.

Although referred to as “settlement,” agro-pastoralists will not stop pasturing completely and feed all their livestock on the settlements. The settlements encompass a pattern of feeding livestock on the settlement combined with managing sustainable livestock farming in harmony with the natural environment using the traditional nomadic pasturing system (semi-settlement).

It is believed that when the “3 lines, 4 fixed properties and 5 public facilities” have been fully constructed and settlement fully attained, this will create a foundation for resolving the issue of overgrazing on spring, autumn and winter pastures, make access to education and medical treatment easier for agro-pastoralists and promote improvement in individuals’ lives.

(Ex.) Settlement projects in Alahake Town and Altay City

The sites are locations being developed and built as “model sites in Altay” based on the Alahake River Eastern Gobi Pasture Improvement Project” being implemented by the Altay municipal government.

Settlement system Collective housing (concentrate housing in a single location to create villages)

○3 Lines

Roads Village roads connecting the settlements with national highways have been constructed.

Service water Service water to ensure drinking water for humans and livestock is being supplied.

Electricity Facilities (power line poles) for supplying electricity to each household have been installed.

○4 Fixed Properties

Housing, Sheds

Agro-pastoralists construct these with assistance from the government (supplies of bricks, other materials).

Fields for feeds, windbreak forest belts

Fields for feed production are developed and allocated to each agro-pastoralist. For windbreak forest belts, appropriate afforestation is implemented for purposes such as protection of fields.

○5 Facilities

Schools

Elementary schools were built with support from large Chinese enterprises. For teachers, agro-pastoralists who have a teaching certificate will be hired. Junior high schools also are being constructed.

Shops Several agro-pastoralists (5, 6 households) run shops.

Clinics, community centers, center for instruction and dissemination of techniques

Existing clinics and community centers in the towns will be utilized, and technical support will be provided by the Alahake municipal government farming technology extension station, which is responsible for disseminating farming management techniques, the forestry management station and agricultural economy station or other entities.

(2) System for dissemination of agriculture and livestock farming with forestry techniques

Organizations responsible for technical instruction in the field have been set up in local governments, while terminal government organizations such as the village farming technology extension station, forestry management station and agricultural economy station act as organizations in charge of direct instruction for farmers and agro-pastoralists. These agencies serve as the windows for instruction on various techniques for agro-pastoralists in the towns.

In addition, depending on the area or technical sector, such organizations also have been established at upper levels of government in cities or provinces, and in the area where the project was implemented the water management station is under the jurisdiction of the city or province.

Furthermore, when implementing guidance for established techniques with the cooperation of the technical specialists at these organizations, it is necessary to understand whether the organizations in question have adequate people or technical capabilities. In the verification study on prevention of desertification, we sought to disseminate established techniques with the cooperation of technicians who were assigned as counterparts. Therefore we believe they have sufficient technical skills to disseminate and provide instruction on the established techniques for agriculture and livestock farming with forestry (the techniques described in the Technical Guide Manual), and expect them to promote enhancement of farming techniques.

4.6 Application of agriculture and livestock farming with forestry techniques

Agriculture, livestock farming and forestry techniques must be established as techniques agro-pastoralists can practice in the settlements. In Chapter 3 Section 3.6, we explained how positioning the following five items as the means to implement measures for prevention of desertification, and packaging them as agriculture and livestock farming with forestry techniques by combining them appropriately at each stage, is extremely useful from the perspective of ease of use.

Self-sufficient production of feed during winter	Establishment of pasturing system that does not require moving to spring, autumn and winter pastures
Improvement of livestock feeding	Study of advantageous selling periods using techniques of off-season breeding and fattening
Diversification of income	Introduction of production of cash crops that will not cause an increase in livestock
Preservation and management of fields	Proper water management and thorough management of windbreak forest belts
Farming improvements	Realization of farm management according to the direction of farming and purposes in the area

In the verification study on prevention of desertification in Asia, we defined the indicators in order that agriculture and livestock farming with forestry techniques are used effectively in farming activities. The farming patterns are explained below.

4.6.1 Farming patterns

Farming patterns show the orientation for how each farmer should develop his farm management, in order to realize farming in accordance with the plan, and should be widely explained to individuals involved in farming in the area as the desirable patterns for farming in the area in the future.

Therefore to focus on sustainable farming to mitigate loads of natural grasslands through the settlement projects and solve the issues noted in settlement projects implemented in the past, in the verification study on prevention of desertification we set up the three farming patterns “Livestock farming Type I”, “Livestock farming Type II” and “Deversified farming (livestock farming and agriculture) type,” as shown in Table 4.6.1. If the farming pattern sought by agro-pastoralists can be converted ultimately to “Deversified farming (livestock farming and agriculture) type,” management that balances mitigation of loads on natural grasslands in the area and development of sustainable agriculture and livestock farming with forestry can be anticipated.

Table 4.6.1 Farming patterns for sustainable farming management

	Livestock farming I	Livestock farming II	Diversified farming type
(1) Management contents	Centered on breeding / sale of sheep	Breeding / fattening of sheep, feeding of cows	Combined livestock farming and agriculture
(2) Improvements	Off-season breeding of sheep	Silage, fattening of sheep, feeding of cows	Production and sale of cash crops
(3) Land use	Alfalfa	Alfalfa, corn	Alfalfa, corn, soybeans, vegetables
(4) Load mitigation effect on natural grasslands (spring, autumnal, winter pasture)	With 1 mu of alfalfa production, load mitigation equivalent to 1 sheep for 180 days can be expected	With 1 mu of corn production, load mitigation equivalent to 2 sheep for 180 days can be expected	With 1 mu of soybean production and sale, income equivalent to 2 sheep will be earned (will be able to eliminate feeding of 2 sheep, and load mitigation equivalent to 2 sheep for 180 days can be expected)

In-stable feeding duration in the settlement: 180 days, 1 mu = 667m^2

4.6.2 Management goal

Normally income goals that can provide an objective target are adopted as management objectives, but in the verification study on prevention of desertification we used net income per capita (average) as the goal, based on the results of the farm economy survey conducted by the government. In the survey, we set up management models that aimed at the income goal by farming pattern, as shown in Fig. 4.6.2. In addition, when setting up typical management models, it is important to sort out goals for livestock feeding, cultivation, labor, yields, income and so on.

(Before settlement)	Livestock farming (Large scale)		Livestock farming (Average scale)	
Livestock (head)	Sheep	100	Sheep	30
	Goats	15	Goats	10
	Cows	10	Cows	5
	Horse (or Camel)	4	Horse (or Camel)	1

(After settlement)	Livestock farming type 1		Livestock farming type 1		Diversified farming type (Agriculture and livestock farming)	
(1) Planted area (mu)	Alfalfa	(100)	Alfalfa	(90)	Alfalfa	(20)
			Corn	(10)	Corn	(10)
					Soybean	(50)
					Sunflower	(20)
(2) Livestock (head) (The largest number of feeding livestock)	Sheep	(92)	Sheep	(82)	Sheep	(29)
	Goat	(12)	Goat	(12)	Goat	(12)
	Cow	(12)	Cow	(12)	Cow	(5)
	Horse or Camel	(1)	Horse or Camel	(4)	Horse or Camel	(1)
(3) Sales (head, kg)	Sheep	(30)	Sheep	(32)	Sheep	(5)
	Goat	(4)	Goat	(4)	Goat	(4)
	Cow	(4)	Cow	(4)	Cow	(2)
	Cashmere	(4)	Cashmere	(4)	Cashmere	(2)
	Wool	(60)	Wool	(60)	Wool	(20)
			Milk	(1,800)	Soybean	(10,000)
(4) Home consumption (head)	Sheep	(3)	Sheep	(3)	Sheep	(3)

Fig. 4.6.2 Typical management models.

4.6.3 Management trial calculation

Management trial calculation is the process of verifying whether each management practice is realized when farmers have undertaken farming in accordance with the farming patterns established. This extremely important for monitoring whether the agro-pastoralists' management will be sustainable. We made the management trial calculations by giving adequate consideration of details investigated up to this point.

Table 4.6.3 Management trial calculation by farming pattern

Unit: yuan

	Livestock farming Type I	Livestock farming Type II	Deversified farming type
(1) Income and expenses			
Gross income	18,800	20,280	41,760
Management costs	4,590	6,020	13,180
Net income	14,210	14,260	28,580
(2) Net income per capita	3,550	3,570	7,150

Note: Net income per capita calculated by dividing net income by the number of household members (4 people per household).

4.6.4 Production techniques

The production techniques for each farming pattern are described below. The details are explained in the Technical Guide Manual, and only a summary is provided here.

(1) Livestock farming Type I

Livestock farming Type I is a farming pattern based on production and processing of good quality herbage. It is a farming pattern in which breeding and sale of sheep is the main activity, with the introduction of techniques for off-season breeding of sheep (summer mating and winter lambing).

When utilizing off-season breeding of sheep, mating on the natural grasslands (August - September) and lambing in settlements (January - February) have to be carried out earlier than the traditional autumnal mating and spring lambing, which leads to different livestock feeding management.

This section describes the production and processing of good quality herbage, which is fundamental for livestock feeding, the efficient use of feeding management facilities and off-season breeding of sheep.

1) Forage production

Outline

Forage production is the most important technique among livestock feeding techniques that do not rely on grazing. To produce good quality winter feed, cultivation of good quality roughage is essential. Roughage is classified into herbage and forage crops. Herbage is classified into legumes and grasses, and forage crops are classified into grain crops and root crops.

Points

Determination of optimum cutting time

To obtain herbage with high nutritive value, herbage is best harvested before flowering, because a plant consumes nutrients in the vegetative organs for flowering. On the other hand, because yield increases as growth progresses, the amount of dry matter is higher when cutting is late. Therefore to obtain alfalfa with as high a nutritive value as possible, cutting is recommended when 50% of the plants in the field have flowered. Because plants may not flower at the second and third cutting depending on climate, the decision to cut should be made when plant height reaches 50-60cm.

First cutting	Second and third cuttings
When 50% of plants in the field have flowered	When plant height reaches 50-60cm
	

2) Hay processing of herbage

Outline

To ensure winter feed with high quality and palatability, it is necessary to carry out not only precise cultivation management of herbage but also precise hay processing. Alfalfa tends to lose its leaves in the process of hay processing. The key point is that high quality is maintained by minimizing this loss.

Points

Factors such as percentage of foreign matter, purity and maturity of the herbage, color tone, and proportion of leaves can be cited as criteria when judging the quality of alfalfa by external appearance.

If herbage cut at the optimum time is fully dried over a short period, flexible, fragrant hay will be produced with many bright yellowish green-colored leaves. If it is raining and drying the alfalfa takes a long time, all leaves will abscise and only stems will remain, turning a brown color with a moldy or rotted odor. This should be avoided because the nutritive value also will decrease sharply.

3) Efficient breeding barn technique

Outline

An animal shed provides a place for livestock to live and a workspace for the breeding farmer. A clean shed is healthy for livestock, and enables a farmer to work efficiently. From a functional point of view, a simple structure in which cages can easily moved as occasion demands, for example, is convenient to use.

Points

Because sheep are sensitive to a humid environment, it is important to keep the shed ventilated and dry.

The basic size of an animal shed is 2-3m^2 a head. For lambing stock, however, the size should be at least 2.5m^2 because the sheep need more space (0.5m^2 a lamb) for nursing. It also is necessary to prepare a play yard for holding sheep when changing litter and to provide enough exercise and exposure to sunlight.

4) Off-season sheep breeding technique

Outline

Off-season sheep breeding technique is a technique to encourage early breeding (summer mating and winter lambing) in place of traditional autumn mating and spring lambing. This technique will reduce the rate of lamb accidents and increase added value because of the early selling period.

Points

The key points for summer mating and winter lambing of sheep are shown below.

- Because mating is carried out on natural grasslands, the activities should be introduced smoothly through planned feeding management of sheep based on farming management and the annual grazing schedule.
- Keep a daily watch on estrus of the female sheep and calculate the estimated date of lambing for each sheep.
- Because lambing occurs during the severe winter season, pregnant sheep should be give a suitable amount of feed according to their stage. Feed quantities should especially be suitable for fetus growth in the last stage of pregnancy or lactation in the first lactation period after lambing.

Farmers should engage in appropriate feeding management, such as installing a fireplace for lambs as a measure against cold.

(2) Livestock farming Type II

Livestock farming Type II is a farming pattern that aims at diversification of income by combining the breeding and sale of sheep with restraints on growth in the number of sheep through fattening of sheep or feeding of cows. For feed, this farming pattern introduces high-yield corn to process silage that is fed to livestock. This section gives an outline concerning feed crop production, silage processing technique, sheep fattening technique and cow feeding technique.

1) Forage crop production

Outline

For corn cultivation, the sowing date is decided in consideration of the different growth period of each type of corn. Intertillage and top dressing are important measures for obtaining good corn growth.

Points

Time of topdressing and optimum harvesting

Topdressing will be applied when the booting stage produces 5-7 leaves. Booting stage is the period of change from a vegetative stage to reproductive stage and the period when nutrition is most needed for the plant. It is a very important period for irrigation and fertilizer.

Optimum harvesting time can be decided by the rate of maturity of the grain. The growth stage of the corn can be determined by checking the position of the milkline separating the yellow and white parts of the grain.

Corn growth stages and characteristics

Maturing stage	Characteristics
Booting stage	Ear begins to show from between ear rose
Heading stage	An earing-up term ear emerges fully
Blooming stage	Flowering period
Milk rip stage	Grain begins to grow larger
Dough stage	Grain begins to change to yellow color
Yellow rip stage	Surface of grain begins to become depressed
Full rip stage	Grains harden completely

2) Silage processing

Outline

Silage is storage feed produced when a feed crop containing a certain amount of water content, such as corn, is cut and placed in a silo, where the sugar in the crop is lactic acid-fermented under anaerobic conditions by lactic acid bacteria. To process good and palatable silage, it is important to implement each process properly.

Points

Points of concern:

When silage quality is poor, the palatability for livestock is inferior and the silage will cause diarrhea and poor intake. When fed to animals for long periods such silage can cause breeding disorders and other problems. Poor quality silage should be avoided or discarded. Poor quality silage is thought to result from the following basic mistakes.

1. Materials (early or late harvesting, too much moisture)
2. Silo (air contamination, poor drainage)
3. Process (cutting length, low sugar content, high moisture content materials)

3) Sheep fattening technique

Outline

Because most nomads depend on selling sheep for income, efficient management with fewer accidents is possible after settlement because winter feed can be produced and animal sheds built. As an income measure, sheep fattening can be adjusted to selling periods based on increased added value or market trends.

Points

Because rapidly increasing feed silage amount or concentration at the beginning of fattening will cause diarrhea and low intake, and daily gain will be slowed, it is important to increase feeding quantity gradually. The quantity of concentrated silage must be changed depending on the quality or intake of forage.

4) Feeding of cows

Outline

Feeding of cows in the settlement, and selling the fresh milk consumed by farmers themselves in the past to a dairy factory, is an effective way to diversify income through livestock farming management. For production of milk it is important to implement sanitary milking that matches cow milk secretion physiology.

Points

- Foremilk must not be thrown on the barn floor. Care must be taken not to spread mastitis from one cow to another.
- If cows are startled or experience stress and pain during milking, the quantity of oxytocin may decline, and care should be paid to decreasing milking volume.
- Rapid multiplication of bacteria can be prevented by lowering milk temperature to less than 10°C within 1-2 hours after milking.
- Only normal milk must be shipped (sold).

(3) Deversified farming type

The deversified farming type model is characterized by the planting of cash crops other than feed production in the settlement fields and earning income from products other than livestock. Diversification of incomes leads to control on the increase in livestock, and as a result can limit the load on natural grasslands. It also is important to aim at sustainable recycling agriculture that makes the best use of the merits of livestock ownership.

1) Cash crop production

Outline

In contrast to food crops for self-consumption or feed crops, cash crops are planted for the purpose of selling them. As production is increased, producers earn more income. Compared with production of herbage and forage crops, cash crop production requires more complicated cultivation management such as irrigation and weed control.

Points

When choosing a cultivated crop as a cash crop, suitability for cultivation and marketability are important. It is important to plant at the optimum date. Optimum irrigation volume should be applied to avoid water deficit or over-irrigation. Because soil fertility is low just after reclamation, application of organic matters is necessary for soil improvement, and topdressing is usually effective.

In such cases, dense planting initially can help assure the required population amount. Dense planting in excess of standards can be effective when the optimum sowing time has been missed as well.

Care must be taken, however, because planting at high density will risk increase of disease. If chemical fertilizer is not purchased in the required amount, livestock manure and compost are applied in excess of the standard level as basal dressing. If irrigation water cannot be obtained in the required amount, drought resistant crops that can grow with less water, or crops with short growth period, should be planted. Harvesting at the optimum time is important. Growing crops that meet buyers' needs also is important for increasing profits. Crop production techniques can be disseminated and improved through guidance by extension station staff or utilization of technical literature. Exchanging information with individuals who have acquired technical skills is another effective means.

2) Measures against noxious organisms

Outline

At the time herbage, crops or vegetable production is started on a settlement, few noxious organisms that can seriously damage plants immediately will exist on land that was not arable land before settlement. Especially in arid and semi-arid areas, pests are very rare. After cultivation they may increase with time, however, and measures to control them within a permissible range will be needed.

Points

In large-scale crop cultivation, weeds can usually be allowed to grow partially. Because crop growth might be influenced if weeds become very dense or exceed the height of crops, however, it is important to prevent weeds from spreading widely. Weed control is necessary not only in fields but also in levees or canals. If weed control is neglected, levees will become a hotbed of weeds, which will spread their seeds and increase weed density in fields in the following year.

In a cultivation environment where irrigation and fertilizer volume can be controlled, pests have the largest influence on production. Because nothing may be harvested when damage is serious, it is important to limit pests within a permissible range. Pathogens (fungi, bacteria, virus, etc.) in general prefer moisture, and their occurrence and spread are restricted in the high solar radiation and minimal rain environments in arid and semi-arid areas. To prevent soil transmission of pests in cropping, a furrow created between different kinds of crops may be effective. Farm water channels also can serve this purpose.

Crop cultivation in the following year should be taken into consideration based on pest occurrence, and when damage is excessive, it will be necessary to cultivate a cleaning crop without regard to profit. Because the presence of noxious animals reduces crop yield in the same manner as weeds and pests, their populations should be kept within a permissible range.

When a cultivation area is small in scale, the effects of damage by rats or birds will be serious, but these effects frequently can be nearly disregarded when farming large-scale fields.

3) Sustainable recycling agriculture

Outline

When forage production and cash crop production are begun after settlement, one advantageous point compared with simple agricultural management is that livestock manure from livestock farming can be used. Management that uses products and by-products from both agriculture and livestock farming efficiently – i.e., a system that combines livestock farming and agriculture – is resource recycling agriculture.

Points

Because fields just after reclamation generally have little organic matter and contain much sandy soil, their holding capacity for nutrients and water is low. Application of organic matter has both direct effects (supply of inorganic materials contained in organic materials, absorption of organic materials and spread of physiological action, promotion of absorption of micronutrients based on chelate formation) and indirect effects (improvement of soil physical properties, promotion of nutrient supply function, spread of soil microorganisms). The indirect effects are more important. For efficient use of organic matter resources, it is necessary to consider factors such as acquisition source, transport cost and labor. If livestock farming is carried out at this stage, it is easy to obtain livestock manure. When livestock manure is applied directly to fields, there will be problems such as, (1) inclusion of seeds of weeds such as Japanese dodder and (2) affects of toxic substances. Therefore to use livestock manure effectively, completely fermented compost should be produced in order to kill seeds and break down toxic substances. This means it is necessary to consider the time and materials for compost production.

Green manure crops are crops grown to improve soil. The purposes of green manure crop cultivation are classified into (1) improvement of soil physical properties, (2) improvement of soil chemical properties, (3) improvement of soil biological properties and (4) environment conservation. The most important aspect of green manure crop cultivation is restoration of organic matter to the soil. Organic matter restoration produces results such as soil aggregation and improvement in fertilizer retention capacity. When organic matter originated from plants increases soil, the C/N ratio may rise and nitrogen starvation may occur. Care must be taken so plowing time is not just before planting. Crops that are host to a specific noxious organism must be selected so they do not affect succeeding crops.

Continuous cropping of a single crop often reduces productivity. Reasons include increasing damage by specific pests, the deficiency of specific nutrients and deterioration of the soil's physical properties. Crop rotation is effective for preventing these problems. It is necessary to create a feasible crop rotation system including herbage, forage crops and cash crops, while ensuring the availability of feed. It is best to incorporate a good balance of legumes, grasses, root vegetables and other crops, so the characteristics of each can be efficiently employed. When crop rotation is carried out by including some crops that are the common host of a specific pest, damage may spread easily. When cultivating crops whose seeds are spread easily as part of a crop rotation system including tall herbages or crops, care must be exercised to not spread seeds, to prevent succeeding crops from being affected. If many seeds have been spread to fields, it will best necessary to control their germination or to plant tall crops in the following year.

A kitchen garden is a small garden using land near a house to grow vegetables mainly for self-consumption. Because the scale is small, cultivation management can be more intensive compared with field cultivation. In addition, this experience of cultivating vegetables can be applied to the field cultivation in the future. Use of livestock excrement is easy because the barn is close to house. A kitchen garden, in other words, can be a miniature model of recycling agriculture.

4.6.5 Field management techniques

It is difficult to carry out farm management without irrigation in arid and semi-arid areas, because evaporation exceeds year-round precipitation. Agro-pastoralists have little experience with irrigation technology, however, and frequently irrigate extensively in the beginning.

For effective use of limited water resources, agro-pastoralists themselves should efficiently carry out the irrigation work. Improvement in yield of forage crops for winter feed or cash crops can be expected as a result.

This section explains the water use techniques for enhancement of production required for management of fields and windbreak forest belts for land conservation.

(1) Water supplies for maintenance and improvement in production

Irrigation refers to supplying water to a field artificially, and is classified into upland irrigation and lowland irrigation depending on the crops. Upland irrigation is the principle of supplying water intermittently, utilizing the water retention capacity of the effective soil layer.

Improving the water supply in fields will lead to improvement in crop yields. High yields and water management technology have a close relationship. In the case of agro-pastoralists unfamiliar with irrigation, however, there are many problems, such as over-irrigation or irrigation water not reaching the ends of the fields. A study should be made to determine how to manage water use properly and improve crop yields, depending on the type of production engaged in by agro-pastoralists.

1) Preparation before sowing

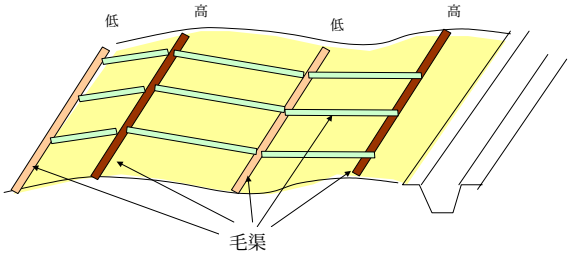
Outline

As preparation work before sowing, farm ditches must be built in fields to irrigate them. On rolling land particularly, farm ditches in the fields show excellent results.

Points

Because farm ditches are earthen canals, they often are damaged in autumn when irrigation stops. Therefore they must be repaired in the following year before irrigation at the beginning of spring.

With experience agro-pastoralists will get accustomed to these works; it is desirable to guide agro-pastoralists just after settlement, however, with training at the beginning of spring.



Farm ditches

Farm ditches in the fields

2) When beginning irrigation - Efficient irrigation method at the field level -

Outline

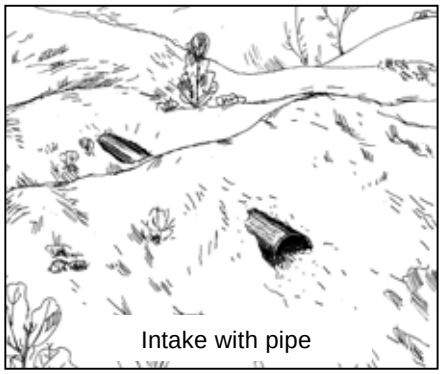
Irrigation work in fields is very difficult for agro-pastoralists. A simple irrigation work method that (1) does not require extensive labor, (2) does not require time and (3) is convenient should be introduced as a turnout and shielding method for fields.

Points

Pipes should be used for intake. The reasons are,

(1) Cutting and banking are extremely labor intensive.
(2) Cutting is easily damaged.
(3) Because a pipe section is smaller than that of concrete boards or cutting, it can be shielded by covering with local materials when not needed.
(4) Does not require time and effort for maintenance.

If materials such as pipes or concrete boards are hard to obtain, however, small stones or other easily obtained materials must be used instead. Furthermore, because pipes are easily stolen they should be set in place with concrete. A method that is efficient and easy to use can be disseminated because agro-pastoralists find it easy to adopt.



Intake with pipe

Shielding by sheet

3) Water management after sowing – Water consumption and farm ditches -

Outline

When implementing efficient irrigation, the irrigation water requirements at the site (field capacity, allowable soil water depletion, effective soil layer and consumptive use of water) should be determined.

In fact, we calculated the consumptive use of water of crops measured by the soil moisture depletion method and the irrigation interval for the fields at the Alahake site, Altay City.

Points

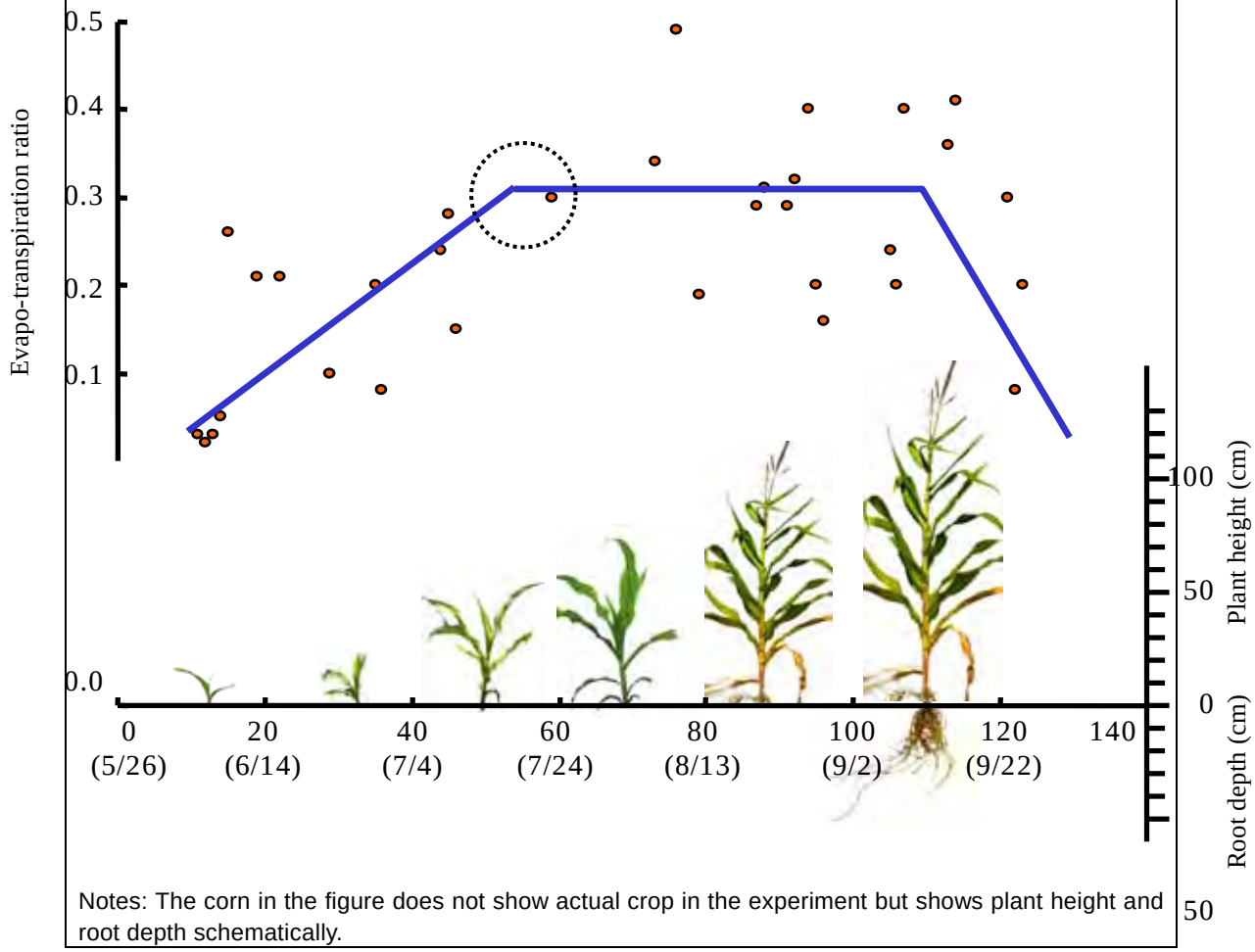
Although measurement of consumptive use of water was performed only for corn, a forage crop, the basic approach is the same for cash crops as well, such as soybeans and sunflowers.

In the climate conditions specific to arid areas with little rain and extensive evaporation, as a result of soil physical properties the soil surface often hardens because of marked evaporation after irrigation. Therefore agro-pastoralists have a custom of not irrigating until emergence, because they fear no emergence from soil hardening.

Because the amounts of initial moisture are absolutely insufficient, however, for crops it is desirable to irrigate after sowing, even if only a small amount of water.

As a result, the soil surface did not harden and the target yield was obtained.

In water supply in the field, practice rather than theory is important. A field trip to an advanced area to observe farmers' irrigation methods will have a sufficient effect.



Notes: The corn in the figure does not show actual crop in the experiment but shows plant height and root depth schematically.

4) Salt accumulation

Outline

In arid areas, measures to prevent a rise in groundwater level or lower the groundwater level are essential to prevent salt damage. Water management by use of leaching to avoid excessive irrigation or reduce salt injury by correctly understanding the consumptive use of water by crops in the fields is important.

Points

All plants do not respond to salinity in a similar manner; some crops can produce acceptable yields at much greater soil salinity than others. This is because some are better able to make the needed osmotic adjustments enabling them to extract more water from a saline soil. The ability of the crop to adjust to salinity is extremely useful. In some areas where a build-up of soil salinity cannot be controlled at an acceptable concentration for the crop being grown, an alternative crop can be selected that is both more tolerant of the expected soil salinity and can produce economically yields.

Crop tolerance and yield potential are given in the following table by FAO.

Where insufficient data exist to give numerical values for tolerance, a relative rating has been assigned to the crop, based on field experience, limited data or observations.

Crop salt tolerance and yield potential

(Unit：ECe (mS/cm))

Crop \ Yield	100%	90%	75%	50%	0%
Corn (sweet corn)	1.7	2.5	3.8	5.9	10
Soybeans	5.0	5.5	6.2	7.5	10
Wheat	6.0	7.4	9.5	13.0	20
Alfalfa	2.0	3.4	5.4	8.8	16
Corn (forage)	1.8	3.2	5.2	8.6	16

Source: FAO irrigation and drainage paper 56 (extract)

(2) Windbreak forest belts for land conservation

Windbreak forest belts demonstrate a number of effects, such as preventing erosion of fields from sand storms, promoting crop growth by weakening wind strength and preventing surface soil flow caused by wind. Therefore to implement agricultural and rural development in arid and semi-arid areas, setting up windbreak forest belts is effective for protecting fields and houses from dryness and strong winds.

1) Construction of windbreak forest belts

Outline

Constructing windbreak forest belts is effective for implementing agricultural and rural development in arid and semi-arid areas. Agro-pastoralists must work in cooperation with the government organizations to construct and manage windbreak forest belts.

Points

To produce healthy windbreak forest belts, it is necessary to combine proper guidance by the government, proper awareness concerning the roles of windbreak forests and voluntary management by agro-pastoralists. The functions of windbreak forest belts will not be demonstrated or maintained unless a system for construction involving both government and agro-pastoralists has been established.

2) Construction plan

Outline

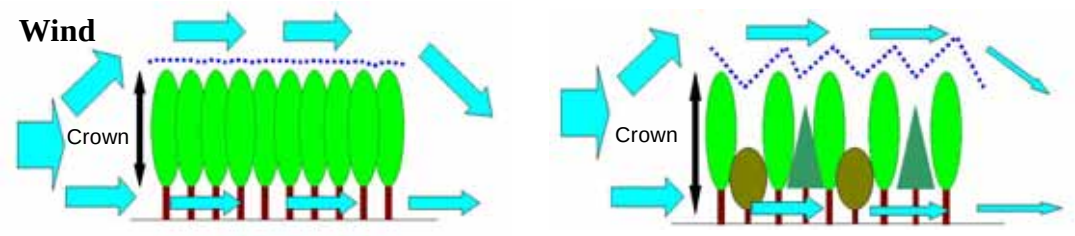
Tree species suitable to the environment of the area should be selected as the species to be used for a windbreak forest belt. Moreover, rather than create forests using a single variety, mixed forests resistant to disease, insect damage and meteorological damage should be constructed by using several tree species.

Points

Local varieties indigenous to the area should be used as the tree species, and the tree species should be selected by taking into consideration the productivity of the seedlings and growth period.

The higher the height of windbreak forest belt and the higher the planting density, the greater are the wind break effects demonstrated. Because a larger volume of water must be ensured when using taller trees, however, in areas in limited water resources taller trees will substantially affect water resources. Moreover, if the tree crowns are clustered tightly, turbulence may result and the effectives and range of the windbreak forest belt may be reduced. Therefore tree species and their width should be selected in accordance with the scale of the fields.

A windbreak forest belt in which the tree crowns have layer structure formed by a mixed forests planted with tall trees and low trees will demonstrate a greater wind break effect than a forest of uniform height, as shown in the figure below. Furthermore, the shorter trees will prevent surface soil erosion caused by wind.



3) Seedling production

Outline

Raising seedlings at the location where windbreak forest belts will be constructed will enable supplementary planting and restoration work in windbreak forest belts to be carried out efficiently. Because it is difficult to perform this work alongside livestock farming or agriculture, however, it is necessary to adopt an efficient way of raising seedlings.

Points

In the survey of the Alahake site, we implemented seedling production in a manner that uses the same irrigation interval of 5 to 7 days as the cultivated crops on the fields. As a result, we obtained results in which the change in seedling survival rate declined gradually from April to June, then showed no changes from July onwards, and ultimately the seedling rate was 25%.

It follows from this that irrigation should be provided once every two days for the initial one-month period after rooted cutting, then after survival irrigate once every 5 to 7 day while checking the conditions of the seedlings and soil dryness. Provided attention is paid to irrigation and weeding for 2 to 3 months after planting, local farmers should be able to enhance this productivity further. Moreover, if seedling fields are located near the fields for cultivation, crop or weed seeds may be carried easily into the seedling fields by water or wind, so weeding should be performed frequently because weeding will affect growth of the seedlings.

4) Implementation of planting

Outline

Because the possible period for planting is shorter in arid areas and the survival rate may decline if planting isn't completed at the optimum time, the steps from seedling transport to planting should be completed rapidly.

Points

The process from removal of seedlings to replanting must be performed smoothly. If a long interval passes between delivery of seedlings to the site and planting, the roots will dry and the survival rate may decline.

Moreover, to promote root growth it is necessary to extend the roots to get them fully used to being in the ground. Planting by folding the roots into a ball and stuffing them into holes worsens survival. Stepping on the soil forcefully and compacting the soil beyond the amount necessity also will prevent root growth. Roots require a certain amount of space in the soil in order to grow, particularly tree species such as *Elaeagnus angustifolia* that have root nodules and fix nitrogen, and inadequate pore space will prevent them from growing.

5) Windbreak forest belt management

Outline

To raise healthy windbreak forest belts after planting, proper management must be implemented. This means creating a system agro-pastoralists will manage in cooperation with the government, as well as creating a shared awareness of windbreak forest belts' effects among all agro-pastoralists in the area.

Points

Post-planting management is critical for a windbreak forest belt. If initial irrigation is carried out appropriately during the initial two or three months after planting in particular, to ensure the planted trees will survive, windbreak forest belts will grow soundly.

When there are dead trees in a windbreak forest belt, crop growth will be affected by wind and sand entering through the sections where trees have died. Therefore supplementary planting should be carried out promptly in dead sections. When supplementary planting is carried out in a windbreak forest belt more than five years after planting, however, the newly planted seedlings may be confined by the preceding planting trees, and supplementary planting should be judged by conditions of the field.

Because it is impossible to prevent damage from livestock through each agro-pastoralist's

management, the agro-pastoralists and local government should work together to implement measures as an entire local community, such as an agreement to prohibit introducing livestock into a field or construction of protection fences.

6) Management incentives

Outline

After creating windbreak forest belts it is necessary to enlighten agro-pastoralists concerning the importance of voluntary management. Giving windbreak forest belts economic value, by means such as enabling agro-pastoralists to use thinned trees or encouraging agro-forestry through cultivation of crops between trees, can serve as incentives for windbreak forest belt management.

Points

Although thinning for management is accepted, this may result in over-cutting unless implemented with attention to density management. Cutting conditions can be checked mutually by implementing on a systematic basis rather than by each agro-pastoralist, and this also will enable thinned trees to be gathered.

When implementing agro-forestry, attention should be paid to not allowing seeds to be carried away in irrigation water after sowing. If the surface is covered with crops, this will result in effective use of water resources, such as controlling outflow of soil or controlling transpiration.

4.7 Project execution

Techniques and methods used to implement a project in accordance with the plan should be arranged systematically, taking into consideration convenience at the time of execution.

In the verification study on prevention of desertification, we summarized the matters considered for development of the fields and infrastructure necessary for settlement construction. We also systematically summarized the production techniques for livestock farming and agriculture, the management techniques for fields and windbreak forest belts and the methods for organized activities according to farming patterns.

4.7.1 Construction of model fields

(1) Construction of the fields

1) Alahake site

(a) Outline of the plan

The fields at the Alahake site are to be developed and constructed jointly by Japan and China, covering ten thousand mu (about 667 ha) including irrigation and drainage canals, roads, windbreak forest belts and land grading, on gradually sloped land on the north side from National Route No. 217 approximately 10km in a northeast direction from the center of town. In conjunction with this, the Chinese side will select settlers (80 households) and construct the infrastructure necessary for forming the village.

(b) Land use plan

The land use plan for the site will promote effective utilization of land resources according to the following basic principles, and enhance agricultural productivity and improve living conditions by settlement of agro-pastoralists.

a. Rationally arrange the lands for agriculture, forestry and other uses according to land conditions.
b. Rationally install irrigation and drainage canals, prevent salt accumulation and seek comprehensive soil improvement and soil fertility enhancement.
c. Cultivate feed crops and food crops, mainly herbage.
d. Arrange fields according to the area or land conditions.
e. Firmly establish a livestock farming system as a supplement to pasturing, mainly for feeding livestock during winter.
f. Improve the ecological environment by setting up windbreak forest belts around fields.
g. Reduce field construction costs by adding originality to the design using Japanese techniques.

In addition, the land use plan and irrigation and drainage canal construction plan for the site are as shown in Table 4.7.1.1.

Table 4.7.1.1 Land use plan and irrigation and drainage canal construction plan for the Alahake site

Classification	Irrigation area			Others					Planned
Items	Field	WFB	Total	Road	IC	DC	RA	Total	area
Area (mu)	8,000	1,580	9,580	273	524	50	400	1,247	10,827
Ratio (%)	74	16	88	3	5	0	4	12	100

WFB: Windbreak Forest Belt, IC: Irrigation Canal, DC: Drainage Canal, RA: Residence Area

Name	Quantity (number)	Length (km)	WG (number)	Bridges (number)	Drops (number)	CB (number)
Branch irrigation canals	1	2.7	3	2		2
Secondary branch irrigation canals	3	7.8	55	6		
Agrarian irrigation canals	80	44.0				
Branch drainage canals	1	4.9		4	3	
Roads for farming		18.2				

WG: Water Gate, CB: Canal bridge

(c) Matters considered

a. As shown in Fig. 4.7.1.1, for field arrangement the contour lines and direction of irrigation were made parallel.
b. The size of a field was set at 150×600m, equivalent to one household.
c. Irrigation canals were constructed as open canals, with all canals except the agrarian irrigation canals lined with concrete blocks to prevent water leakage.
d. The land was graded to remove undulations, and ditches were made in the fields.
e. Windbreak forest belts with width of 14m were created by planting trees around the fields.
f. Consideration was given to ensure no obstacles for passage of farming machinery.

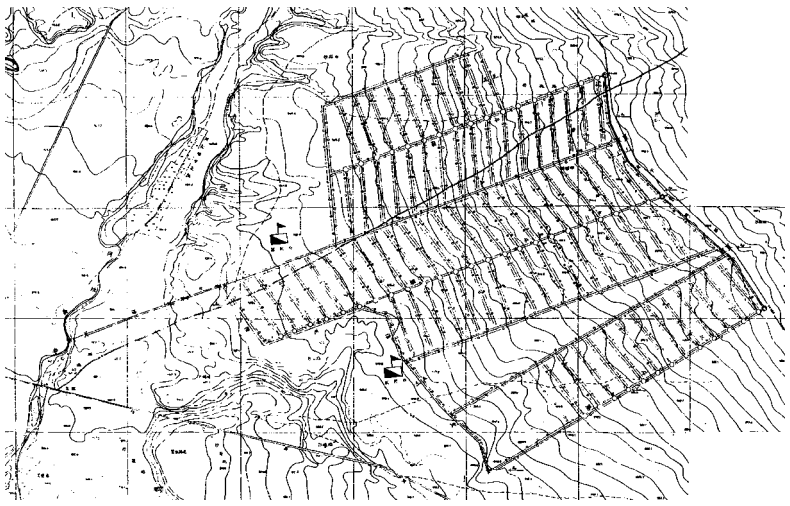


Fig. 4.7.1.1 Plane figure of Alahake site in Altay City

2) Kerdala site

(a) Outline of the plan

The fields at the Kerdala site are to be developed and constructed jointly by Japan and China, covering ten thousand mu (about 667 ha) including irrigation and drainage canals, roads, windbreak forest belts and land grading, at the end of the Kemur head works. In conjunction with this, the Chinese side will select settlers and construct the infrastructure necessary for forming the village.

(b) Land use plan

The land use plan for the site is identical to the plan for the Alahake site. The land use plan and irrigation and drainage canal construction plan for the site are as shown in Table 4.7.1.2.

Table 4.7.1.2 Land use plan and irrigation and drainage canal construction plan for the Kerdala site

Classification	Irrigation area			Others					Planned
Items	Field	WFB	Total	Road	IC	DC	RA	Total	area
Area (mu)	8,484	1,279	9,763	166	428	266	240	1,100	10,863
Ratio (%)	78	12	90	2	4	2	2	10	100

WFB: Windbreak Forest Belt, IC: Irrigation Canal, DC: Drainage Canal, RA: Residence Area

Name	Quantity (Number)	Length (km)	WG (Number)	CB (Number)
Main irrigation canals	1	2.0	1	
Branch irrigation canals	1	4.2	7	8
Secondary branch irrigation canals	7	11.3	42	
Agrarian irrigation canals	49	29.4		
Branch drainage canals	1	4.2		
Roads for farming	8	15.5		

WG: Water Gate, CB: Canal bridge

(c) Matters considered

a. As shown in Fig. 4.7.1.2, for field arrangement the contour lines and direction of irrigation were made parallel.
b. The size of a field was set at 230×600m, equivalent to two households.
c. Irrigation canals were constructed as open canals, with all canals except the agrarian irrigation canals lined with concrete blocks to prevent water leakage.
d. There are some semi-fixed sand hills in the fields, and because of the concern that grading all of the land at the site might cause sand to be blown onto adjacent land, land grading methods were studied.
e. Windbreak forest belts with width of 14m were created by planting trees around the fields.
f. Consideration was given to ensure no obstacles for passage of farming machinery.

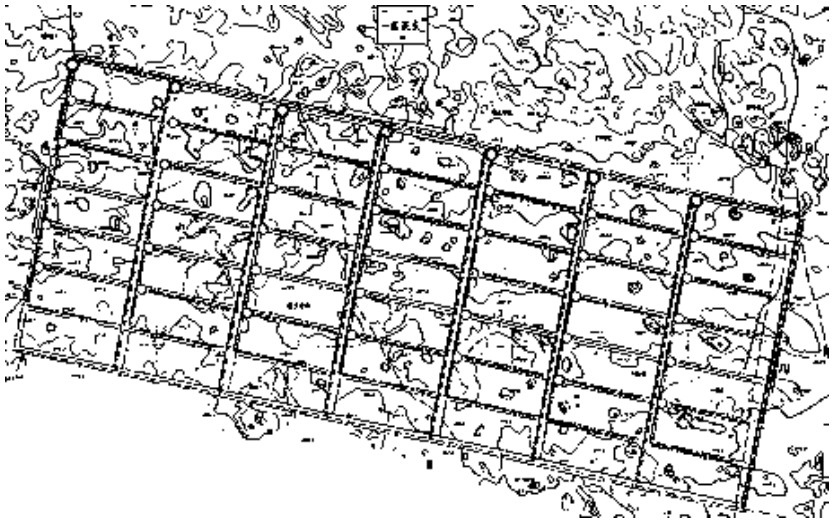


Fig. 4.7.1.2　Plane figure of the Kerdala site in Habahe County

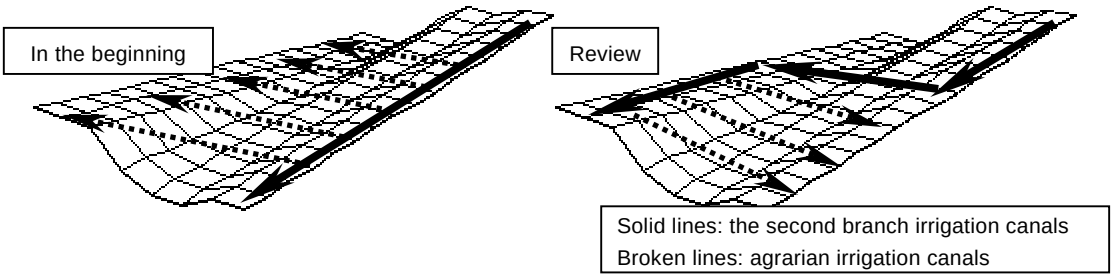
(2) Modification of the level of field construction

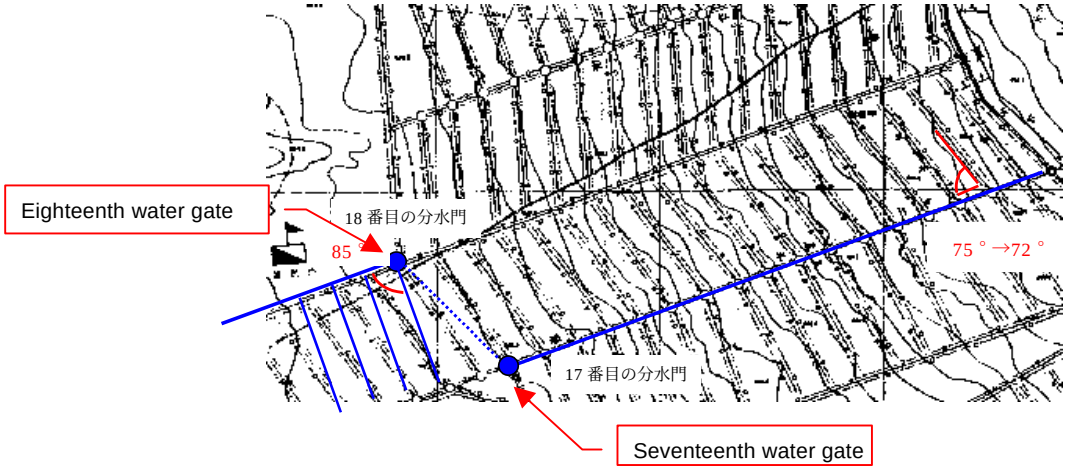
During implementation of the survey, Japanese and Chinese technicians studied whether it would be possible to reduce construction costs by suitably reviewing the construction details related to construction of the fields at the beginning and building the fields with consideration of local topographical conditions. As a result, as of August 2005 we were able to realize construction cost reductions concerning the following three items.

1) Review of design on reclaimed fields, 2) Review of construction standards for routes for transportation of crops, 3) Matters to consider for reclamation of fields on degraded lands

1) Review of design on reclaimed fields (Alahake site)

The initial plan was one in which the secondary branch irrigation canals were straight, as shown on the left in the following figure. Because the inclination of the terrain was reverse in the forward canals from the eighteenth water gate, however, this meant having to excavate the ground in order for water to flow to the agrarian irrigation canals from the secondary branch irrigation canals. As a better measure, by changing the location of the second branch irrigation canals from the eighteenth water gate to the location shown on the right in the following figure, we could eliminate nearly all ground excavation. Although this added to the length of the secondary branch irrigation canals, because this reduced the amount of soil work we could realize cost savings of 10.8%, or roughly 72,000 yuan (about 1.0 million yen), as shown in Table 3.7.1.3.





Cost reduction

First

Name	Number	Unit	Amount (1,000yuan)	Amount (1,000yen)
Amount of soil	12,252	m3	212	3,179
Irrigation Canal	3,000	m	453	6,788
Total			665	9,968

Alteration

Number	Unit	Amount (1,000yuan)	Amount (1,000yen)
2,867	m3	50	750
3,600	m	543	8,145
		593	8,895

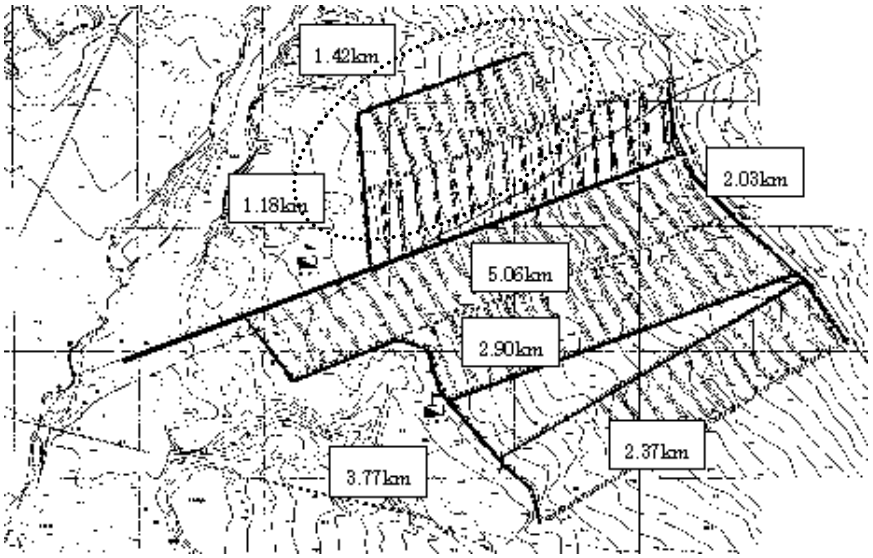
Differential

Number	Unit	Amount (1,000yuan)	Amount (1,000yen)
△ 9,835	m3	△ 162	△ 2,429
600	m	90	1,357
		△ 72	△ 1,073

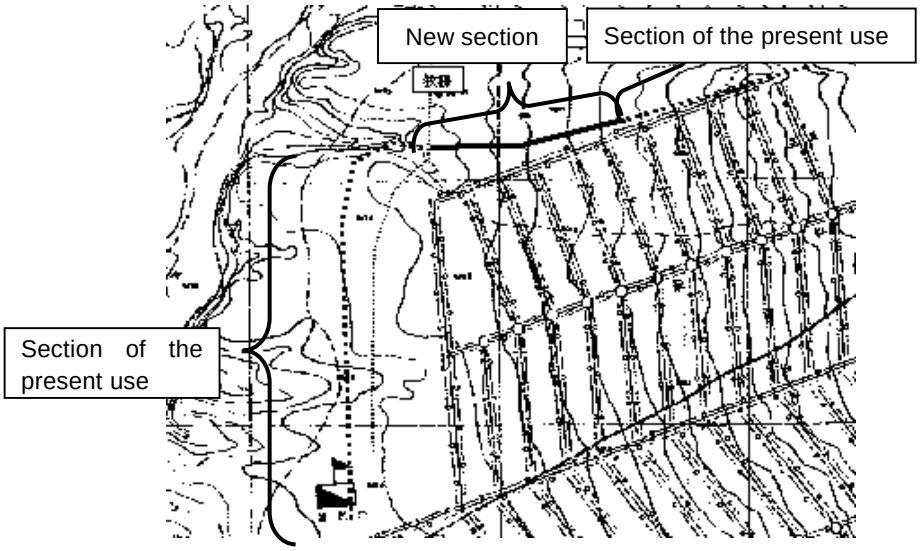
2) Review of construction standards for routes for transportation of crops (Alahake site)

The following matters were planned as road construction works in the initial plan.

Items	Length(km)	Amount of soil (m^3)	Gobi stones (m^3)
Main roads	5.06	32,890	6,115
Branch roads	13.14	85,410	15,725
Total	18.20	118,300	21,840



As a result of a site survey concerning the dotted lines in the Fig. above, because there were section that could be used as roads we did not carry out road work-related construction an only created a road with a width of about 3m over which tractors can pass only in the section without land. As a result, we were able to reduce the length of road-related extensions from 2.6km to 0.9km costs and realize cost savings of 65.4%, or roughly 77,000 yuan (about 1.2 million yen), as shown in the following Table.



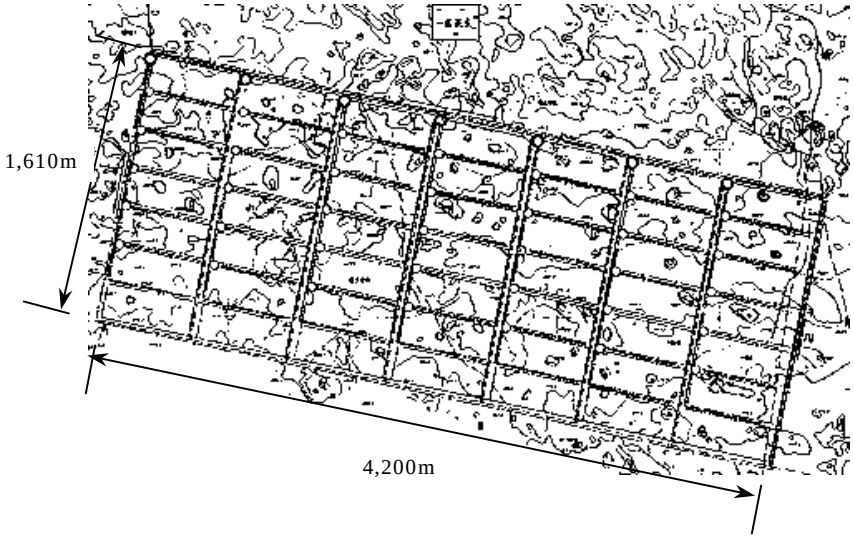
Cost reduction

First					Alteration				Differential			
Name	Number	Unit	Amount (1,000yuan)	Amount (1,000yen)	Number	Unit	Amount (1,000yuan)	Amount (1,000yen)	Number	Unit	Amount (1,000yuan)	Amount (1,000yen)
Roads	2.6	km	117	1,762	0.9	km	41	610	△1.7	km	△77	△1,152

3) Matters to consider for reclamation of fields on degraded lands (Kerdala site)

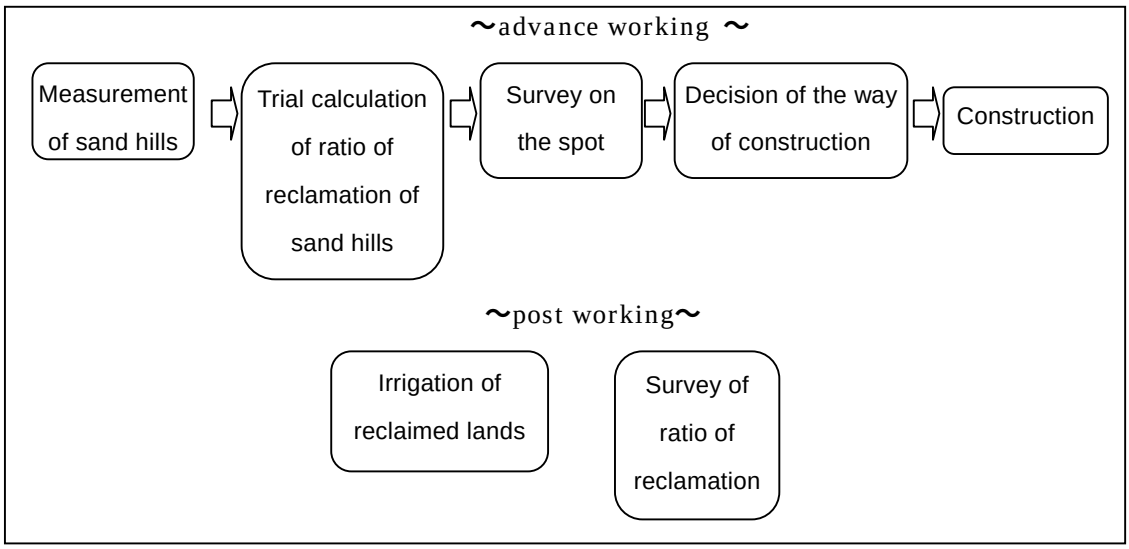
When implementing reclamation of fields on degraded lands in arid and semi-arid areas, especially land with sand hills, careful attention must be given to the method and time of reclamation. There also are concerns that if errors are made in the manner or time of reclamation this could cause sand storms from fixed or semi-fixed hills, resulting in secondary damage to surrounding land. These matters must be considered adequately at the time of reclamation. In the verification study on prevention of desertification, we implemented reclamation of fields on degraded lands. This section introduces this case study.

There are many large and small sand hills at the site, which experiences strong winds throughout the year. Because *Agriophyllum squarrosum* is present on the sand hills, they are fixed.



When reclaiming sand hills, simply making advance measurements and then grading by bulldozer is not a recommended approach. The reason is that grading fixed sand hills may cause sand storms from the effect of the wind. Therefore it is necessary to adopt a construction method that will not, to the extent possible, cause sand storms. Furthermore, in the verification study on prevention of desertification we designed a construction method for reclamation of fields that would not cause sand storms on degraded lands. The work process is shown below.

Please refer to the Technical Guide Manual for a more detailed explanation of each process.



(3) Construction management

1) Quality Control

We summarized the composition of the concrete lining blocks used for construction of the second branch irrigation canals in Alahake and Kerdala sites, and their production process.

(a) Composition of concrete lining blocks

We summarized the composition of the concrete lining blocks as shown in Table 4.7.1.3; the percentages for concrete materials at the Alahake and Kerdala sites are given in the pie chart shown in Fig. 4.7.1.3.

Although the composition of cement at the Alahake and Kerdala sites is nearly identical, slightly more coarse aggregate (20-40mm) was used at the Kerdala site than at Alahake. Looking at the blocks produced, however, much more coarse aggregate appears to have actually been used at Alahake. We believe the control procedure used at Kerdala when sifting aggregate in each size (two sizes, 20-40mm and 5-20mm) probably was more stringent. Moreover, the ratio of water to cement 1 was 55% at the Alahake site and 50% at the Kerdala site; because the ratio of water to cement 1 under the general standard in Japan is less than 60%, there was no problem in particular.

Table 4.7.1.3 Composition of concrete lining blocks

Unit:kg

Site name	Water	Cement	Sand	Fine aggregate (5-20mm)	Coarse aggregate (20-40mm)
Alahake	180	330	660	459	851
Kerdala	50	100	192	117	273

Source: Display boards at the sites

Left: Alahake, Right: Kerdala

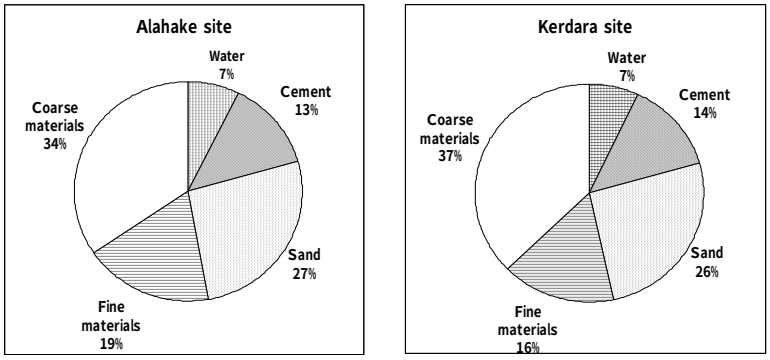


Fig. 4.7.1.3 Composition of secondary branch irrigation canal lining blocks

Table 4.7.1.4 Ratio of concrete materials and classification

Site name	Water	Cement	Sand	Fine aggregate (5-20mm)	Coarse aggregate (20-40mm)
Alahake	0.55	1.00	2.00	1.39	2.58
Kerdala	0.50	1.00	1.92	1.17	2.73

Classification of materials used

Site name	Water	Cement
Alahake	Alahake River	Ordinary Portland Cement
Kerdala	Kemur irrigation canal	

Note: It is reported that no problems were found with chloride content in the water quality tests.

(Implemented in FY2002)

(b) Block production process

In the process for making blocks at the Alahake site, the blocks are produced vertically, three at a time.

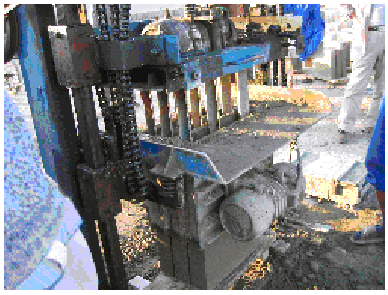
Production process

a. Raw concrete stirred by a mixer is placed into the machine.
b. Machine eliminates air from the concrete and forms blocks by vibration for one minute.
c. Upper section of the machine is raised and the concrete blocks pushed out.
d. Concrete is carried using carts.

At the Kerdala site, three blocks are produced at once using a frame on the flat ground.

Production process

a. A vinyl sheet is spread on prepared flat ground, and the frame placed on the sheet.
b. Raw concrete stirred by a mixer is put into the frame.
c. Blocks are hardened and air eliminated by flat plate vibrator.
d. Surface finish working is implemented in two steps (Coarse → Fine).
e. Blocks are left at the spot for about three days.



Upper photograph: Production conditions at the Alahake site

Below photograph: Production conditions at the Kerdala site

The strengths and weaknesses of the concrete block standards and production processes at the Alahake and Kerdala sites are shown in the following Table.

Table 4.7.1.5 Merits and demerits of concrete block standards and production processes

Division	Alahake site	Kerdala site
Standard	40×40×8cm (about 30kg per block)	40×60×6cm (about 34kg per block)
Production process	Machine	Manual labor
Strengths	・Fast production time ・Can produce with few people	・Water flow resistance is low because surface of blocks is fine ・Strength can be ensured because blocks are hardened using a flat-plate vibrator
Weaknesses	・Water flow resistance is high because surface of blocks is rough ・Machinery breaks down frequently ・Easily deformed when being carried because they are produced vertically	・Wide yard must be ensured ・Requires many workers

2) Process management

Process management refers to actions for the purpose of managing execution of a plan within the designated construction timeframe. Because construction quality and costs are influenced significantly by the construction progress, management of work progress is the key consideration in process management. We compared the execution process with the planned process, to continually check how implementation was progressing vis-à-vis the plan, and attempted to implement the project according to plan as much as possible.

a. Management procedure

We adopted a procedure of submitting a construction record for each week and schedule plan for the following week. The information entered on these items is shown in Table 4.7.1.6. In addition, for the whole process, a process table in the form of a bar chart was submitted after the construction contract.

Table 4.7.1.6 Information entered on construction records and schedule plans

Construction record	Month and date, weekday, weather, outline of construction, number of machines used, workers utilized
Schedule plan	Month and date, weekday, details of main work

b. Results

After proposing this process management procedure, the construction information for the week and schedule plan for the next week were submitted from the Irrigation Bureau in Altay City every Monday morning, which enabled us to understand in detail the causes of construction delays. As a result, processes that were initially delayed were resolved by an appropriate introduction of additional machinery and workers,

which enabled completion of the work within the planned construction period. The following photograph shows a weekly reports submitted by the Irrigation Bureau in Altay City.

工 事 周 报

工程名称：实证固地二年度 监督职员：[illegible] 现场代理人：热斯汗

工 期：2019.6月

作业实施事项

月日	星期	天气	施工概要	使用机械台数	使用劳力数	特记事项
[illegible]	[illegible]	中雨	在办公室计算工作	无	无	
[illegible]	[illegible]	晴	上土地测量为10号田	无	6	
[illegible]	[illegible]	晴	上土地测量11、12号田	无	6	
[illegible]	[illegible]	晴	在办公室计算工作	无	无	
[illegible]	[illegible]	晴	测量自然沟	无	6	
[illegible]	[illegible]	晴	测量自然沟	无	6	
[illegible]	[illegible]	晴	办公室计算工作	无	无	

阿勒泰市阿拉哈克地区防止沙漠化对策实证调查园地工程

现场代理人：热斯汗

次周作业预定

月日	星期	主要作业预定
8月30日	星期一	上土地测量采田等整土地
8月31日	星期二	〃
9月1日	星期三	〃
9月2日	星期四	办公室设计计算工作
9月3日	星期五	〃
9月4日	星期六	工地整备工作
9月5日	星期日	〃

4.7.2 Construction of housing and other infrastructure

The construction of infrastructure such as housing in the settlement is shown below for the example of the Alahake site. The newly built settlement (Alahake site) of Oimake Village, created as government administration village in March 2004, had been divided into two hamlets as of May 2005.

○"3 Lines, 4 Properties and 5 Facilities" constructed for the settlement project

- 3 Lines: Roads, service water, electricity lines
- 4 Properties: Housing, sheds, fields for feed, wind break forests
- 5 Facilities: Clinics, schools, shops, community center and organization for instruction and dissemination of techniques

(1) 3 Lines

The roads, water supply and electricity are nearly completed. In Oimake Village Section 1, service water lines will be installed in 2005 (Table 4.7.2.1).

Table 4.7.2.1 Construction and future planned consolidation of the 3 Lines

Name of village: Oimake Section 1

Lines	Present construction situation		Future construction plans
	Completed	Not completed	
Roads	○		Will be built continuously according to demand.
Water	Households:	Households: X 90	Installation planned for 2005.
Electricity	○ Households: 90	Households:	—

Construction completed: ○, Not yet built: X

Name of village: Oimake Section 2

Lines	Present construction situation		Future construction plans
	Completed	Not completed	
Roads	○		
Water	○ Households: 121	Households:	
Electricity	○ Households: 121	Households:	

Construction completed: ○, Not yet built: X

(2) 4 Properties

The housing and sheds for livestock have been constructed by agro-pastoralists, on the basis of assistance (supply of bricks and other materials) from the Altay City office and Alahake Town office. On the other hand, the fields and windbreak forest belts will be built by the organization implementing the project.

At the Alahake site, the agro-pastoralists are being settled at a rate of about 20 households annually according to the housing location diagram show in Fig. 4.7.2.1, and have been constructing their homes immediately and producing crops on the fields with support from technicians at the town office. Moreover, the silos for silage and sheds also are being constructed one by one.

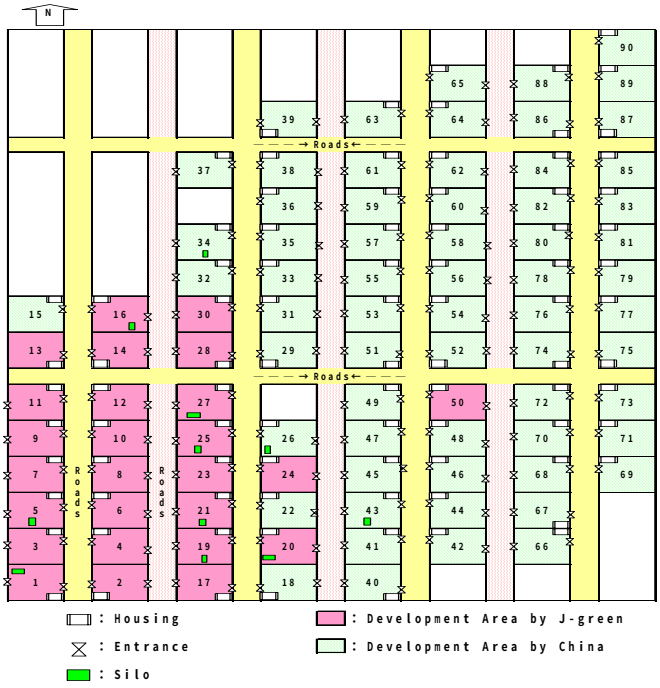


Fig. 4.7.2.1 Housing location diagram (Alahake site)

(3) 5 Facilities

Although the school and shops have been constructed, the clinic, community center and center for instruction and dissemination of techniques have not been built because the government does not have sufficient funds. For the time being, the communities are supposed to use existing facilities (Table 4.7.2.2).

Table 4.7.2.2　Construction and future planned consolidation of the 5 Facilities

Name of village: Oimake Section 1

5 Facilities	Present construction situation		Future construction plans
	Completed	Not completed	
Clinic		X	Planned, but funds not available
School		X	Under construction
Shops	○		
Community Center		X	Planned, but funds not available (Using existing facilities for time being)
Center for instruction and extension of techniques		X	Planned, but funds not available (Using existing facilities for time being)

Construction completed: ○, Not yet built: X

Name of village: Oimake Section 2

5 Facilities	Present construction situation		Future construction plans
	Completed	Completed	
Clinic		X	Planned, but funds not available (Using existing facilities for time being)
School	○		
Shops	○		
Community Center		X	Planned, but funds not available (Using existing facilities for time being)
Center for instruction and extension of techniques		X	Planned, but funds not available (Using existing facilities for time being)

Construction completed: ○, Not yet built: X

4.7.3 Implementation, management and dissemination procedures

To execute, operate and manage and disseminate settlement programs in accordance with the plan, technical guidance concerning farming and organized activities should be implemented. In the verification study on prevention of desertification, we implemented farming guidance such as training for enhancement of farming techniques for agro-pastoralists and organized activities based on cooperative or group efforts.

(1) Farming guidance

To support enhancement of agro-pastoralists' farming techniques following settlement and understand issues, we implemented training and workshops for the agro-pastoralists.

The main goal of farming guidance is to disseminate techniques to agro-pastoralists. We adopted training themes that included techniques in accordance with their capabilities and interesting techniques, implemented technical visits, lectures and site training to encourage as much participation by the agro-pastoralists as possible, and promoted the dissemination of techniques concerning the construction of sheds, cultivation of feed and cash crops, pest control, construction of irrigation canals and irrigation.

For agro-pastoralists to implement sustainable agriculture and livestock farming, they not only must acquire farming techniques but also must be able to improve their lives and reform their awareness of the environment. We therefore worked through discussions in workshop and other means to enlighten attitudes concerning issues such as realization of lives with a larger role for women and efforts for environmentally-friendly farming.

When providing such farming guidance it is important to use appropriate methods and select an approach, from among alternative methods such as technical visits, training by lectures, hands-on site training, study of issues in workshops, technology transfers to technicians through seminars and understanding of agro-pastoralists' hopes by means of questionnaire surveys, according to the circumstances of both the trainers and trainees.

(2) Organized activities

In addition to acquiring the techniques and knowledge necessary to implement new farming activities based on settlement, agro-pastoralists must be able to anticipate results such as provision of labor based on cooperative operations, cost-cutting through the cooperative use of machinery, more efficient water management operations for irrigation and cultivation of a cooperative consciousness. Therefore with the cooperation of technicians at government organizations, we implemented

organized activities concerning cooperative use of machinery, cooperative marketing of products and water management.

1) Cooperative use of machinery

Use of agricultural machinery is indispensable for performing agricultural work effectively and efficiently on fields. In this situation, cooperative use of machine is very effective for preventing surplus investment by individuals. In the verification study on prevention of desertification, we implemented training for agro-pastoralists who wish to process corn into silage at the site, and taught the importance of cooperative use of the machinery (cutter) necessary to produce silage. Because a certain amount of labor is necessary to process silage, several agro-pastoralists will form a group and use the machinery in turn, with the group members performing the series of operations cooperatively. The decision of the individuals' use of the machinery is made by the village chief, who takes into consideration factors such as the corn harvesting period, and this approach has been adopted as an organized activity.

When implementing such cooperative use, it is important to begin by determining rules and reaching an agreement concerning the use of the equipment. In addition, as a demonstration case, four organizations for cooperative use of machinery were created by three agro-pastoralists each, on the condition that the groups bear 50% of the purchase cost of the silage production machinery.

2) Cooperative marketing of products

In many cases, producers sell their livestock products through intermediaries. Prices, however, are based on decisions by merchants, the buyers. When the market is of a certain size, or the distribution infrastructure is in place, one means for producers to overcome such disadvantageous conditions is the cooperative marketing approach. Therefore with the support of the government, we implemented cooperative marketing of sheep in order to study the advantages of selling livestock products through cooperative marketing. As a result, through cooperative marketing we were able to sell at prices higher than the market price by ensuring sheep lots of a certain size. Normally, cooperative marketing of products has been adopted by individuals who have same thoughts and strategies on sales, who form a group for the purpose of raising income. Because in this case the goal was simply unification of sales, a broad approach on cooperation encompassing production and feed management was considered. For such an effort, it was necessary to formulate a realistic plan, taking into consideration the level of cooperative marketing experience in the area. Moreover, when taking this approach it also is important to pursue the plan while obtaining support from the government as needed. In addition, as a demonstration case, at the Alahake site we were able to increase the unit price by about 3% through cooperative

marketing of sheep.

3) Foundation and management of a water users' association

Water use facilities are utilized cooperatively and require a certain amount of costs for operation, maintenance and management, which the users must pay. For this reason, establishment of a water users' association composed of the agro-pastoralists who are the users is required for the purpose of maintaining and managing such facilities. From the stage of formulating the plan, preparations for foundation of a water user's association should be commenced through the organizations implementing the measures for prevention of desertification, such as the village committee in the area, and the association established after drafting regulations, having them ratified based on discussions among the agro-pastoralists concerned and selecting officers. The existence of related laws and ordinances also should be confirmed, and if procedures for the foundation and registration of such an association are defined the water users' association should be set up in accordance with such rules. Detailed rules for water use and management should be adjusted according to actual conditions after actual application has begun, based on discussions with the agro-pastoralists.

(a) Rotation irrigation

An irrigation basin is divided into several blocks, and the water distribution procedure to supply water irrigation to each block in turn is referred to as rotation irrigation. With an irrigation area covering several hundred ha, without an agreement on rotation irrigation at the branch canal level disputes frequently will arise because the downstream areas are in a disadvantageous position for water distribution compared with the upstream areas. For this reason, a water users' association must determine the irrigation water supply procedure. Irrigation in arid and semi-arid areas requires active reservation of water resources, and when a water shortage has occurred unavoidably every agro-pastoralist should reduce the area for irrigation that year in response to the shortfall. The burden for a water shortage lies on each agro-pastoralist. Even in such instances, the water volume to distribute to the terminal field lots must be ensured. Moreover, water sluice gate operation is difficult without sufficient technology. When water is delivered to the canals in the first year of water distribution, it may not be distributed to all corners of the fields because of an insufficient water level. To prevent this situation, as long as skill in operating the irrigation system is limited, measures are required to assure a certain water level in the terminal field lots and to distribute water to fields with an especially large difference in water level.

(b) Water use facilities maintenance and management

Adequate water use facilities maintenance and management extends the life of the facilities and reduces costs. Maintenance and management involves full-time monitoring, periodic observation, inspections, repairs, emergency measures for flood prevention during flooding periods, annual maintenance and removal of sediment during normal periods when water flow is halted and renewal of the facilities. To implement adequate maintenance and management by a water users' association, easy-to-understand visual instructions for the daily checkpoints should be prepared for each facility. Regardless of facilities maintenance and management, the local government must take the lead to instruct agro-pastoralists during the initial stage until management by a water users' association becomes routine. Training seminars must be held periodically as an instruction method, with the purpose explained exactly so the agro-pastoralists thoroughly understand the need. Depending on circumstances, it will be necessary to consider assembling the agro-pastoralists for regular and unscheduled repairs of weirs or maintenance, management, and cleaning of canals.

(c) Cost control

If the costs related to water supply facilities operation are not covered by the earnings produced by use of the facilities, the facilities will not result in sustainable production activity. The fee the water bureau receives from water users based on a specified method is called a water charge. The purpose of water charge collection is to promote rational use and conservation of water resources, and to secure the funds for repair, maintenance and management of irrigation facilities. The funds required for large-scale facilities construction or repairs are set aside to maintain simple restoration or large-scale restoration of irrigation facilities. The biggest reason agro-pastoralists' will not pay their water charge is that water is not actually delivered as approved. Generally the concept of the agreement appears to be they will pay the water charge will be paid if water is delivered, and will not be paid if water is not provided.

(d) Water management education and dissemination activities

An extension staff at the on-site water control station frequently is the individual who is in daily direct contact with agro-pastoralists concerning water management. The abilities of the person positioned at the lowest level of the local government also are critical. Locating the most suitable individual is often is difficult, however. A young person with limited experience who is unacceptable to the agro-pastoralists may be given this responsibility. When deciding to organize agro-pastoralists in a rural village, it is necessary to select a suitable person from the settlement to become an instructor and provide the training so that individual will become an expert.

4.8 Area evaluation

If agro-pastoralists develop sustainable agriculture and livestock farming with forestry on the settlements, this can be expected to greatly affect natural grasslands and nomadic grazing techniques because the farming patterns used in the past will change. When taking measures for prevention of desertification through settlement, it is necessary to understand these changes sufficiently.

4.8.1 Survey of the nomadic pasturing system

The most important thing to consider in the shift from nomadic grazing to settlement is how to incorporate the activities performed in the settlement in the past as part of the nomadic grazing system.

For that purpose, it is necessary to clarify the following matters.

(1) Preparation of a nomadic grazing calendar

(2) Management nomadic grazing routes

(3) Livestock productivity as part of nomadic grazing

(1) Preparation of a nomadic grazing calendar

By preparing a nomadic calendar, a plan can be creating in which agricultural activities on the settlement and livestock farming activities involving nomadic grazing do not overlap. For agriculture in particular, spring is a time for performing important chores like plowing and sowing, so it is important to prepare a nomadic calendar as shown in Fig.4.8.1.1. in order to understand activities, ensure the necessary workforce is available and promote smooth activities on the settlement.

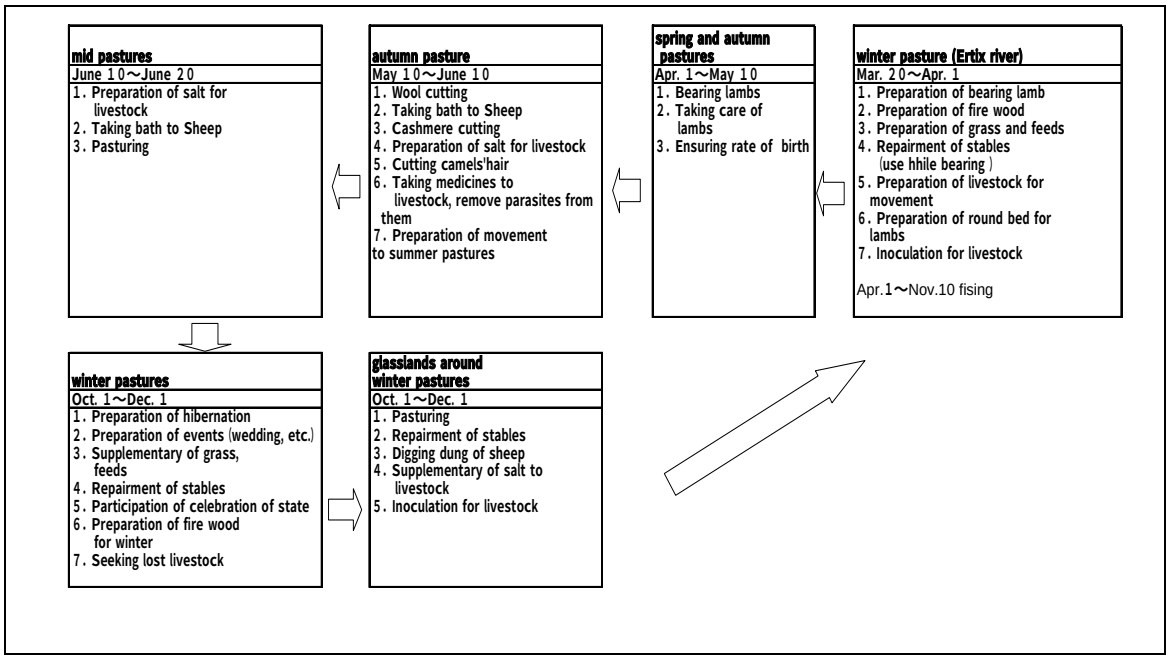


Fig. 4.8.1.1 Nomadic calendar in Jiayilema town.

(2) Management of nomadic grazing routes

Digitalizing the data on nomadic routes makes it possible to prepare a plan to prevent natural grasslands degradation by managing the schedules for movement by each agro-pastoralist.

GIS (Geographic Information System) technology can be used effectively to digitalize data on nomadic routes. The nomadic routes can be correctly plotted by fitting livestock with GPS (Global Positioning System) devices and overlaying the data on a satellite photograph. Furthermore, by combining this with vegetation data it is possible to study how the grass resources of the area are used, and consider the effects of settlement on prevention of desertification. The procedure for monitoring nomadic routes is shown in Fig. 4.8.1.2.

○Monitoring procedure

① Livestock are fitted with a GPS monitoring device (photograph at right).

② Routes, migration distances and times, etc. are recorded

③ Actual nomadic routes can be understood correctly by overlaying GPS data on a satellite photograph (photograph below).

Ex.) Nomadic routes for Alahake town (The white line shows the migration routes for spring, summer, autumn and winter)

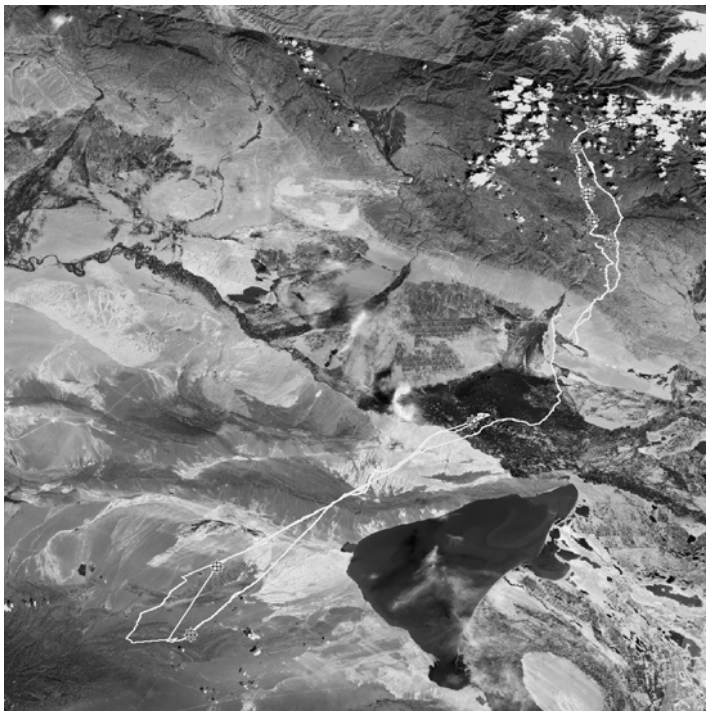


Fig. 4.8.1.2 Procedure for monitoring nomadic routes

(3) Livestock productivity as part of nomadic grazing

By understanding livestock productivity as part of nomadic grazing, a plan to incorporate activities into the nomadic grazing system to prevent a drop in the productivity of livestock feeding on the settlement because of nomadic grazing can be prepared.

Livestock abilities are determined by the quantity and quality of the grasses and feed crops provided as feed, with the results evident in a change in weight. Therefore to understand livestock productivity, it is important to manage livestock weight.

The procedure for monitoring of livestock productivity as part of nomadic grazing and the change in livestock weight during migration during nomadic grazing are shown in Fig. 4.8.1.3.

○Monitoring procedure

(1) Investigate the effect of movement among grasslands on sheep weight.

(2) Measure sheep weight before and after movement.

(3) Because changes in weight differ between each seasonal grasslands, it is important to know livestock productivity in each season.

○Change in weight of livestock during migration under nomadic grazing (Alahake Town)

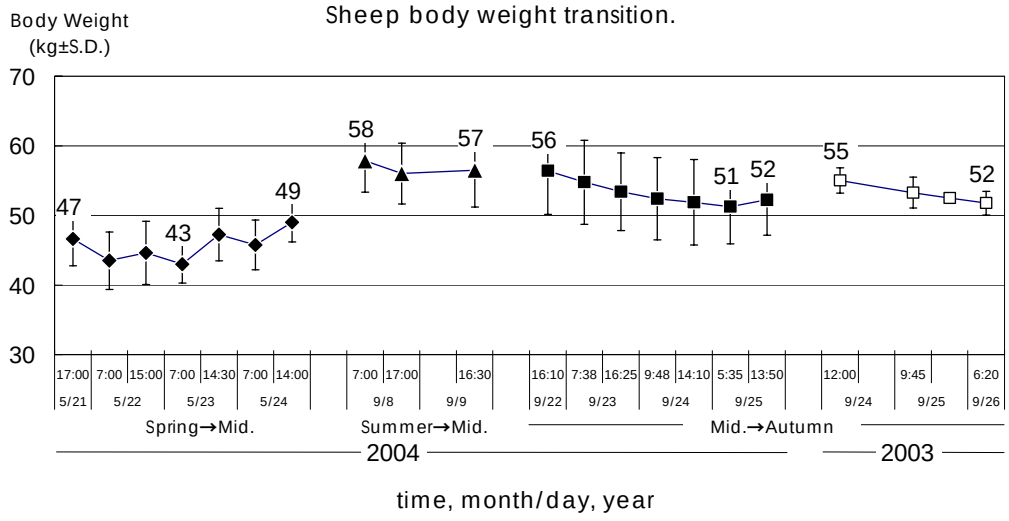


Fig. 4.8.1.3 Procedure for monitoring livestock productivity under nomadic grazing

4.8.2 Effects on natural grasslands

As shown in Fig. 4.8.2.1, the affect activities in a settlement have on the target area must be understood and linked to prevention of desertification. This means it is important to understand the extend to which loads on natural grasslands have been mitigated, and the extent to which natural grasslands vegetation has recovered.

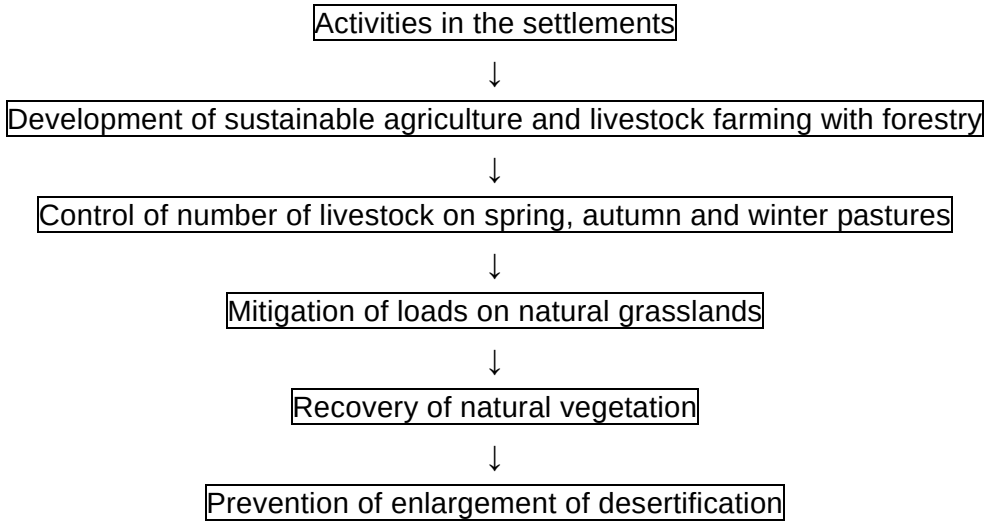


Fig.4.8.2.1 Mechanism for prevention of desertification through activities in the settlements

(1) Mitigation of loads on natural grasslands

○Change in number of pastured livestock in winter pastures

To promote prevention of desertification through settlement, it is necessary to understand the number of pastured livestock dependent on the natural grasslands. When using natural grasslands for pasturing, the early spring, late autumn and winter seasons are periods when grass resources are scarce and pasturing places heavy loads on the natural grasslands. Therefore where livestock are fed during the early spring, late autumn and winter seasons is very important.

In the Altay Administrative Office Area, the number of livestock pastured to winter pastures is restricted by the government. As shown in Fig. 4.8.2.2, although the number of feeding livestock in the area is increasing, the number of livestock pastured to winter pastures is nevertheless nearly unchanged. This shows the increased head of livestock have been fed in areas other than the pastures.

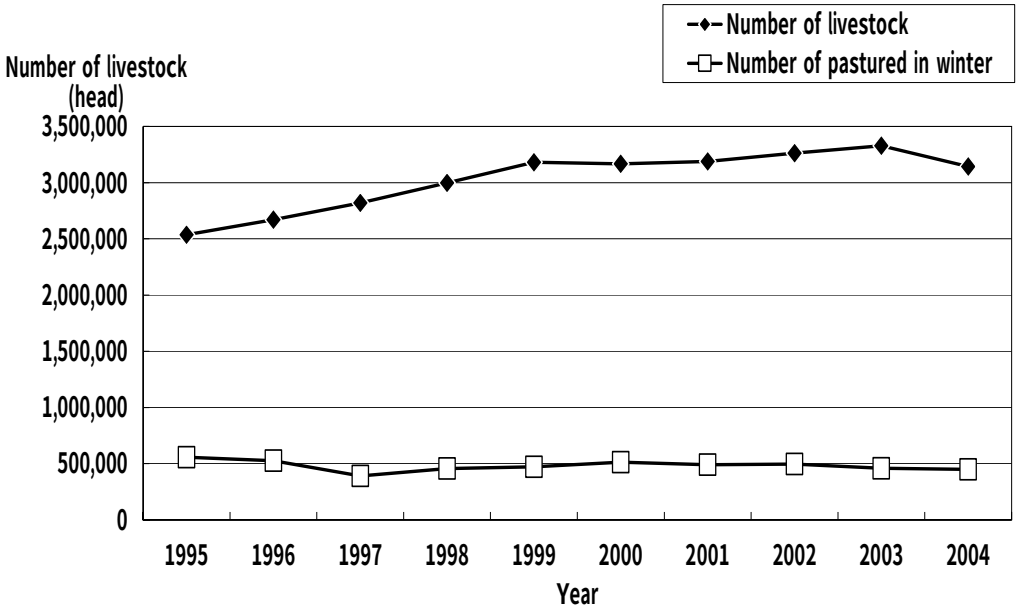


Fig. 4.8.2.2 Change in number of feeding and pastured livestock in the Altay Area

(2) Recovery of natural grasslands vegetation

○Change in vegetation from prohibition on pasturing

A prohibition on pasturing is one of the most effective ways to restore natural grasslands vegetation. Because the periods when pasturing is prohibited are periods when grassland productivity is remarkably low, however, a prohibition should be implemented after studying the purposes and effects. Prohibitions on pasturing include both a total ban on pasturing and seasonal prohibitions on pasturing. A total ban on pasturing is adopted when it is difficult for natural grasslands to recover in the short-term, to attempt to restore pasture land by prohibiting all use. Seasonal prohibitions on pasturing are a means of restricting the use of natural grasslands only during certain times of year. Sustainable natural grasslands use can be anticipated particularly when the use of natural grasslands is restricted until autumn, when plants become fruitful, because this leads to the formation of abundant seed banks.

4.8.3 Influence on the nomadic pasturing system

Nomadic grazing is a form of livestock farming in which nomadic people move with their livestock in search of water and grass. In nomadic grazing of China, Mongolia and Central Asia five livestock – sheep, goats, cows, horses and camels – are raised, with the number of each of them depending on environmental conditions in an area. This system depends on natural grasslands for nearly all feed. Therefore any change in the number of livestock will greatly affect vegetation. When feeds are produced in a settlement, the rate of dependence on the natural grasslands for feed declines and the style of nomadic grazing also may change. The role of the settlement as part of the nomadic grazing system must be positioned firmly.

(1) Changes in the nomadic pasturing system

1) Traditional nomadic pasturing system

Nomadic grazing in Xinjiang Uygur Autonomous Region is classified into the following three types.

Movement in two seasons: Nomads move between summer-autumn pastures and winter-spring pastures.

Movement in three seasons: Nomads move among spring-autumn pastures, summer pastures and winter pastures.

Movement in four seasons: Nomads move among spring pastures, summer pastures, autumn pastures and winter pastures.

In the Altay Area, the system of movement in four seasons has been adopted. The main characteristic of this system is the long migration distances between each pasture, with nomads and their herds moving 500km over the course of a year.

2) Modern nomadic pasturing system

The settlements usually are formed in the vicinity of spring, autumn and winter pastures. Therefore the production of feed crops after settlement can lead to the mitigation of loads on the pastures. To produce crops for feeding livestock all year on a settlement, however, the fields for feed crop cultivation must be created. Livestock are pastured in mountainous areas with ample grass resources in summer, and fed in the settlement in other seasons, thereby forming a nomadic grazing system that can be said to use natural resources effectively. Because pasturing to the mountainous areas requires manpower to move the livestock, however, consignment of pasturing or cooperative pasturing is implemented for households that to not have the means. This also must be noted in order to understand the number of livestock.

(2) Change in awareness after settlement

The change in awareness after settlement is discussed below from the government and the agro-pastoralists' point of view.

1) Government

For government organizations, the following three points are cited as the goals of settlement.

(1) Economic development and social stability

(2) Improvement of the ecological environment through feed production

(3) Improvement of living conditions and sustainable development of livestock farming

Study of the Settlement of Agro-pastoralists and Construction of Feed Bases in Xinjiang

The construction of artificial fields for feeds is a strategic measure to develop productive capacity to extend grasslands, combine agriculture and livestock farming, improve conditions of production, increase storage of feeds, convert style of management, feed livestock on the settlement during winter, achieve a balance between feed and livestock, a seasonal balance and a nutritional balance, improve the ecological environment and realize sustainable development of livestock farming on the pastures. Therefore, the policy for management of fields seeks to foster diversified management centered on livestock farming, and must to address the needs of livestock farming and agro-pastoralists' lives, with the goal of enhancing fertility and sustainable growth of herds. The policy also must seek to enhance economic results and earnings centered on feed production, to enable agro-pastoralists to be self-sufficient in food crops and appropriately produce industrial crops.

The settlement of agro-pastoralists and construction of feed bases in Xinjiang Province is one form of economic development work to improve production conditions and facilities in livestock farming areas, as well as one form of social development work that will build the economy in distant regions, foster solidarity of the people, encourage national defense and achieve social stability. Moreover, it is a program to resolutely address the degradation of pastures, restore the mountains and rivers in Xinjiang and create a wholesome, beneficial way of life for our descendents. Finally, these works are urgent, important system engineering that will enable all agro-pastoralists in Xinjiang to overcome poverty, become wealthier and gain practical benefits, and are aimed at a gradual improvement in the standard of living, improvement of living conditions and sustainable development to meet the long-term needs of all people.

(Extract from "Study of the Settlement of Agro-pastoralists and Construction of Feed Bases in Xinjiang")

2) Agro-pastoralists

For agro-pastoralists, the following points are cited as having improved after settlement.

(1) Movement is no longer necessary and they can lead a stable life.

(2) Are able to produce feeds for their livestock.

(3) Access to schools and hospitals has become easier.

Opinions of agro-pastoralists who settled

Before settlement, we had to move every season, which was extremely time consuming and tiring. Since settlement we have been able to enjoy our lives with our families, and earn money without as much effort. Before we had to make cheese from leftover milk, but now we can earn income by selling milk, so our living conditions are getting better. And because we can buy vegetables we have better nutrition and our families' health conditions are better. We can listen to the radio and watch TV, which enables us to understand what's going on in the world, and that enables us to utilize our abilities. We can take life a little easier, without worrying about meals or living quarters. We can see a doctor when we feeling ill. Because transportation conditions are much better, it's very convenient if we want to go somewhere. And when we have money, we can buy anything that we need for our daily lives.

Chapter 5 Reference Data

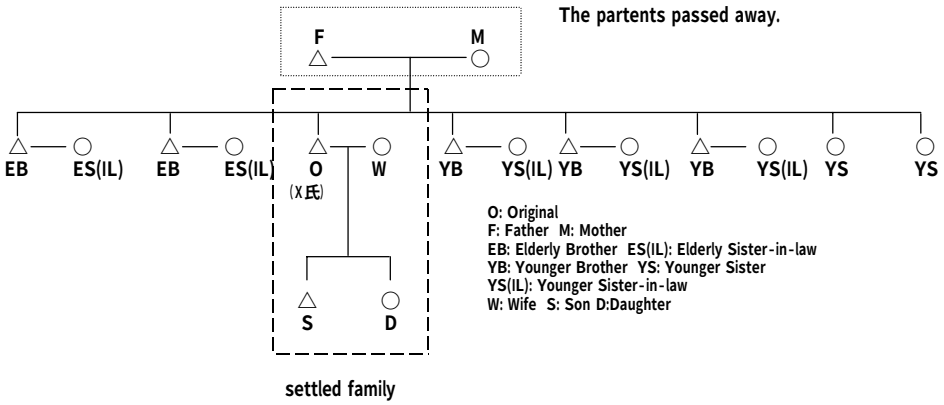
The reference data and procedure for the socioeconomic survey for the case studies in the verification study on prevention of desertification introduced in Chapter 4 are described below.

5.1 Social conditions

5.1.1 Population and household

We clarified that the settlement patterns at the Alahake site, which we studied to analyze the trend in the increase in number of households, mainly fall into two cases as shown in Fig. 5.1.

Case 1 (Case when all family members have settled)



Case 2 (Case when the son of the family has settled)

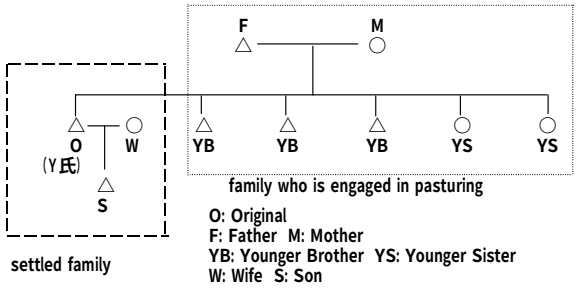


Fig. 5.1 Settlement patterns at the Alahake site

When we analyzed households of agro-pastoralists settled in the survey site, we found there are two patterns, one in which the household economy unit (production, management and consumption) is a large family including parents and offspring, and one in which the unit is a single household (most of which are a nuclear family), and

clarified that selection tends to depend on the settlers' management circumstances. Basically settlers will produce, manage and consume without relying on their family (parents, brothers), but when they have not received livestock because they are unmarried, or when they receive financial support from parents or brothers because of unstable management after settlement, in most cases individuals make a living as part of a household economy unit formed by an extended family. At such times, individuals will produce feed for livestock on the fields for the extended family, provide part of the crop to other family households in return for receiving support for the bulk of their consumption needs from parents or brothers who handle the pasturing. Because the household (family pattern) also affects settlers' family economics in terms of production, management and consumption, and style of living, it is important to give attention to such matters on a survey.

5.1.2 History and ethnic groups

(1) History of the Altay Administrative Office Area

The Xinjiang Uygur Autonomous Region can be roughly divided into the Tarim Basin (Southern Xinjiang Region) surrounded by the Tianshang and Kunlun Mountains, and the Junggar Basin (Northern Xinjiang Region) surrounded by the Tianshang and Altay Mountains. A unique history centered on the nomadic people had been developed in the Northern Xinjiang Region.

In the second half of the 2nd century B.C., the Xiongnu and Wusun governed the area, with the center of Wusun located in the western Ili Region. The fact the Han made women of the royal family twice marry a Wusun king in order to oppose Xiongnu is known well. Although violent struggles between the Han and Xiongnu continued for control over the Southern Xinjiang Region, Xiongnu eventually lost to the Han and gradually declined after the 3-4th century. This period was followed by the rise of Rouran. To achieve independence from Rouran rule, the Gaochedingling moved to the Northern Xinjiang Region at the end of the 5th century, and afterwards this region was under Turkish, or Tujue, rule. In the second half of the 6th century, Tujue expanded power and also ruled the oasis area of the Southern Xinjiang Region. Tujue was divided into eastern and western areas in the end of the 6th century, and the Northern Xinjiang Region fell under the rule of West Tujue.

Tang rulers later advanced into the western regions, and fought with and ultimately overpowered West Tujue in the mid-7th century. The Tang government established administrative offices to control nomadic people of the area in the north of Tianshang, creating a vast empire ruling over an unprecedented large area stretching from northern to central Asia. In the middle of the 8th century, however, Tang power was exhausted by wars and rule of the western area was loosened. This was followed by the growth of the Uygur, who expanded their ruling area, but when their rule was

overthrown in the mid-9th century many of them migrated to the Tianshang area.

Although this area was later governed by the West Uygur, whose rule was center in the Turpan area, by the beginning of the 12th century the area was governed by the Calah Kitaj (Xiliao). At the beginning of the 13th century, it fell under the sway of the Mongolia Empire. As part of the Mongol Empire, groups such as the Wokuotai Han and Chahetai Han ruled this area. Although the Northern Xinjiang Region was part of the Turkish world until this time, during this period the Weilate tribe of Mongolia also emigrated from near Lake Baikal and the region gradually fell under the rule of the Mongolian world. During the Junggar Kingdom period from the mid to late-17th century to the 18th century, the Weilate advanced as far as the Southern Region and Central Asia, building a large nomadic state. This state disappeared under attacks by the Qing dynasty, however, in the mid-18th century. The Xibo from the northeastern area of China and Mongolians from Nei Mongol emigrated for defense of the border areas in the second half of the 18th century. Their descendents formed the original inhabitants of the area and continue to live in the area today.

From the latter half of the 18th century, many Kazaks of Turkish descent came to settle in the Northern Xinjiang Region, and today their descendents reside in most of the livestock farming area of the Northern Xinjiang Region, especially in the Ili Kazak Autonomous Prefecture.

Thus historically in this area, an oasis culture centered on the Uygur and a livestock farming culture of the Northern Xinjiang Autonomous Region centered on the Kazak were formed, each ethnic group affected by these cultures in accordance with natural conditions and deeply related to other influences such as distribution of population, ethnic composition and religious faith.

(2) Main ethnic groups residing in the Altay Area

(a) Han

The Han are the main race of China and are part of the Sino-Tibet language group. They spread their farming culture in the Yellow River Basin around B.C. 3000, which evolved into the Yellow River civilization. Today they account for more than 90% of China’s population.

(b) Kazak

The Kazak, an ethnic group of Turkish origin, are distributed from the Republic of Kazakhstan to the Junggar area of the Northern Xinjiang Autonomous Region. This nomadic group migrated to the pastures in Kazakhstan after becoming independent from the Uzbek, who rose under Abul Heil Han in the middle of the 15th century. Kazak means "the free persons who left the tribe" in the Turkish language.

(c) Uygur

The Uygur are an ethnic group of Turkish origin who reside in Xinjiang Uygur Autonomous Region as well as other countries such as Afghanistan, Turkmenistan and Uzbekistan.

(d) Hui

When Genghis Khan and the Mongols swept westward at the beginning of the 13th century, they brought back many Arabic and Persian peoples from western and central Asia. many of these individuals moved to central China or the frontier regions for defense and commerce. The Hui are an ethnic group formed through assimilation into the Muslim population that originally resided in this area and intermarriage with the Han, Uygur and Mongolian groups in the area. The Hui is China’s most widely dispersed ethnic minority, and also are thought to be the most numerous of all ethnic minorities residing in China’s cities.

5.2 Legal system concerning natural resources and environment (extract)

5.2.1 Laws concerning land resources management

(1) Law of the People's Republic of China on Prevention and Control of Desertification

This Law was enacted to prevent land desertification, rehabilitate desertified land, maintain eco-safety, and promote sustainable economic and social development (enforced in January 2002).

The national government will prepare a national plan for prevention of desertification, which will adopt measures to reduce desertified lands while restraining the tendency of such lands to expand, and local governments will prepare a regional plan for prevention of desertification based on the national plan. Through this law the government seeks to improve the ecological environment and promote a stable life for agro-pastoralists based on control of desertified lands and recovery of vegetation through installation of windbreak nets, afforestation, a ban of deforestation and preservation of pastures.

In addition, when exploitation and construction activities are to be carried out on desertified land, the potential environmental impact on the local and regional ecology must be assessed and a report on the environmental impact submitted.

(2) Law of The People's Republic of China on Water and Soil Conservation

This law was formulated for the purpose of prevention and control of soil erosion, the protection and rational utilization of water and soil resources, mitigation of flood, drought and sandstorm disasters, improvement of the ecological environment and the development of production (enforced in June 1991).

When conducting production activities that may cause soil erosion, organizations and individuals are obligated to take measures to protect soil resources and promote soil conservation through preventive measures such as encouraging afforestation in forests and on grasslands, sowing on grasslands and prohibiting cultivation in steep slope areas.

(3) Land Management Law of the People’s Republic of China

This law was enacted for the purpose of strengthening land management, protecting and developing land resources and rationalizing land use and development, while imposing restrictions on land ownership and use and ensuring lands are strictly managed in accordance with the law (most recently revised in August 1998).

Under this law, land is owned by the national government or farmers’ groups, and groups and individuals have the right to use land and land use rights may be

transferred, but no group or individual may buy, sell, occupy or infringe on or illegally transfer land.

The national government will prepare general plans for land use based on the system for control of land use, and has the obligation to protect farmland by dividing all land into land for agriculture, land for construction and unused land according to use. Converting land for agriculture into land for construction is limited strictly.

Moreover, in the general plans for land use, the national government will set up bases for production of cereals and vegetables as the districts for protection of agriculture, and is obligated to protect and manage these lands strictly in accordance with the goal of promoting production in the future. In agricultural districts, the construction of buildings as well as forestry and fruit production are prohibited.

5.2.2 Laws concerning water resources

(1) Water Law of the People's Republic of China

This law was enacted for the purposes of rational development, utilization and protection of water resources, prevention of water disasters, realizing the comprehensive benefits of water resources and meeting the needs of national economic development and society (enforced in October 2002).

Under the law, water resources are attributed to the national government, which is required to formulate a strategic plan for water resources and encourage organizations and individuals to use water resources in accordance with the law when implementing water resources development, utilization and protection measures. The law provides that water demand by use such as daily needs and industry and the ecological environment must be given adequate consideration during water resources development and use, and that limiting factors related to implementation of projects in area where water resources are insufficient also must be considered.

(2) Law of the People's Republic of China on Prevention and Control of Water Pollution

This law was enacted for the purposes of preventing and controlling water pollution, protecting and improving the environment, safeguarding human health, ensuring effective utilization of water resources and promoting social development (latest revision enforced in May 1996).

This law is applied to prevent the pollution of surface water such as rivers, lakes, dams and canals and groundwater. In addition to water quality standards and pollutant discharge standards, the law also prescribes pollution prevention measures. As a regulation concerning agriculture, the law stipulates provisions that require agricultural chemicals to be used in compliance with national regulations and standards for safe use of agricultural chemicals.

5.2.3 Laws concerning agriculture, livestock farming and forestry

(1) Agriculture Law of the People's Republic of China

This Law was enacted for the purpose of consolidating and strengthening the position of agriculture as the foundation of the national economy and developing the rural socialist market economy, safeguarding the rights and interests of agricultural production and management organizations and farmers, and promoting the sustained, steady and sound growth of agriculture and the rural economy (latest edition enforced in March 2003).

Under this law, the basic objectives of agricultural development are to ensure a stable supply of agricultural products, increase the income of farmers and raise their living standards. The law provides for measures such as establishing the agricultural production and management systems needed to achieve these goals and support that will contribute to stable production of foods and stabilization of the market for distribution of agricultural products.

(2) Grassland Law of the People's Republic of China

This law was enacted for the purpose of protecting, developing and making rational use of grasslands, improving the ecological environment, maintaining biological diversity, modernizing livestock farming and promoting the sustainable development of the economy and society (latest edition enacted in December 2002).

By enactment of the law (1985), the state owns and manages natural grasslands, and agro-pastoralists can use natural grasslands (pastures) after obtaining natural grasslands usage rights from the government. Agro-pastoralists are under the jurisdiction of a town, the lowest administrative organization, and can follow nomadic pasturing under strict control by the local government on natural grasslands under the town’s jurisdiction. Most agro-pastoralists pasture their livestock on natural grasslands described on their usage permit issued by the government, borrowing seasonal pasture natural grasslands and setting up their yurts in designated locations each year. When the law was initially enacted, many disputes occurred among agro-pastoralists concerning issues such as pasturing locations, but these have been mediated and resolved based on the provisions of the law by the local governments at each level, and currently there are few problems.

In addition, the term of use prescribed by usage permits is 50 years, on the condition that the area for use shall be the area designated when the rights were distributed, even if changes such as a transfer of livestock management between generations, change in family composition or change in number of livestock occurs. Although this does not provide flexibility, Chinese authorities are aware of this issue and are considering whether to implement revisions.

(3) Forest Law of the People's Republic of China

This law was enacted for the purpose of protecting, nurturing and rationally utilizing forest resources, accelerating the greening of state land, demonstrating the roles of forests in terms of storing water, saving soil, regulating the climate, improving the environment and supplying forest products, and meeting the needs of socialist construction and people's lives (latest edition enforced in April 1998).

The law divides forests into five categories encompassing protection forests, timber forests, economic forests, firewood forests and forests for special use, and seeks to protect forest resources and enhance forest areas by organizing people's afforestation services among local residents to conduct afforestation activities, based on afforestation projects prepared by the local governments.

In addition, the law prescribes the regulations concerning cutting of timber in forests and other issues that also should be observed, and seeks to protect and foster forest resources by measures such as cracking down on illegal cutting through a permit system for cutting timer.

(4) Ordinance for Returning Farmland to Forests or Grasslands and Covering Hills with Afforested Trees

This ordinance was enacted for the purpose of restoring land to natural forests and grasslands by prohibiting unsuitable agriculture in areas suffering environmental deterioration and restricting use of mountain lands (enforced in January 2003).

The targeted lands are steeply sloped areas subject to earth and sand slides, farmland developed in semi-arid areas that can lead to desertification and abandoned degraded land. The ordinance seeks to restore ecological environments by intentionally halting cultivation, restoring forests and natural grasslands by planting trees and grasses suitable to the area and restoring and protecting vegetation by prohibiting cutting and gathering on existing forests and grasslands for a specified period of time.

Because farmers' income may decline and their lives affected if restoration of farm land to forest or grassland and afforestation of hillsides is implemented, compensation is required. The national government provides food assistance and subsidy grants (5 years for economic forests, 8 years for ecological forests) as compensation for prohibiting cultivation.

(5) Management Regulation to Maintain a Balance Between Pastures and Livestock

This regulation was enacted based on the Grassland Law of the People's Republic of China, in order to protect and improve the ecological environment, promote the sustainable development of livestock and promote the protection and rational use of

natural grasslands (enforced in March 2005).

The regulation seeks to encourage agro-pastoralists to produce feed on farmland, feed livestock in sheds on the settlements and work to mitigate loads on natural grasslands, in order to maintain a balance between herbage volume and the number of feeding livestock.

Based on the “standard livestock loads on natural grasslands” designated by the national government, local governments will prepare “specific standard livestock loads on natural grasslands,” verify livestock loads on natural grasslands and clarify the livestock feeding volume of agro-pastoralists and other pasture users.

In addition, to make the regulation effective local governments and pasture users are to enter agreements, and local governments can take actions such as imposing penalties in the event of violations of the regulation, which establishes an approach aimed at realizing an ecological environment that balances grasslands and livestock and promotes development of sustainable agriculture and livestock farming.

5.2.4 Laws concerning the environment

(1) Environmental Protection Law of the People's Republic of China

This law was enacted for the purpose of protecting and improving the people's environment and the ecological environment, preventing and controlling pollution and other public hazards, safeguarding human health and promoting social development (enforced in December 1989).

Under the law, environmental protection plans prepared by the national government must be incorporated into national economic and social development plans, and the national government will adopt policies that coordinate environmental protection activities with economic construction and social development.

Furthermore, local governments are to prepare an environmental protection plan after carrying out environmental research and evaluations, and implement measures to protect and improve the environment and prevent pollution.

When carrying out projects that will affect the environment, organizations and individuals must evaluate the pollution the project is likely to produce and its impact on the environment, and decide upon preventive measures.

(2) Environmental Impact Assessment Law of the People’s Republic of China

This law was enacted for the purpose of preventing the occurrence negative affects on the environment following implementation of plans and construction works and promoting development that balances the economy, society and the environment, while implementing strategies for sustainable development (enforced in September 2003).

Under this law, governments are obligated to implement and environmental impact

assessment, including analysis and measurement of the environmental impact, prevention of negative environmental effects and implementation of measures to alleviate environmental effects, when preparing plans concerning industry, agriculture, livestock farming, forestry, energy, irrigation, transportation, urban construction, tourism and natural resources development, and must submit a report on the results of the assessment to the governmental organization that will approve the project. Furthermore, for construction projects, the organization implementing the project must perform an environmental impact assessment, including environmental protection measures, an economic cost-benefit analysis and analysis and projection of the environmental impact based on effects of the project, in accordance with national government regulations.

The law was enacted to reduce negative affects on ecosystems and the environment, and based on the law, stricter analyses are implemented for industrial projects that are considered to have a larger than normal impact on the environment.

5.3 Socioeconomic survey methods

There are several methods to understand the socioeconomic conditions of an area. This section introduces the socioeconomic survey methods we used, centered on the cases in the Altay Administrative Office Area.

The two methods for understanding socioeconomic conditions are literature surveys and field surveys. The typical approach is to first develop a general understanding of the area by performing a literature survey to review existing literature and materials from related surveys, then conduct a field survey by means such as interview surveys, questionnaire surveys, focus group discussions and observation and measurement.

5.3.1 Literature survey

When collecting data in a socioeconomic survey, begin by implementing a survey of existing materials and literature summarizing the results of surveys conducted across a broad range, including the survey target area. In the literature survey, sources that can be used include statistical data reported periodically by the government or other entities, the results or reports from similar or related surveys, and information obtained from the Internet.

If necessary, a literature survey can be implemented again after the field survey.

5.3.2 Field survey

Because it is difficult to gather pinpoint data on an area be means of a literature survey, a field survey must be carried out in order to gather data.

In a field survey, methods for obtaining information include interviews on local conditions with concerned parties, questionnaires, focus group discussions, a Participatory Rural Appraisal (PRA), and observation and measurement. An outline of each survey method including contents and procedures is introduced below. For easy reference, Table 5.3.2 shows which survey method is best adopted for the matters that must be understood when conducting a socioeconomic survey.

Table 5.3.2 Matters to be studied and suitable data gathering methods

	matters to grasp								
	consciousness and thoughts		activities		acknowledges		situation of life		social relations
	grasping consciousness and thoughts quantitatively	grasping consciousness and the reasons in detail	grasping situation of activities quantitatively	grasping concrete methods and activities accurately	grasping the amount of acknowledges and accuracy	grasping resources, belongings and products, etc.	grasping economic conditions quantitatively	grasping situation of life	grasping social relations
Example / Way of collection	・The rate of persons who think so ・The degree of satisfaction of activities ・Recognition of the issues and the rate of them	・strength of consciousness ・trigger resulting in thoughts ・factors of situation subject to thoughts	・The rate of users of techniques introduced ・The frequency of practices ・The frequency of meeting	・The concrete ways of implementation ・The frequency of utterances ・the amount of participants etc.	・The ratio of correct answers of acknowledges introduced	・The area of forests and fields ・The amount of harvests ・The amount of livestock ・properties	・Income ・Composition of expenses ・prices	・health conditions ・degree of education ・life time ・The role of male and female	・dicision- makers ・relationship among members or groups
interview survey	○	◎	◎	○	◎	○	○	○	◎
questionnaire survey	◎	△	◎	△	◎	○	◎	○	△
Focus group discussion	○	◎	○	○	△	○	○	○	○
PRA	○	◎	○	○	△	○	○	○	◎
Observation			○	◎		◎		○	○
measurement				○		◎		○	

◎the most suitable, ○possible, △maybe possible

(1) Hearings (Interview survey)

Hearings (interview survey) are the method most frequently used to obtain a reply or information orally from individuals, including individuals who are not used to writing or who cannot read or write, through verbal questions and answers.

There are several methods to choose, depending on the subjects and inquiry format; a door-to-door interview survey is the form used most frequently. A hearing has the advantage of not only being able to understand the participants' replies, but also of being able to read the atmosphere and expression by which the responses are given. There are two alternatives for inquiry items and contents. One is structured interviews, in which the inquiries and response alternatives are prepared in advance and the interviews conducted according to these materials, and the other is unstructured interviews, in which these items are not prepared and the questioning or interviews are conducted freely with the subjects on the themes or points to be confirmed. Generally the former is effective when collecting quantitative information, while the latter often is more effective when collecting more qualitative information. A third alternative is the semi-structured interview method, which mixes these two methods to enable subjects to respond flexibly. It is important to use these methods appropriately depending on the matters you wish to inquire about and understand.

(2) Questionnaire surveys

Questionnaire surveys are a method in which participants answer a questionnaire on which questions and alternative answers have been prepared in order. In most cases using this method the participants write their responses directly on the questionnaire, making it a suitable means for understanding information and statistical and quantitative replies targeting many people. There are several methods, and it is important to consider and decide on a method to adopt depending on the distribution and collection procedure, number of examiners, time or period of the survey and the time required to complete the survey. If the survey respondents are fixed and the same questions are asked continually over several years, a questionnaire is very useful because the changes over consecutive years also can be read from the survey results, in order to analyze trends.

Questionnaire Survey for agro pastoralists

After sufficiently considering the period required for the entire procedure from preparation of the questionnaire through implementation, tabulation of the results and analysis, a schedule for conducting the questionnaire survey must be prepared. It is

also important to conduct a preparatory survey (pre-survey) with several people tentatively and modify the questionnaire based on the results. The procedure for preparing a questionnaire is shown briefly below.

○Procedure for preparing a questionnaire

a. Consider what kind of information is to be obtained.
b. Consider the specific questions needed to obtain this information.
c. Consider the response form. (free reply form or reply form with alternatives)
d. Consider the order of questions.
e. Consider the procedure for summarizing the results.
f. Consider the form layout.
g. Translate the questionnaire into the local language if necessary.
h. Print and prepare the required number of copies.

Other important matters for preparing a questionnaire are shown below.

○Important matters for preparing a questionnaire

(1) When preparing a questionnaire, take into consideration socio-cultural aspects, such as ethnic group, religion, unsuitable words and polite expressions, while using clear words as concretely as possible. You should also consider the order of the questions, to ensure the questionnaire does not intentionally guide responses.

(2) Do not ask two or more matters in one sentence. If respondents answered “yes” to the question, “Did you not receive a medical checkup because you did not have any money,” you cannot clarify whether the medical checkup was not received only to save money or if it was not received because the respondent did not have the money, even though he/she wanted to receive the checkup.

(3) Prepare a questionnaire after thinking first about the procedure to be used for summarizing and analyzing the results. When the procedure for summarizing the results is considered after the survey, you may find a question needed for summarizing and analyzing the results was omitted, or you did not ask about an important background factor.

(3) Focus group discussion

Focus group discussion is a method to understand the results of discussion or thinking of individuals who have particular characteristics. Discussions are best held with about 10 people, because the discussion venue may be biased to particular

Workshop by women
(Woman on the left is Facilitator)

persons if there are many participants.

The key feature of this method is that it puts emphasis on participants sharing opinions freely, and seeks to elicit participants' memories, facilitate discovery and expand ideas based on discussion. To create a venue for free discussion, the individual encouraging the discussion (facilitator) must try to create an atmosphere that will enable participants to speak truthfully without tension. Several steps to prepare for playing this role are shown below. Furthermore, if the participants are female, the facilitator should be a woman. It is also important to designate a note-taker other than the facilitator to record the contents of the discussion. In addition, because the facilitator's key role is to move the discussion along, basically it is better for the moderator to just jot down notes rather than try to record what is said in detail.

(1) Create a relaxed atmosphere.
(2) Be receptive to comments, even if negative comments are made.
(3) Do not have a bias only toward particular speakers, and encourage persons who say little and urge them to speak. However, do not guide the discussion and stay in the role of leader.
(4) Use suitable expressions to stay on topic and keep discussions from straying off the theme.
(5) Ask questions to clarify the contents of comments, if needed.
(6) (6) Try to get participants to reply not only to the facilitator, by encouraging participants to discuss among themselves.

(4) Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal is a survey method adopted in recent years by many organizations, including those in charge of international cooperation, as one means for collecting information.

This method is a means for obtaining more precise information, eliciting the potential capabilities of local residents and have them take action for reform while learning from one another and developing activities based on empowerment to the weaker members of society and local resident leadership, by the individuals conducting the survey learning from the opinions and thinking of the local people.

When implementing a survey using this method it is important to conduct the survey using the tools described below, while also keeping the following perspective in mind to the extent necessary.

Moreover, interview surveys and focus group discussions also are used as tools for this method to clarify opinions and thoughts.

○Main tools

1) Mapping

A method for showing on a map how far individuals travel in their daily activities by writing the resources, facilities or other items used in daily life on the map of the area.

Different maps can be created, such as patterns for men and women, different generations or economic brackets.

2) Calendar, daily schedule

By making an annual calendar of daily lives or a daily schedule showing the daily life patterns of people in the area, it is possible to understand circumstances such as work sharing between men and women or different social strata and extract issues such as whether a labor burden exists.

3) Social relationship diagram

A diagram on which related people, groups, institutions and organizations are listed to show, for example, how closely related they are to each other or a project, which units have influence over others, or whether the relationships are dominant or antagonistic, on which the strength of relationships and influence can be shown by means such as size or overlap of figures or the thickness, color or type of line.