# CHAPTER 5 LIVESTOCK FARMING SYSTEM IMPROVEMENT PLAN

## 5.1 DEVELOPMENT COMPONENT AND PROJECT

In Chapter 3, the three components of "Pasture utilization / Well development and management", "Livestock products improvement" and "Herders economic stabilization" were mentioned as necessary for improvement of the livestock farming system in rural areas. It was further mentioned that the "Human resources development" component is also essential in the implementation of these development components. In addition, the projects to achieve each component were identified as shown in Table 5.1.1. In this chapter, each component and project improvement plan of livestock farming system in rural area is summarized, reflecting knowledge obtained from results of the Pilot Study described in Chapter 4.

Table 5.1.1 Development Component and Project

| Policy／End Outcome | Development Component | Project |
|---|---|---|
| Improvement of Livestock Farming System in Rural Area | Pasture utilization/ Well development and management | Pasture utilization and well development project |
| | Livestock products improvement | Veterinary service improvement project |
| | | Superior livestock breeding project |
| | | Livestock farming technique improvement project |
| | | Capacity building for risk management project |
| | Herders economic stabilization | Livestock farming improvement project |
| | | Market and distribution of livestock products improvement project |
| | Human resources development | Human resources development through each project |

## 5.2 COMPONENT OF PASTURE UTILIZATION / WELL DEVELOPMENT AND MANAGEMENT

Pasture resources and water resources are the foundation of the pastoral livestock system; if one of them is absent, pastoral herding can't succeed. However, at present, the imbalance in distribution of both is becoming a factor that disturbs proper seasonal migration.

Since the aim of both the improvement of pasture utilization and the well development are to increase pasture utilization to its potential, these should be considered as a unit. For this reason, the project for this component shall be the combined "pasture utilization and well development project".

(1) Outline of the Project

After changing to market economy, well operation and maintenance, and pasture utilization that were managed by the *Negdel* have become herder responsibility. However, well operation and maintenance could not be continued without clear responsibility in the privatizing condition that was transferred from the planned economy. In addition, unused and low used pasture is expanding, migrating to the summer/ autumn camp gets decreased, and yearly overgrazing around the winter/spring camps bring devastation of pasture.

For these reasons, the government needs to remove constraints on pasture utilization through effective well development, and improve prerequisites to actualize pasture management over the whole area; simultaneously, they need to carry out proper pasture utilization conducted mainly by herders, and measures necessary for continuation of well operation and maintenance.

(2) Target Group and Implementing Organization

| | |
|---|---|
| Target group: | Herder groups |
| Implementing organization: | Ministry of Food and Agriculture, agriculture agency in *Aimag*, and *Soum* government |

(3) Purpose

1) Project Purpose

Sustainable pasture utilization system is established.

2) Overall Goal

*Pasture can be utilized sustainably by continuous improvement of carrying capacity.*

(4) Outputs

This project aims to achieve "improvement of methods to use pasture", "well development", and "continuation of well operation and maintenance" by proper regional pasture utilization, well development that is prerequisite of pasture utilization, and various approaches to actualize sustainable maintenance of pasture and wells.

1) Pasture Utilization System is Improved

Since pasture management is to be implemented mainly by herders in the region, it is necessary to deepen their understanding, and stimulate spontaneous action. Therefore, *Soum* government plays a central role in establishment of "pasture monitoring system" with consideration of both aspects of production and utilization, and prepares relative information through herders training to achieve proper pasture utilization in the region.

2) Wells are Developed in Certain Level

In order to achieve proper pasture utilization, it is necessary to remove constraints on pasture utilization as "lack of water resources", and for timely pasture utilization. For this reason, the government plays central role in implementation of well development.

3) Well Operation and Maintenance are Continued

Operation and maintenance of the improved well have to be managed under responsibility of herders who are also users, and need to use the well continuously together with pasture. For this reason, it is necessary to increase herder's ownership and also establish supporting system by *Soum* government and *Aimag* government.

(5) Input

Pasture diagnosis training, Pasture monitoring, Wells improvement, Training for well operation and maintenance, *Soum*'s supporting system for wells improvement and wells operation and maintenance (Group support activity fund, *Soum* Well Fund, getting a person responsible for operation and maintenance)

## 5.2.1 BASIC CONCEPTS IN PLAN FORMULATION

(1) Utilization of GIS Data

In this project, a plan is formulated based on an understanding of the whole areas condition, which is gained by overlapping wells distribution and pasture carrying capacity by using GIS. The data of topographic character, river, spring, and lake is digitized data from topographic map scale 1:500,000.

Basic data for well development is based on the well database that was prepared by UNDP in 1991, and is now controlled by the Institute of Geoecology. This data of *Dornogobi Aimag* was reviewed and updated by *Aimag* agriculture agency and the JICA Study.

Basic data of the pasture carrying capacity was based on "Evaluation of carrying capacity, ecology and its value in Mongolia", (Livestock Research Institute, 2000, *Tserendash* et.al)".

(2) Setting Stable Water Supply Pasture

As an indicator for pasture utilization or well improvement, setting water supply rate is important work. Consequently, within 5 km from water resource was set as the stable water supply pasture (5km Zone) that can be utilized with a well. In addition, from the viewpoint of pasture utilization by livestock, this stable water supply pasture was divided into stable water supply pasture (3 km Zone) that is utilized by smaller livestock, and stable water supply pasture (3-5 km Zone) that is utilized by larger livestock.

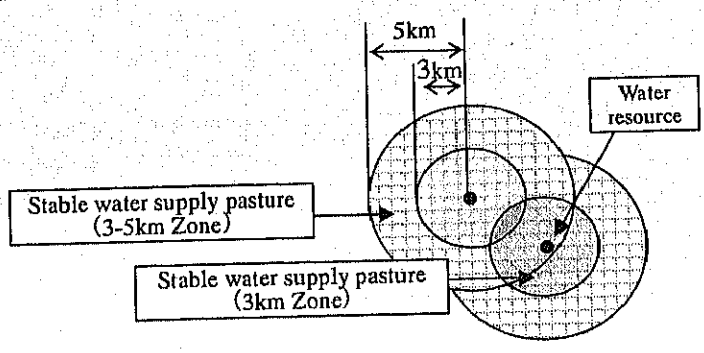


Fig.5.2.1 Stable Water Supply Pasture

(3) Relation between Carrying Capacity used for Plan and Stable Water Supply Pasture

Within the stable water supply pasture (5 km Zone), the nearer to the center of the water resource, the more excessive concentration of pasture utilization. Although it is expedient to assume that larger livestock utilizes (3-5 km Zone), actually (3 km Zone) is also utilized. In the planning, it is necessary to calculate carrying capacity in consideration of such actual utilization.

Using the area ratio of (3 km Zone) and (3-5 km Zone) and livestock ratio of smaller one and larger one, the utilization ratio of (3-5 km Zone) was estimated to be 0.56, given utilization ratio of (3 km Zone) as 1.

Thus, actual carrying capacity of (3-5 km Zone) was set to be 60% in the plan. If larger livestock increases and livestock composition ratio in the area changes in the future, it will be necessary to increase this ratio and review utilization ratio of (3-5 km Zone).

Table 5.2.1 Utilization Ratio of Stable Water Supply Pasture (*Dornogobi*)

| | Stable water supply pasture (3 km Zone) | Stable water supply pasture (3-5 km Zone) |
|---|---|---|
| Carrying capacity | 1,400,277 | 965,301 |
| Livestock number in 2002 | 1,039,665 | 403,680 |
| Ratio: Carrying capacity/Livestock number | 74% | 42% |
| Utilization ratio of carrying capacity (Based on 1 for 3 km Zone) | 1 | 0.56 |

(4) Setting Pasture Utilization Ratio due to Difference of Water Supply Efficiency

Water supply efficiency for livestock differs due to water supply capacity of well.

Water supply efficiency depends on well's capacity, livestock number around the well, and pasture productivity; corresponding to this result, pasture utilization ratio changes. Carrying capacity was calculated on the assumption that water supply efficiency is 1 for pasture utilization around the Production Well, 0.9 for hand-used Shaft Well, 0.8 for the Traditional Well, and 0.7 for spring, respectively.

Table 5.2.2 Setting Pasture Utilization Ratio Corresponding to Kind of Water Resources

| Kind of water resources | Production Well, Shallow Well, Rehabilitated Shaft Well, pond | Hand-used Shaft Well | Traditional Well | Spring |
|---|---|---|---|---|
| Pasture utilization ratio | 1 | 0.9 | 0.8 | 0.7 |

(5) Treatment of Nature Preserve in Planning

Generally use of livestock farming in the nature preserve in the Study Area is forbidden, but actually, use is continuing. Therefore, it is assumed that present use condition continues but there will not be promotion to do so accompanying new development. Therefore, targeted area in the plan will add the area of (5 km Zone) used in the nature preserve at present to each *Aimag* area except nature preserve. Also, carrying capacity is estimated in the same way.

(6) Basic Concept of Well Development Plan

Master plan on well development was formulated to effectively utilize the regional carrying capacity in consideration of pasture condition in the 3 *Aimags* of the Study Area. The first well development plan, which is considered to be preferentially developed, was formulated considering rehabilitation and alternative construction of the existing wells that have high potential of water resources, and the existing data of the water resources investigation.

## 5.2.2 PASTURE USE AND MANAGEMENT

(1) Basic Policy of Pasture Use and Management

The most important matter from the viewpoint of pasture use and management is to correct the imbalance of these two resources. It is the basic idea in this plan to facilitate seasonal migration due to the restriction of low vegetative productivities in the Gobi region.

It is important to maintain and stabilize the level of carrying capacity for sustainable development of pastoral livestock system. The four measures to stabilize or to raise the carrying capacity are as follows:

i) To reduce livestock number and alleviate the pressure on pastures (Social restriction).
ii) To cultivate fodder crops to increase land productivity (Intensive land use).
iii) To stabilize the utilization of unused and low used pasture by improving water supply (Well development).
iv) To upgrade herder skill for appropriate seasonal migration and efficient way of feed-water (Water-feed management / Pasture management).

Nevertheless, in actuality it is almost impossible to restrict the number of herder livestock in these approaches. Also large-scale cultivation of fodder crops is difficult in the environment of Gobi region because it is unprofitable, especially in case of using irrigation. In addition, careful consideration and evaluation of environment are required such as soil salinization and sustainability of land use.

In this project, as a continuous measure to improve the carrying capacity, it is planned to combine the basic policies both to develop wells in Low Use and Unused Pastures (Aspects of hardware development) and to improve technical skills for monitoring in pasture management (Aspects of software development). As a result of some activities of pasture use and management, sustainable system for pasture use will become established and continuous improvement of carrying capacity will be achieved. Outline of pasture use and management is shown in the next figure.

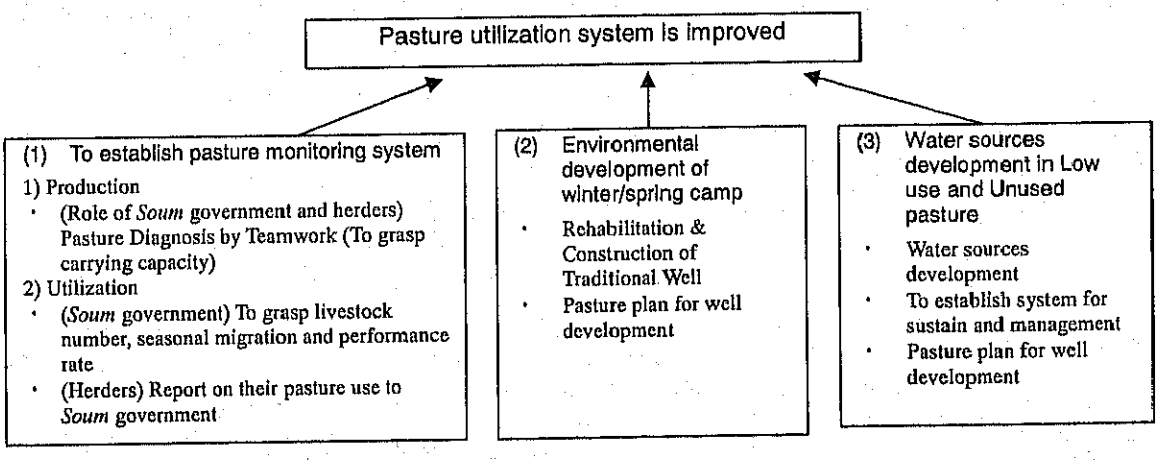


Fig.5.2.2 Activities for Pasture Use and Management

Pasture use and management will be conducted as an organic part of the main activities as follows: To establish pasture monitoring system; To develop environment of Winter/Spring Camp; To develop water sources in Low use and Unused pasture.

(2) To Establish Pasture Monitoring

Pasture monitoring activities will mainly be conducted by *Soum* government. It will be principally composed of two aspects of pasture management: production and utilization.

1) Monitoring in Pasture Production

Meteorological agency is conducting measurement of pasture every year, but measuring points are limited and there is also a problem that it is not always effective information to the herders. Therefore it is recommended for *Soum* government to conduct pasture diagnosis by simplified pasture measurement as an appropriate technology through team work together with herders. Characteristics and points of differences between this simplified method and that of meteorological agency are shown below.

Table5.2.3 Comparison of Two Pasture Measurement Systems

| | Simplified Pasture Measurement through Team Play between Herders and *Soum* Government | Observation Operation by Meteorological Agency |
|---|---|---|
| Purpose | Offering carrying capacity information for winter/spring camp | To formulate policies for preparation of hay and feedstuff for coming winter |
| Target | Mainly to herders | Administration and Herders, mainly to the former |
| Method | By estimating productivities from Height (H) and Coverage (C) | By measuring Dry Matter Weight (DMW) |
| When to measure | August – September (every year) | July – August (every year) |
| When is the information delivery | October – November (every year) | August-September (every year) |
| Accuracy & Specialty | Relatively in lower level, training acquired | Relatively in higher level, fairly trained |
| Sites to measure | Many (30 points planned) | Not many (a few up to around 10) |
| Location | Widely distributed in *Soum* area | Mainly near *Soum* center and few other sites |

General concept and steps for pasture diagnosis by team work between herders and *Soum* government is shown in Fig.5.2.3.

Collecting and delivering information between herders and *Soum* government will be conducted by *Bag* governor. *Bag* governor will also be in charge of coaching simplified pasture measurement method to herders. Therefore it is required to provide continuous training for pasture management to both *Bag* governor and herders. Training will be held by *Soum* government and the agricultural officer will calculate the results of pasture measurement collected from herders and deliver back carrying-capacity information to herders. Moreover, *Soum* government will make records and accumulate changing data for several winter/spring camps as widely collected information.

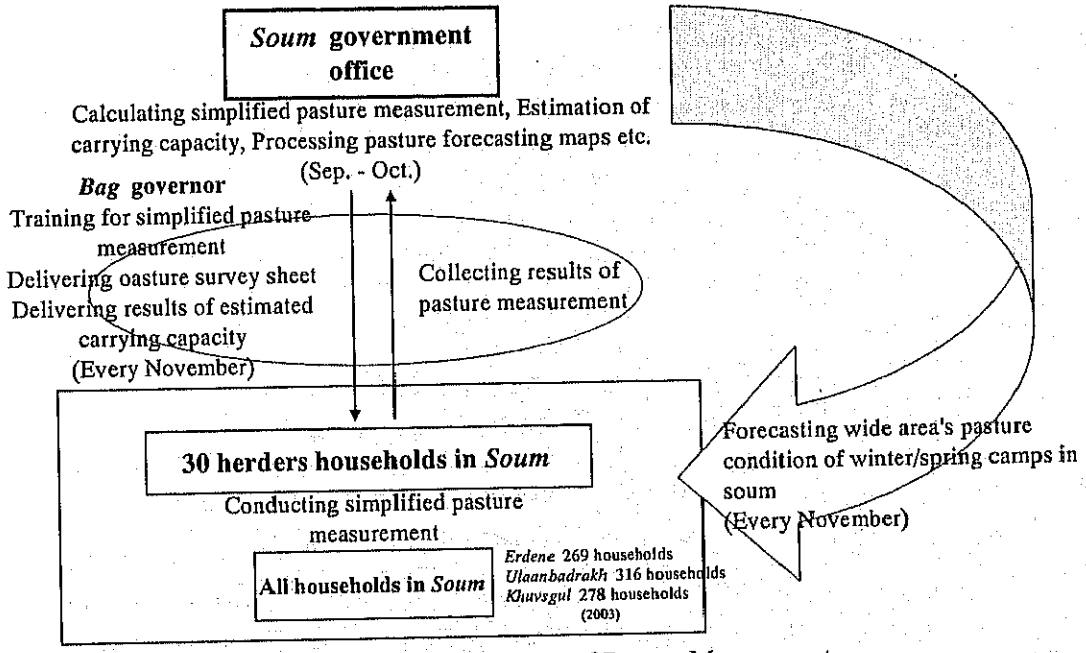


Fig. 5.2.3 General Concept of Pasture Management

2) Monitoring in Pasture Utilization

In addition to monitoring pasture production, it is recommended to establish continuous system for monitoring pasture utilization. As related with well development plan as mentioned later, it is planned to identify facts of herder seasonal migration and combination of water sources through monitoring. *Soum* government will record two basic kinds of herder information:

- Livestock number per household
- Monthly combination of water sources per a family (Annual migration record for herders)

Frequency of water sources used in a period will be summed up and multiplied by livestock number to calculate performance rate of water sources. For performance rate of each water source or well, indicators for seasonal use and concentration of livestock number to specific water sources will become known. Since 3 or 4 wells are used by one family annually in seasonal migration in Gobi, it is possible to make use of monitoring information for appropriate pasture use according to carrying capacity. Monitoring of pasture utilization is helpful and useful when it is combined with that on pasture production and will achieve continuous improvement of carrying capacity.

3) Guideline for Appropriate Size of Livestock Number and Utilization Balance

i) Appropriate Level of Livestock Number considering Environmental Aspects

In this plan, based on estimated carrying capacity by Livestock Research Institute (*S,Tserendash* et al. 2000), taking account of the recent trend of climate such as drought, the appropriate number of livestock is proposed, the carrying capacity is multiplied by 0.9 as safety ratio for the fluctuation.

Table 5.2.4 Appropriate Livestock Number in each *Aimag*

| | | Yield (kg/ha) | Livestock number (s.u./km$^2$) | Appropriate livestock number per well (s.u.)* |
|---|---|---|---|---|
| *Dundgobi* | North** | 285.6 | 50.1 | 1416 |
| | South | 155.1 | 33.0 | 933 |
| | Ave. | 197.9 | 42.1 | 1190 |
| *Dornogobi* | Northeast | 150.7 | 32.1 | 906 |
| | Southwest | 147.1 | 31.3 | 885 |
| | Ave | 149.5 | 31.8 | 899 |
| *Umnugobi* | North | 122.2 | 26.0 | 735 |
| | South | 89.8 | 19.1 | 540 |
| | Ave | 106.2 | 22.6 | 639 |

Note : 1 Stable water supply pasture for one well is calculated in 3km in radius
*s.u.=Sheep Unit; Carrying capacity for one sheep
**Annual nutritional need is calculated by 570kg/s.u./year instead of 470kg/s.u./year

It is a tentative goal to achieve annual carrying capacity of Stable water supplied pasture (3 km Zone). But in reality, herders are using a well in combination with the other water sources and pasture use is much more complicated than the model. It is possible to know condition of seasonal use of each well through continuing observation and record by pasture analysis such as productivity, livestock number, and migration record for combination of water sources. *Soum* government will calculate performance rate of well (Seasonal livestock per well) based on basic information gathered by pasture monitoring. In addition, comparing with appropriate level of livestock number, it will be a guideline for pasture management.

ii) Alleviation of Pasture Use at the Center of Water Sources and Maximum Use of 3～5 km Zone.

According to distances from water sources (such as well), Stable water supplied pasture (3 km Zone) and, Stable water supplied pasture (5 km Zone) are set. By proportion of overlapping of both pastures in *Dornogobi*, livestock number is divided as follows.

1. Stable water supplied pasture (3 km Zone) = Small livestock (Whole number) + Large livestock (Whole number x 0.6)
2. Stable water supplied pasture (3-5 km Zone), which is completely outside of Stable watered supplied pasture (3 km Zone) = Large livestock (Whole number x 0.4)
3. Stable water supplied pasture (5 km Zone) = Small livestock (Whole number) + Large livestock (Whole number)

Livestock number (In real numbers and in sheep units) in each division of Stable water supplied pasture in utilization balance with carrying capacity is shown in Table 5.2.5.

Table 5.2.5 Utilization Balance of Carrying Capacity in Stable Water Supplied Pasture in *Dornogobi Aimag*

| 3km Zone | Carrying Capacity (s.u.) | Livestock number within 3km Zone | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1999 | | | 2002 | | |
| | | No. of livestock | Sheep unit | Balance(%) | No. of livestock | Sheep unit | Balance(%) |
| *Airag* | 83,599 | 58,782 | 96,624 | 115.6 | 53,261 | 75,037 | 89.8 |
| *Altanshiree* | 74,898 | 58,781 | 98,340 | 131.3 | 38,429 | 58,957 | 78.7 |
| *Dalanjargalan* | 81,769 | 85,521 | 151,581 | 185.4 | 50,236 | 74,541 | 91.2 |
| *Delgerekh* | 90,706 | 89,679 | 171,160 | 188.7 | 52,279 | 91,890 | 101.3 |
| *Erdene* | 121,410 | 72,387 | 124,774 | 102.8 | 52,665 | 76,720 | 63.2 |
| *Ikhet* | 67,027 | 58,831 | 106,228 | 158.5 | 39,076 | 60,696 | 90.6 |
| *Khatanbulag* | 124,770 | 122,012 | 190,668 | 152.8 | 91,962 | 121,844 | 97.7 |
| *Khuvsgul* | 121,190 | 78,593 | 131,547 | 108.5 | 51,930 | 76,575 | 63.2 |
| *Mandakh* | 105,443 | 69,406 | 106,180 | 100.7 | 66,484 | 90,987 | 86.3 |
| *Saikhandulaan* | 108,987 | 56,287 | 88,394 | 81.1 | 62,399 | 88,811 | 81.5 |
| *Sainshand* | 22,241 | 52,725 | 68,238 | 306.8 | 55,299 | 65,378 | 294.0 |
| *Ulaanbadrakh* | 135,240 | 84,689 | 124,360 | 92.0 | 63,292 | 79,833 | 59.0 |
| *Urgun* | 99,563 | 68,091 | 104,999 | 105.5 | 52,186 | 73,246 | 73.6 |
| *Zamyn-Uud* | 4,306 | 7,602 | 8,635 | 200.5 | 4,985 | 5,150 | 119.6 |
| Total | 1,241,147 | 963,386 | 1,571,728 | - | 734,483 | 1,039,665 | - |
| Total (Average)* | 1,214,601 | 903,059 | 1,494,855 | 123.1 | 674,199 | 969,137 | 79.8 |

| 3～5km | Carrying Capacity (s.u.) | Livestock number within 3～5km Zone excluding 3km Zone | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1999 | | | 2002 | | |
| | | No. of livestock | Sheep unit | Balance(%) | No. of livestock | Sheep unit | Balance(%) |
| *Airag* | 36,766 | 9,472 | 56,206 | 152.9 | 5,851 | 34,488 | 93.8 |
| *Altanshiree* | 35,703 | 9,186 | 54,542 | 152.8 | 5,085 | 29,911 | 83.8 |
| *Dalanjargalan* | 19,913 | 7,729 | 46,051 | 231.3 | 3,056 | 18,084 | 90.8 |
| *Delgerekh* | 20,029 | 7,422 | 44,184 | 220.6 | 3,759 | 22,219 | 110.9 |
| *Erdene* | 45,782 | 11,516 | 67,936 | 148.4 | 5,582 | 32,393 | 70.8 |
| *Ikhet* | 19,114 | 6,079 | 36,306 | 189.9 | 2,934 | 17,478 | 91.4 |
| *Khatanbulag* | 123,950 | 15,210 | 88,280 | 71.2 | 7,242 | 41,112 | 33.2 |
| *Khuvsgul* | 39,760 | 8,065 | 46,982 | 118.2 | 3,992 | 22,594 | 56.8 |
| *Mandakh* | 50,966 | 9,701 | 55,634 | 109.2 | 6,900 | 38,999 | 76.5 |
| *Saikhandulaan* | 47,574 | 8,246 | 48,156 | 101.2 | 7,048 | 40,923 | 86.0 |
| *Sainshand* | 14,127 | 8,337 | 48,978 | 346.7 | 6,029 | 34,842 | 246.6 |
| *Ulaanbadrakh* | 62,683 | 11,306 | 65,819 | 105.0 | 5,155 | 29,211 | 46.6 |
| *Urgun* | 48,792 | 10,558 | 62,602 | 128.3 | 6,413 | 37,721 | 77.3 |
| *Zamyn-Uud* | 3,241 | 2,611 | 15,536 | 479.4 | 643 | 3,705 | 114.3 |
| Total | 568,400 | 125,438 | 737,212 | - | 69,689 | 403,680 | - |
| Total (Average)* | 551,032 | 114,490 | 672,698 | 122.1 | 63,017 | 365,133 | 66.3 |

| 5km Zone | Carrying Capacity (s.u.) | Livestock number within 5km Zone | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1999 | | | 2002 | | |
| | | No. of livestock | Sheep unit | Balance(%) | No. of livestock | Sheep unit | Balance(%) |
| *Airag* | 120,365 | 68,254 | 152,830 | 127.0 | 59,112 | 109,525 | 91.0 |
| *Altanshiree* | 110,601 | 67,967 | 152,882 | 138.2 | 43,514 | 88,868 | 80.4 |
| *Dalanjargalan* | 101,682 | 93,250 | 197,632 | 194.4 | 53,292 | 92,625 | 91.1 |
| *Delgerekh* | 110,735 | 97,101 | 215,344 | 194.5 | 56,038 | 114,109 | 103.0 |
| *Erdene* | 167,192 | 83,903 | 192,710 | 115.3 | 58,247 | 109,113 | 65.3 |
| *Ikhet* | 86,141 | 64,910 | 142,534 | 165.5 | 42,010 | 78,174 | 90.8 |
| *Khatanbulag* | 248,720 | 137,222 | 278,948 | 112.2 | 99,204 | 162,956 | 65.5 |
| *Khuvsgul* | 160,950 | 86,658 | 178,529 | 110.9 | 55,922 | 99,169 | 61.6 |
| *Mandakh* | 156,409 | 79,107 | 161,814 | 103.5 | 73,384 | 129,986 | 83.1 |
| *Saikhandulaan* | 156,561 | 64,533 | 136,550 | 87.2 | 69,447 | 129,734 | 82.9 |
| *Sainshand* | 36,368 | 61,062 | 117,216 | 322.3 | 61,328 | 100,220 | 275.6 |
| *Ulaanbadrakh* | 197,923 | 95,995 | 190,179 | 96.1 | 68,447 | 109,044 | 55.1 |
| *Urgun* | 148,355 | 78,649 | 167,601 | 113.0 | 58,599 | 110,967 | 74.8 |
| *Zamyn-Uud* | 7,547 | 10,213 | 24,171 | 320.3 | 5,628 | 8,855 | 117.3 |
| Total | 1,809,548 | 1,088,824 | 2,308,940 | - | 804,172 | 1,443,345 | - |
| Total (Average)* | 1,765,633 | 1,017,549 | 2,167,553 | 122.8 | 737,216 | 1,334,270 | 75.6 |

* Total and average score of 12 soums, excluding Sainshand and Zamyun-Uud

Source: Turendersh et.al, JICA

Comparing with utilization balance in Stable water supplied pasture (3 km Zone) and (3-5 km Zone), there is no big difference between both in 1999, when livestock number was considered excessive in number, as 123.1% and 122.1% respectively. But scores have a much wider difference between (3 km Zone) and (3-5 km Zone) in 2002 as 79.8% and 66.3% respectively. This means that livestock is distributed with high density in (3 km Zone) and with low density in (3-5 km Zone) meaning that livestock have a tendency to gather near the well.

From the viewpoints of livestock and pasture management, it is recommended to lead livestock to (3-5 km Zone), which is considered edge of 5 km in radius more actively and consciously as grazing policy. Besides, it will also be an effective way to make maximum use of (3-5 km Zone) by increasing number of big livestock and improving livestock constitution balance in accordance with natural conditions of Gobi.

4) Significance of Establishing Pasture Monitoring System

Relationship of water supply capacity, livestock number and carrying capacity is shown in the next figure. Present conditions and goal of pasture management for well development plan as mentioned later are set in place respectively. Roles of livestock and pasture management technologies are also presented in the figure.

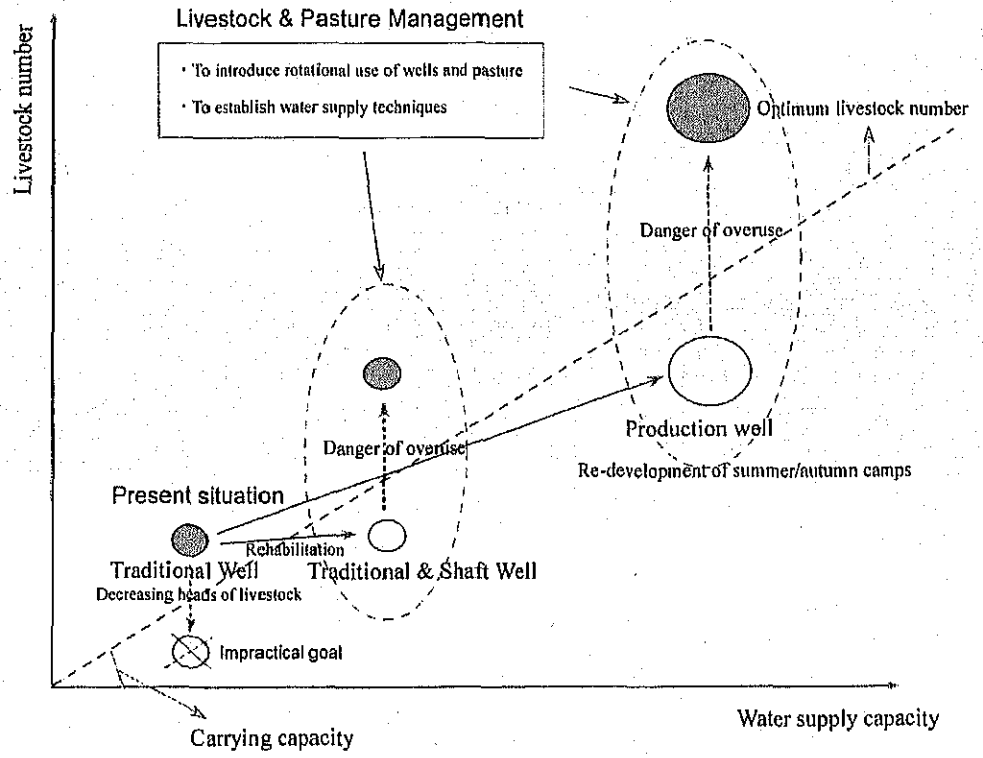


Fig.5.2.4 Relationship among Water Supplying Capacity, No. of Livestock and Carrying Capacity

As is the case of extremely low water supply of old Traditional Wells in present winter/spring camps, vegetative degradation around wells accelerates due to large number of livestock vying for water supply. Increasing water supply capacity contributes to

increasing livestock in number, but not to contribute improving carrying capacity around wells directly. Therefore, increasing water supply capacity implies the danger to cause overuse of pasture. But it is possible to alleviate this danger by improving water supplying and livestock management techniques. In this way, it is requested to take a balance of hard and soft development techniques because they are closely connected each other. Hence, it is important to establish pasture monitoring system as soft aspect, as well as development and enriching of water supply facilities as hard aspect in both for winter/spring camp and for unused and low used pasture.

(3) Need for Pasture Management Plan in Accordance with Well Development

Pasture management plan in accordance with well development is divided into two plans. One is Environmental development of winter/spring camp, and the other is development of unused and low used pasture. Narrative summary of each activity on aspects of hard and soft is shown in the next table.

Table 5.2.6 Improvement and Development of Water Sources and Pasture Management

| | Watering Facilities(Hard) | Pasture use(Soft) |
|---|---|---|
| Environmental development of winter/spring camp | Rehabilitation & construction of watering facilities in winter/spring camp (Feed water tank) | Improvement plan to alleviate concentration around Traditional Well (Well use rules) |
| Development of unused and low used pasture | Development of water facilities in unused and low used pasture for summer and autumn pasture (well, feed water tank, storage water tank) | Development of watering technique for Production Well, Shallow Well |

Respective activities for <Environmental development plan for winter/spring camp> and <Low use and unused pasture development plan> are summarized as follows:

Table 5.2.7 Two Plans: Watering Development Plan and Pasture Management

| | Environmental development of winter/spring camp | Development of unused and low used pasture |
|---|---|---|
| Output | • Improving watering capacity<br>• Improvement of watering techniques<br>• Development of facilities in winter/spring camp | • Expansion of seasonal migration pasture<br>• Improving watering capacity<br>• Improvement of watering techniques |
| Activities | • Rehabilitation of Traditional Well<br>• Rehabilitation and construction of Production Well etc.<br>• Development of facilities in winter/spring camp<br>• Introduction of scheduling of watering time and rotational use of well use<br>• Organization of herders group | • Rehabilitation and construction of Production Wells, etc.<br>• Improvement of watering facilities<br>• Organization of herder groups |

Activities for <Environmental development of winter/spring camp> include development of use of Traditional Wells, such as introduction of scheduling of watering time and rotational use of well use and making rules for herders, as well as rehabilitation of winter shelter and storage for fodder. But also include rehabilitation and construction of old Traditional Wells by co-work as easily started activities by herders relating to watering. Improving watering capacity will shorten time for watering and lead to heighten water efficiencies.

1) Plan for Environmental Development of Winter/Spring Camp

Activity items of herder groups, regional government, central government and donors are respectively summarized below.

Table5.2.8 Plan for Environmental Development of Winter/Spring Camp

| | Activity items | Activities for herders group | Activities for *Solum* government and *Aimag* government | Activities for government and donors |
|---|---|---|---|---|
| 1 | Rehabilitation of Traditional Well | · Supplying labor for rehabilitation of Traditional Well or Shaft Well | | · Supplying materials and trucks for rehabilitation of Traditional and Shaft Well |
| 2 | Rehabilitation and construction of Production Well etc. | · Formulating herders group Operating & Maintenance | · Organizing herders group | · Rehabilitation and construction of Production Well etc. |
| 3 | Introduction of scheduling of watering time and rotational use of well use | · Introduction and operation of well use rules (scheduling for watering) | · Managing of well use rules by herders | · Instruction of well use rules by herders |
| 4 | Development of facilities in winter/spring camp | · Rehabilitation of winter shelter | | |
| | | · Rehabilitation & construction of storage for fodder | | |

i) Rehabilitation and Construction of Traditional Well

For environmental development of winter/spring camp, Traditional Well is recommended to be constructed. Traditional Wells are the most common type of wells, which conventionally support the pastoral livestock system in Mongolia. Thus for infrastructure development and for operation and maintenance systems, herders will be asked to participate spontaneously and actively. It is also important from viewpoint of pasture use to grow tendency making Traditional Wells to improve water supply capacity.

ii) Rehabilitation and Construction of Production Wells, etc.

If water supply efficiency of Traditional Wells in winter/spring camp is less than 0.1 liter/s, average number of livestock to water per hour is as follows: less than 70 in summer～autumn, less than 120 in winter～spring, and less than 90 annually.

Table5.2.9 Water Supply Efficiency and Number of Livestock per Hour to Supply Water

| | Average Yield (l/s) | Number of livestock per hour (s.u.*) | | |
|---|---|---|---|---|
| | | Summer～Autumn | Winter～Spring | Average. |
| High | 0.5< | 360< | 600< | 450< |
| Middle | <0.1-0.5< | <70-360< | <120-600< | <90-450< |
| Low | <0.1 | <70 | <120 | <90 |

*s.u.=Sheep Unit: Carrying capacity per sheep

If water supply efficiency of Traditional Well in winter/spring camp is less than 0.1 liter/s, watering time will be as shown in the next table. In case of livestock number around 200～300 s.u., it takes at least 2.5 hours, 500～600 s.u. at least 5 hours, and 800～1,000 s.u. at least 8 hours.

Table5.2.10 Water Supply Efficiency and Required Time to Feed-Water per Livestock Number

| | Average Yield (*l*/s) | Number of livestock (s.u) | | |
|---|---|---|---|---|
| | | 200~300 | 500~600 | 800~1,000 |
| High | 0.5< | <0.5hour | <1hour | <2hour |
| Middle | <0.1-0.5< | <0.5~2.5hour< | <1~5hour< | <2~8hour< |
| Low | <0.1 | 2.5hour< | 5hour< | 8hour< |

Principally, rehabilitation and construction of Production Wells is the priority to develop unused and low used pasture. However, when using Traditional Wells with extremely low water supplying abilities as seen above, there is going to be degradation of pasture by surplus number of livestock staying around the well. In this case, it is strongly recommended to investigate to change water sources from Traditional Well to Production Well.

iii) To Introduce Rotational Utilization System for Traditional Well

In parallel with rehabilitation and construction of wells in winter/spring camp, it is required to improve methods of water supplying in present wells. In particular, water supply in Traditional Wells is significantly low (214 s.u./h, annual average), and it is difficult to supply water in a short time. Consequently, staying long time beside wells causes higher impact on pasture and degradation of vegetation by overuse. To avoid this situation as much as possible and to operate smoothly, it is important to build up a mechanism to have rotation among neighbor wells.

iv) To Develop Facilities in Winter/Spring Camp

In parallel with water source development and improvement of water feeding technology, it is important to rehabilitate facilities in winter/spring camp, such as winter shelter and storage for fodder.

2) Plan for Developing Unused and Low Used Pasture

Activity items of herders group, regional government, central government or donors are respectively summarized as follows.

Table 5.2.11 Development Plan in Unused and Low Used Pasture

| | Activity items | Activities for herders group | Activities for *Soum* government and *Aimag* government | Activities for government and donors |
|---|---|---|---|---|
| 1 | ・ Rehabilitation and construction of Production Wells, etc.<br>・ Improvement of watering facilities | ・ Supplying labor for rehabilitation & construction of Production Well<br>・ To attend seminars | ・ To design water tank, etc.<br>・ To give seminars | ・ To develop well<br>・ To instruct to design of water tank, etc. |
| 2 | ・ To organize herders group | ・ Organized operating and maintenance of wells by herders group | ・ To manage and coordinate herders group | ・ To instruct herders group |

Although use of ponds or lakes are important in summer/autumn camp, it depends on the large fluctuation of rainfall year by year and thus remains unstable with uncontrolled factors.

Well development plan mainly by developing Low Use and Unused Pasture is mentioned in section 5.2.3, Well Development Plan.

In relation with well development, the principle for pasture management plan in order to improve use of Production Well is as follows:

i) Installation of Production Well in Summer/Autumn Pasture and Facilitation of Seasonal Migration

It is ideal to use pasture through seasonal migration; however, it is not achieved since no water source in some summer / autumn pasture. Also, it is getting more difficult to conduct such migrations under present conditions because of increasing number of herder households and their livestock. In this plan, Production Wells are constructed for summer/autumn camps as the first step to reactivate seasonal migration operation, at least twice a year. Considering the difficulty of seasonal migration at present, it is unrealistic to construct wells at summer/autumn camps in remote sites. Therefore, it aims to increase the available areas for summer/autumn camps gradually from the pastures adjacent to winter/summer camps.

ii) Holding Seminars

It is essential to improve consciousness of herders group to use well and pasture systematically and by schedule. For this purpose, it is important to develop environmental thinking through seminars or workshops on pasture use and management for herders as well as for *Aimag* government, *Soum* government and *Bag* Governor. It is absolutely required to inform about the concept that there is a limit for carrying capacity around the well.

iii) Establishing Techniques for Livestock Management using Production Well

a. Pasture Monitoring System Using Production Well

Since the water supply efficiency of Production Well is high, it is possible to feed-water a large number of livestock at one time (900 sheep unit/hour on annual average). On the other hand, Production Well has a great danger to degrade the pasture by concentration of livestock exceeding the pump discharge capacity. Therefore, it is essential for *Soum* government to continuously conduct monitoring for carrying capacity around the well and performance rate of the Production Well.

b. Shape, Size and Allocation of Water Supply Facilities

Average design standard feed-water volume by type of livestock per day is shown in the following table.

Table 5.2.12 Design Standard Feed-Water Volume

| Kinds of Livestock | Water consumption for one livestock per one day (liter) | | |
|---|---|---|---|
| | Late spring ~Early autumn | Late autumn ~Early spring | Average |
| Camel | 55 | 40 | 48 |
| Horse | 40 | 30 | 35 |
| Cattle | 40 | 30 | 35 |
| Sheep | 5 | 3 | 4 |
| Goat | 5 | 3 | 4 |

Source: Ministry of Food and Agriculture

Average water yield by well type is shown below:

Table5.2.13 Yield of Well by Well Type

| | Average yield (*l*/s) | No. of livestock per hour (s.u.) | | |
|---|---|---|---|---|
| | | Summer~Autumn | Winter~Spring | Average. |
| Production Well | 3.273 | 2357 | 3928 | 2946 |
| Shallow Well | 0.775 | 558 | 930 | 698 |
| Shaft Well | 0.455 | 328 | 546 | 410 |
| Traditional Well | 0.238 | 171 | 286 | 214 |

Source: Institute of Geoecology

After changing from *Negdel* period to market-oriented economy, all the livestock including big and small ones are fed around one unit well. Land use around one well is much more complicated than before. Thus it is becoming difficult to predict and to plan to feed water uniformly and systematically. Utilizations of wells have an infinite variety. There are varieties in regions and in herder's uses even for the same type of wells. In this situation, water supply methods to livestock need to be more precise.

Lessening the wasted time for waiting around Production Well is one of the ways to conserve vegetative condition around wells. Therefore, it is important to seek efficient water supply methods. Two specific ways to establish techniques for livestock and pasture management in relation with water source development are as follows:

-1- To Improve Feed Water Tank

It is required to design feed - water tank according to herd size and allow the number of livestock to be supplied water in a short time for herders who have large number of livestock. Another concept is to allocate feed water tank in a radial pattern.

-2- To Set Up Water Storage Tank

From the standpoint of pasture management, the merits of setting up water storage tanks are as follows:

- It is possible to supply water right after livestock gather around the well.
- It is possible to compensate for a well's slow water supplying ability by reserving and not wasting time for livestock waiting around the well.
- It also makes it possible for women and children to supply water easily.

## 5.2.3 IMPLEMENTATION OF WELL DEVELOPMENT

(1) Purpose of Well Development

Well development in the area aims to achieve "improvement of water supply efficiency in using pasture" and "Expansion of usable pasture area in unused and low used pasture"; thus, the precondition for proper pasture utilization will be maintained.

The Action Plan of the Government of MONGOLIA for 2004-2008 states the objective as follows: *"Repair and renovate up to 1,900 wells and dig up to 800 wells of engineering design in the Gobi and steppe regions with the assistance of the state budget, domestic and foreign aid, loans and donations; encourage the participation of local citizens in digging new manually operated wells."*.

(2) Basic Policy

The well development plan has the following goals.

1) To Carry Out the Well Development Based on Herders Requests.

The herders' willingness to use wells is essential to achieve its sustainable operation and maintenance in pasture. Well utilization varies in livestock farming according to its type and environment. Hence, well development will be carried out based on the request of herders. On the other hand, *Soum* government has to consider balance of wells in their territory in executing development plans by risk management.

2) Introduction of Well Development Process combined with Pasture Management

Through well development, herders will be pulled into the pasture management system in the region. The necessary cooperation of herders on pasture management will be herder's obligation and included in the well use contract.

3) Building up the Operation and Maintenance System by Herders Has to Be Developed Concurrently with Well Construction Works.

Herder well maintenance activities should be started from the beginning of well utilization. Therefore, the formulation of well operation and maintenance has to be carried out concurrently with execution of well construction works.

- To organize herders group and introduce the well use contract to clarify the responsibility for well maintenance.
- Herders group should assist the well construction works to increase their recognition that it is their well.
- Introduce herder contribution to heighten herder's ownership for sustainable well operation and maintenance.
- It is for construction of wells, to establish group internal fund for operation and maintenance and to decide role allocation in the herder group, set as obligations for construction of wells, to establish group internal fund for its operation and to decide role definition in the herder group.

- To have *Soum* government support the system of herder's operation and maintenance of well.

4) Effective Use of Existing Unusable Wells

There are many unusable wells and their rehabilitation will be carried out as a priority since it is cheaper than new well construction. Moreover, when the well cannot be rehabilitated, a new well will be constructed next to the existing well based on its characteristics, since its success rate is better than construction in a new place.

5) Development of New Wells

Concurrently with the rehabilitation of existing wells, it is better to make new wells with high potential of water resources based on water resources investigation to use pasture without existing wells.

6) Effective Distribution of Wells

The pasture area 3 km from the well is to be used when well is constructed. (hereinafter this area is called stable water supply pasture (3 km Zone) ). In the rehabilitation / new construction plan of engineering wells such as Production Well, Shallow Well and Shaft Well, distribution of them is to be decided to broaden their stable water supply pasture (3 km Zone). Concretely, it is set as an index of well distribution, which the rehabilitated /new constructed wells in future have to be 6 km away from existing wells. It doesn't matter that the Traditional Well, spring and lake exist within 6 km zone in rehabilitated/new constructed wells because it will contribute to the improvement of present water supply efficiency and also ensure pasture utilization; this means that if there are other water sources, the pasture utilization can be continued even when the engineering well becomes broken.

7) Selection of Target Well from Economic Viewpoint

i) Rehabilitation

The wells with small yield have to be operated longer to obtain enough water. Due to that, introduction of pump and generator in such wells has no economic effect considering operation and running cost. In the Study, 0.6 *l*/s is set as regulation yield for well rehabilitation so that wells with less than 0.6 *l*/s are excluded as rehabilitation candidates. It is necessary to examine the introduction of a more convenient pumping system in combination with renewable energy such as solar or wind power for these wells.

ii) New Construction

New construction will be started from the site where water depth is expected to be shallow by water resources exploration. In this selection, water quality and well yield in the existing wells also should be considered.

(3) Implementation System

The implementation of well development should follow "General rules concerning rehabilitation/ new construction, the financing, possession and utilization of the engineering wells and the water source" issued in July, 2005.

For well development, the local government such as *Soum* government and agriculture agency in *Aimag* government should gather requests from herder groups. The works of well development is to be carried out by state budget or other donor's project.

Implementation system and role allotment in well development, pasture utilization management and operation and maintenance of well is shown in Fig.5.2.5.

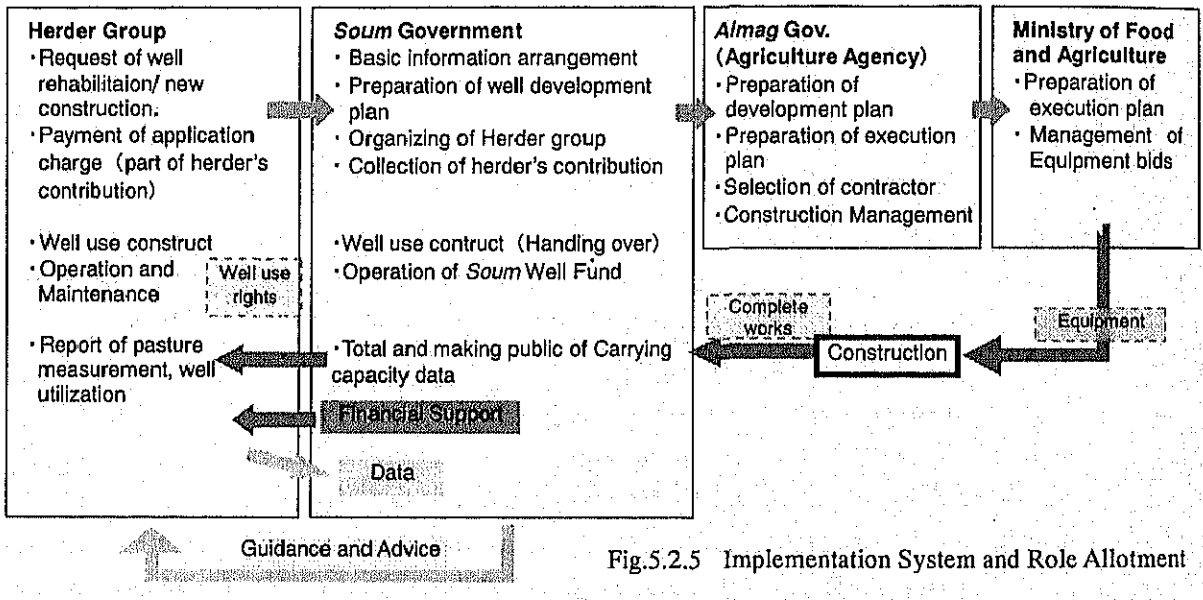


Fig.5.2.5 Implementation System and Role Allotment

Fig.5.2.6 shows the detail implementation schedule. 2 years is needed after the selection of wells from herder's request to hand over the well.

| Items | Participant (Responsible person) | 1st Year | | | | | | | | | | | | 2nd Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Organizing the herder group | *Soum* Gov. | → | | | | | | | | | | | | | | | | | | | | | | | |
| **First Contribution of Herder Group** | **Herder Group** | | ★(Application Charge) | | | | | | | | | | | | | | | | | | | | | | |
| Preparation of well development plan (listing) | Herder Group, *Soum* Gov. *Aimag* Gov. | | | | | | | | | | | | | | | | | | | | | | | | |
| Examination of validity of well maintenance plan | Project | | | | | | | | | | | | | | | | | | | | | | | | |
| Rehabilitation possibility survey/ geophysical survey | Project | | | | | | | | | | | | | | | | | | | | | | | | |
| Decide of object (construction/rehabilitation) well | *Soum* Gov., Project, *Aimag* Gov. | | | | | | | | | | | | | | | | | | | | | | | | |
| Equipment Procurment (Bit, Contract, Delively) | Project, MFA | | | | | | | | | | | | | | | | ☆(Deliverly) | | | | | | | | |
| Rehabilitation/Construction Bit | Project, *Aimag* Gov. | | | | | | | | | | | | | | | | | | | | | | | | |
| **Complete of Herder Contribution** | **Herder Group** | | | Saving (including cost for O & M fund) | | | | | | | | | | | | | ★ | | | | | | | | |
| Rehabilitation/Construction Works | Project | | | | | | | | | | | | | | | | | | | | | | | | |
| Well use contruct | *Soum* Gov., Herder Group, Project | | | | | | | | | | | | | | | | | | | | | | | | |

Fig.5.2.6 Detail of Well Development Execution

(4) Master Plan of Well Development

1) Target

Target development level of Master Plan is to be decided considering pasture condition of each *Aimag* and the risk to raise the water supply rate to 100% for the whole pasture area. The development level in each pasture class is set to be 90% in Steppe and Desert-Steppe area, and limited to 70% in Desert. As a result, the target of master plan in each *Aimag* in pasture area and carrying capacity become 67,007 km$^2$ and 2,629,000 heads (s.u.: sheep unit) in *Dundgobi*, 90,758 km$^2$ and 2,824,000 heads (s.u.) in *Dornogobi*, 129,185 km$^2$ and 2,724,000 heads (s.u.) in *Umnugobi*.

Below, the comparison is carried out between target in Master Plan and livestock number (converted into sheep unit) in present (2004) and before *Dzud* damage (1999). In *Dundgobi*, the present number is the same as Master Plan, but 1999's data exceeded it. Hence, the Master Plan's goal means only that the number of present livestock can be bred stably, and that it cannot reach the number in 1999. Therefore, the other kinds of development activities such as improvement of livestock quality should be considered in *Dundgobi*.

Table 5.2.14 Development Level in Pasture Class

| Pasture Class | Carrying Capacity | Development Level |
|---|---|---|
| Desert | 0~0.156 | 70 % |
| Desert-Steppe, Steppe | Over 0.156 | 90% |

Table 5.2.15 Target in Master Plan (1000 head s.u.)

| | | *Dundgobi* | *Dornogobi* | *Umnugobi* |
|---|---|---|---|---|
| Target | Area (km$^2$) | 67,007 | 90,758 | 129,185 |
| | Carrying Capacity (1000 s.u) | 2,629 | 2,824 | 2,724 |
| Livestock at Present (2004) | | 2,642 | 1,836 | 1,664 |
| (Ratio of Target to 2004) | | 100% | 65% | 61% |
| Livestock before Present (1999) | | 3,859 | 2,328 | 2,706 |
| (Ratio of Target to 1999) | | 147% | 82% | 99% |

2) Number of Wells in Master Plan

"The development area" is assumed to be the part of remainder by which the present stable water supply pastures is excluded from the target area. The necessary number of wells for the development area is assumed as planning number in master plan.

i) Present Status of Pasture Utilization and Well Development

The area and carrying capacity in stable water supply pasture (3 km Zone) and stable water supply pasture (5 km Zone) are calculated for present well distribution.

Table 5.2.16 Present State of Pasture Utilization

| | | Area ($km^2$) | | | Carrying Capacity (1000s.u.) | | |
|---|---|---|---|---|---|---|---|
| | | *Dundgobi* | *Dornogobi* | *Umnugobi* | *Dundgobi* | *Dornogobi* | *Umnugobi* |
| Target Goal | | 67,007 | 90,758 | 129,185 | 2,629 | 2,824 | 2,724 |
| Stable water supply pasture (3km Zone) | | 44,967 | 47,401 | 63,980 | 1,778 | 1,293 | 1,286 |
| Stable water supply pasture (3-5km Zone) | | 17,891 | 31,287 | 36,065 | 369 | 517 | 495 |
| Stable water supply pasture (5km Zone) | | 62,858 | 78,688 | 106,771 | 2,148 | 1,810 | 1,780 |
| No. of Water Source | Production Wells | 70 | 134 | 85 | - | - | - |
| | Shallow Wells | 21 | 12 | 109 | - | - | - |
| | Shaft Wells(with Pump) | - | 56 | - | - | - | - |
| | Shaft Wells(Hand-drawing) | 1,219 | 1,102 | 676 | - | - | - |
| | Traditional Wells | 1,497 | 1,380 | 2,002 | - | - | - |
| | Spring | 143 | 135 | 506 | - | - | - |
| | Lake | 503 | 8 | 530 | - | - | - |
| | Sub Total | 3,453 | 2,827 | 3,908 | - | - | - |
| Part of Stable water supply pasture (3km Zone) by 1 water source | | 13 | 17 | 16 | 0.515 | 0.457 | 0.329 |
| Stable water supply pasture (3km Zone) for 1 water source | | 18 | 28 | 27 | 0.622 | 0.640 | 0.456 |

* For calculation of the present situation, the following conditions were adopted for GIS data

| | *Dundgobi* | *Dornogobi* | *Umnugobi* |
|---|---|---|---|
| Production Well | Recorded as used | Recorded as used | Recorded as used |
| Shallow Well | Recorded as used | Recorded as used | Recorded as used |
| Shaft Well | The condition is not clear. All wells are set as hand - drawing well. | The wells rehabilitated since 1998 are set as pump drawing well. | The condition is not clear. All wells are set as hand - drawing well. |
| Traditional Well | | The unused 60 wells in *Erdene*, *Ulaanbadrakh*, *Khuvsgul* confirmed in Pilot Study is excluded. | |

ii) Development Area (Area will be Stable Water Supply Pasture by the Plan)

"The development area" is assumed that the part of remainder by which the stable water supply pastures (3 km Zone) calculated is excluded from the whole developed area set as target goal. They are 22,040 $km^2$ in *Dundgobi*, 43,357 $km^2$ in *Dornogobi*, and 65,205$km^2$ in *Umnugobi*. Moreover, the necessary development in carrying capacity is 851,000 heads (s.u.) in *Dundgobi*, 1,531,000 heads (s.u.) in *Dornogobi*, 1,438,00 heads (s.u) in *Umnugobi*, calculated with stable water supply pasture (3 km Zone) and Master plan's goal.

Table5.2.17 Potential Pasture Area and Carrying Capacity

| | Area ($km^2$) | | | Carrying Capacity (1000 s.u.) | | |
|---|---|---|---|---|---|---|
| | *Dundgobi* | *Dornogobi* | *Umnugobi* | *Dundgobi* | *Dornogobi* | *Umnugobi* |
| 3km Zone | 22,040 | 43,357 | 65,205 | 851 | 1,531 | 1,438 |
| 5km Zone | 4,149 | 12,070 | 22,414 | 481 | 1,014 | 944 |

iii) Number of Wells in Master plan

Based on the overlapping of stable water supply pasture by each well in exiting condition, average increased area of stable water supply pasture (3 km Zone) per well and one (5 km Zone) are used in the calculation.

Total necessary number of wells in 3 *Aimags* is 8,261 calculated on the assumption that target area should be covered with stable water supply pasture (3 km Zone), and 1,482 wells with stable water supply pasture (5 km Zone).

The total number of water sources, present number of water sources and required number of wells, is 3,681 in *Dundgobi*, 3,261 in *Dornogobi*, 4,728 in *Umnugobi*, when it consider with stable water supply pasture 3 km Zone.

Table5.2.18 Necessary and Total Number of Wells in Master Plan

| | | *Dundgobi* | *Dornogobi* | *Umnugobi* | Total |
|---|---|---|---|---|---|
| Necessary Number | with stable water supply pasture (3 km Zone) | 1,692 | 2,568 | 3,989 | 8,261 |
| | with stable water supply pasture (5 km Zone) | 228 | 434 | 820 | 1,482 |
| Total Number | with stable water supply pasture (5 km Zone) | 3,681 | 3,261 | 4,728 | 11,670 |
| | with stable water supply pasture (3 km Zone) | 5,145 | 5,413 | 7,891 | 18,449 |

(5) First Well Development Plan

It will take a long time to complete the above Master Plan. However, the first step of implementation should be rehabilitation or alternative new construction of existing wells and new construction based on the existing results of geophysical exploration. The first well development plan is settled based on such information.

1) Number of Wells

i) Basic Policy in First Well Development Plan

a. Exclusion of Double Count

When a well can produce enough yields, it doesn't make sense to put 2 wells in 1 place to increase water supply efficiency for livestock. Therefore, when there are 2 candidate wells for rehabilitation or new construction adjoining within 6 km, the better one should be selected in the plan based on data of their yield, water level, constructed year, and type of works (rehabilitation or construction).

b. Required Yield for Pump Setting

Economic efficiency is not good in the well with poor yield since the generator has to be operated a long time to obtain enough water. Therefore, the standard yield for setting a pump on a well is determined as 0.6 *l*/s which is slightly faster than hand drawing with bucket.

In Shaft Wells, the pump will be set for wells with 0.6 *l*/s or more yield and the rest will use hand drawing, the as same as present. Moreover, Shallow Wells with less than 0.6 *l*/s yield are to be excluded in the plan.

c. Future Number of Wells

The working life of Shaft Well and Tradition Well are said to be short. Hence, decreasing these types of wells is considered in the plan.

ii) New Construction and Rehabilitation Feasibility by Well Type

Basic policies of new construction and rehabilitation by well type are summarized as follows:

| Well Type | Basic Policy |
|---|---|
| Production Well | Rehabilitation has the priority for new construction. New wells will be constructed on the unused and low used pasture when necessary or near the same location when the existing well cannot be rehabilitated. |
| Shallow Well | Only the wells with high feasibility are to be rehabilitated. New wells will be constructed on the unused and low used pasture when necessary, or near the same location when the existing well cannot be rehabilitated or is abandoned Shaft Well. |
| Shaft Well | These will be rehabilitated through installing a power pump for improvement of water supply to pastures and promotion of the well utilization.<br>It cannot be newly constructed. Thus abandoned Shaft Well will be replaced as Traditional Well when its water level is shallow and as Shallow Well when it is deep but has high yield capacity. |
| Traditional Well | These will be constructed or rehabilitated by herders to maintain the present distribution. The administration will support it. |

a. Production Well

The share of repairable Production Well was about 53% in 3 Pilot Study *Soum* and their success rate of rehabilitation was 90%. Thus, it is expected that half of existing non-operating wells can rehabilitated.

Table 5.2.19 Operation Rate of Production Well in 3 *Soums* in Pilot Study Area

| Name of *Soum* | No. of Wells | Used Well | Unusable Well | Feasibly Rehabilitated Well | |
|---|---|---|---|---|---|
| | | | | No. of Wells | Rate |
| *Erdene* | 21 | 5 | 16 | 5 | 0.31 |
| *Ulaanbadrakh* | 21 | 4 | 17 | 10 | 0.59 |
| *Khuvsgul* | 23 | 1 | 22 | 14 | 0.64 |
| Total | 65 | 10 | 55 | 29 | 0.53 |

(Source: JICA Study 2003)

The share of repairable Production Well among non-operating ones is 56% in *Dundgobi* and 51% in *Umnugobi* in the database. Thus, these wells are assumed to be candidates for rehabilitation and other non-operating wells will be replaced by new construction.

In *Dornogobi*, well database was revised by agriculture agency in *Aimag* government and number of wells evaluated as uncertain condition became more than 70%. Thus, they are set as rehabilitation candidates provided that the wells be evaluated as feasibly rehabilitated and uncertain condition wells, but constructed after 1984.

Table5.2.20 Number of Production Wells in the Plan

| | *Dundgobi* | *Dornogobi* | *Umnugobi* |
|---|---|---|---|
| Rehabilitation | 117 | 74 | 117 |
| New Construction | 93 | 66 | 114 |

b. Shallow Wells

Only the wells with high feasibility are to be rehabilitated since the share of feasibly rehabilitated Shallow Well is low.

The share of feasibly rehabilitated Shallow Well in non-operated ones was about 35% in the results of well inventory survey in *Dornogobi*. Based on the success

rate of rehabilitation in Production Well, the share of feasibly rehabilitated Shallow Well is set as 30%.

Table 5.2.21 Availability of the Casing Mounted with Unused Shallow Well

| Casing Pipe | *Erdene* | *Ulaanbadrakh* | *Khuvsgul* | Total |
|---|---|---|---|---|
| Usable | 1 | 0 | 8 | 9 |
| Not Usable | 1 | 0 | 4 | 5 |
| Total | 2 | 0 | 12 | 14 |

(Source: JICA Study 2003)

The share of feasibly rehabilitated Shallow Well among non-operating ones is as high as 72% in *Dundgobi* and 44% in *Umnugobi* in the database, but its evaluation is felt to be doubtful by Pilot Study experience. Thus its evaluation is changed from old well in feasibly rehabilitated to needs new construction and so the share of rehabilitation wells reaches 30%.

Uncertain condition wells where changed into need new construction in *Dornogobi*, because the share of feasible rehabilitated well is as low as 15%. Some uncertain condition wells were classed into feasible rehabilitated.

Table 5.2.22 Number of Shallow Wells in the Plan

| | *Dundgobi* | *Dornogobi* | *Umnugobi* |
|---|---|---|---|
| Working | 21 | 2 | 109 |
| Rehabilitation | 52 | 27 | 84 |
| New Construction | 121 | 58 | 195 |

c. Shaft Wells

-1- Selection of Wells to be Rehabilitated

Rehabilitation means pump installation in the Shaft Well.

There are 2 purposes in Shaft Well rehabilitation. One is to decrease the workload and make water-supplying times shorter on the wells with low water level. The other is to improve the water supply efficiency on the wells with high yield. Therefore, the pump will be installed on the well whose statistic water level is deeper than 6 m or its yield is more than 0.6 *l*/s.

Table 5.2.23 Purpose of Rehabilitation by Shaft Well Type

| Evaluation of Rehabilitation | Yield Q≧0.6*l*/s | Water level ≦6m | Rehabilitation |
|---|---|---|---|
| ○ | ○ | ○ | Rehabilitation for decreasing the workload of hand-drawing |
| ○ | × | ○ | Rehabilitation for decreasing the workload of hand-drawing |
| ○ | ○ | × | Rehabilitation for improving water supply |
| × | × | × | Use as hand-drawn well |

-2- Deceasing the Number of Shaft Well and Alternative Construction

According to the well inventory survey in *Dornogobi*, there are 1,210 Shaft Wells in total, of which 428 are unused. Moreover, the casing is unavailable in 234 wells (about half) and it is evaluated as impossible to be rehabilitated.

Thus, it is assumed that number of Shaft Wells will be decreasing since Shaft Wells constructed in 1960's will be abandoned in next 10 years, but that alternative wells for these abandoned wells will be constructed. Traditional Wells will be constructed when water level is shallower than 6 m and Shallow Wells will be selected when yield is more than 0.6 *l*/s. These Traditional Wells will be deeper than other ones so that the administration should positively take part in its construction to advance it.

-3- Number of Wells

According to the above two concepts, the plan of pump installing and alternative well construction (the rehabilitation and new construction plan) is prepared. Based on the distribution in Production Wells and Shallow Wells plan, the rehabilitation and alternative new construction wells are to be decided so that their stable water supply pasture (3km Zone) does not overlap.

Table 5.2.24 Number of Shaft Wells in the Plan

| | | *Dundgobi* | *Dornogobi* | *Umnugobi* |
|---|---|---|---|---|
| Present number | Operating | 1219 | 393 | 158 |
| | Possible to be rehabilitated | 51 | 679 | 518 |
| | Unusable | 227 | 77 | 217 |
| | Rehabilitated | - | 56 | - |
| Abandoned in next 10 year (Constructed in 60's) | | 237 | 231 | 217 |
| Number in Plan | Pump Setting | 201 | 227 | 111 |
| | Hand-drawing | 889 | 652 | 408 |
| | Construction of New Shallow Well | 64 | 45 | 24 |
| | Construction of New Traditional Well | 140 | 17 | 97 |

d. Traditional Wells

In the plan, the rehabilitation of Traditional Well means the large scale works such as digging the foundation rocks out. Thus there is basically no difference in the workload from new construction.

It is said that the working life of Traditional Wells is about 20 to 30 years and also its rehabilitation is required frequently from flood damage, etc. Therefore, it is assumed that 5 Traditional Wells need such care in each *Soum* in 1 year, and that half of them are to be rehabilitated and the remaining half are to be new.

Table 5.2.25 Number of Traditional Wells in the Plan

| | *Dundgobi* | *Dornogobi* | *Umnugobi* |
|---|---|---|---|
| Rehabilitation | 375 | 300 | 350 |
| New Construction | 375 | 300 | 350 |

e. New Drilling Wells

In this plan, new wells will be constructed in the place where it has good possibility based on the results of geophysical exploration carried out in the Study or by Ministry of Food and Agriculture. The Traditional Wells will be constructed where the expected depth is shallower than 6 m. Shallow Well will be selected when the depth is shallower than 40 m, and Production Wells in deeper places.

The implementation of new drilling works is expected after the rehabilitation and alternative new construction described in items i) to iv). Thus its distribution was decided based on the above plan.

Table5.2.26 Number of New Drilled Wells in the Plan

| | *Dundgobi* | *Dornogobi* | *Umnugobi* |
|---|---|---|---|
| Production Well | 0 | 72 | 16 |
| Shallow Well | 78 | 32 | 72 |
| Traditional Well | 30 | 7 | 1 |

f. Total Number of Wells in Plan

Total number of wells by well type is summarized in the table below.

Table 5.2.27 Total Number of Wells by Well Type in the Plan

| | Well Type | Total Number | Of which | | | | |
|---|---|---|---|---|---|---|---|
| | | | Production Well | Shallow Well | Shaft Well | Traditional Well | New Drilling Well |
| *Dundgobi* | New Construction | | | | | | |
| | Production Well | 93 | 93 | | | | 0 |
| | Shallow Well | 263 | | 121 | 64 | | 78 |
| | Traditional Well | 543 | | | 138 | 375 | 30 |
| | Rehabilitation | | | | | | |
| | Production Well | 117 | 117 | | | | |
| | Shallow Well | 52 | | 52 | | | |
| | Shaft Well (with Pump) | 201 | | | 201 | | |
| | Traditional Well | 375 | | | | 375 | |
| *Dornogobi* | New Construction | | | | | | |
| | Production Well | 144 | 73 | | | | 71 |
| | Shallow Well | 132 | | 58 | 43 | | 31 |
| | Traditional Well | 323 | | | 16 | 300 | 7 |
| | Rehabilitation | | | | | | |
| | Production Well | 66 | 66 | | | | |
| | Shallow Well | 26 | | 26 | | | |
| | Shaft Well (with Pump) | 219 | | | 219 | | |
| | Traditional Well | 300 | | | | 300 | |
| *Umnugobi* | New Construction | | | | | | |
| | Production Well | 114 | 104 | | | | 10 |
| | Shallow Well | 260 | | 171 | 23 | | 66 |
| | Traditional Well | 435 | | | 84 | 350 | 1 |
| | Rehabilitation | | | | | | |
| | Production Well | 103 | 103 | | | | |
| | Shallow Well | 71 | | 71 | | | |
| | Shaft Wells(with Pump) | 93 | | | 93 | | |
| | Traditional Well | 350 | | | | 350 | |

2) Water Supply Pasture Area and Carrying Capacity

The carrying capacity of the water supply pasture area after completion of the first well development plan is calculated according to the assumptions and measures described in section 5.2.1.

As a result, the share of stable water supply pasture (3 km Zone) after first well development by the Master Plan is 75% in *Dundgobi*, 57% in *Dornogobi* and 55% in *Umnugobi*. Moreover, the share of stable water supply pasture (5 km Zone) is 100% in *Dundgobi*, 94% in *Dornogobi* and 90% in *Umnugobi*. Thus the target is almost achieved.

However, in carrying capacity, the share of stable water supply pasture (5 km Zone) becomes only 87% in *Dundgobi*, 72% in *Dornogobi* and 74% in *Umnugobi*. And so, well development contributes to increase of water supply.

Table 5.2.28 Summary of First Well Development Plan

| | | Area(km2) | | | Carrying Capacity (1000 s.u.) | | |
|---|---|---|---|---|---|---|---|
| | | *Dundgobi* | *Dornogobi* | *Umnugobi* | *Dundgobi* | *Dornogobi* | *Umnugobi* |
| Master Plan | | 67,007 | 90,758 | 129,185 | 2,629 | 2,824 | 2,724 |
| Present Condition | Stable water supply pasture (3km Zone) | 44,967 | 47,401 | 63,980 | 1,778 | 1,293 | 1,286 |
| | Stable water supply pasture (3-5km Zone) | 17,891 | 31,287 | 36,065 | 369 | 517 | 495 |
| | Stable water supply pasture (5km Zone) | 62,858 | 78,688 | 106,771 | 2,148 | 1,810 | 1,780 |
| | | | | | | | |
| After First Well Development Plan | Stable water supply pasture (3km Zone) | 50,080 | 51,492 | 71,660 | 1,946 | 1,459 | 1,489 |
| | Stable water supply pasture (3-5km Zone) | 16,726 | 33,818 | 44,424 | 353 | 586 | 535 |
| | Stable water supply pasture (5km Zone) | 66,805 | 85,310 | 116,084 | 2,299 | 2,045 | 2,024 |
| Share of After First well development plan in Master Plan | Stable water supply pasture (3km Zone) | 0.75 | 0.57 | 0.55 | 0.74 | 0.52 | 0.55 |
| | Stable water supply pasture (5km Zone) | 1.00 | 0.94 | 0.90 | 0.87 | 0.72 | 0.74 |
| No. of Water Source | Production Wells | 280 | 344 | 302 | | | |
| | Shallow Wells | 336 | 170 | 440 | | | |
| | Shaft Wells (Pump) | 201 | 275 | 93 | | | |
| | Shaft Wells (Hand) | 889 | 642 | 349 | | | |
| | Traditional Wells | 1,665 | 1,398 | 2,087 | | | |
| | Spring | 143 | 135 | 506 | | | |
| | Lake | 503 | 8 | 530 | | | |
| | Sub-Total | 4,017 | 2,972 | 4,307 | | | |
| Stable water supply pasture (3km Zone) for 1 water source | | 12 | 17 | 17 | 0.484 | 0.491 | 0.346 |
| Stable water supply pasture (5km Zone) for 1 water source | | 17 | 29 | 27 | 0.572 | 0.688 | 0.470 |
| Increasing by First well Development Plan | Stable water supply pasture (3km Zone) | 5,113 | 4,091 | 7,680 | 168 | 167 | 203 |
| | Stable water supply pasture (5km Zone) | 3,947 | 6,622 | 9,313 | 151 | 236 | 244 |
| Remaining development area after First Well Development Plan (without in Area (3km Zone) ) | | 16,927 | 39,266 | 57,525 | 683 | 1,365 | 1,235 |
| Remaining development area after First Well Development Plan (without in Area (5km Zone) ) | | 202 | 5,448 | 13,101 | 330 | 779 | 700 |
| Required Number of well (cover by stable water supply pasture (3km Zone) | | 1,358 | 2,266 | 3,457 | | | |
| Required Number of well (cover by stable water supply pasture 5km Zone) | | 12 | 190 | 486 | | | |

Moreover, the present number of livestock can be feeding stably after completing the first well development plan in *Dornogobi* and *Umnugobi* when (5 km Zone) is used in the calculation. However, the present number in *Dundgobi* exceeds the Carrying Capacity in the First Plan.

Table 5.2.29 Comparison with Present Livestock Number

| | *Dundgobi* | *Dornogobi* | *Umnugobi* |
|---|---|---|---|
| Present Livestock Number (Year 2004) (1000 .s.u) | 2,642 | 1,836 | 1,664 |
| Share of present number to results of First Well Development Plan | 115% | 90% | 82% |

3) Relation with Master Plan

The stable water supply pasture area and carrying capacity are compared by present state, First Well Development Plan, Master Plan. In the results, both pasture area and carrying capacity increase from the present state to the first well development plan, and then Master Plan.

The share of Master Plan to whole *Aimag* area is 90% in *Dundgobi*, 83% in *Dornogobi*, 78% in *Umnugobi*.

Table 5.2.30 Comparison with Whole Area and its Carrying Capacity

| | | Water Supply Pasture ($km^2$) | | | Carrying Capacity (1000 heads s.u.) | | |
|---|---|---|---|---|---|---|---|
| | | *Dundgobi* | *Dornogobi* | *Umnugobi* | *Dundgobi* | *Dornogobi* | *Umnugobi* |
| Stable Water Supply Pasture and Carrying Capacity | Present State | 62,858 | 78,688 | 106,771 | 2,148 | 1,810 | 1,780 |
| | First Well Development Plan | 66,805 | 85,310 | 116,084 | 2,299 | 2,061 | 2,074 |
| | Master Plan | 67,007 | 90,758 | 129,185 | 2,629 | 2,824 | 2,724 |
| The Share of each Condition to Whole Area | Present State | 84% | 72% | 65% | 66% | 42% | 46% |
| | First Well Development Plan | 89% | 78% | 70% | 71% | 48% | 54% |
| | Master Plan | 90% | 83% | 78% | 81% | 65% | 71% |

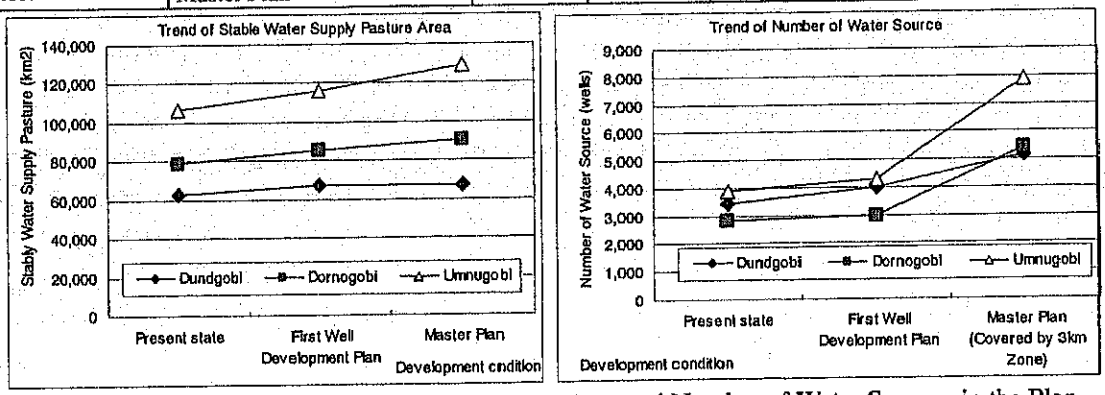


Fig.5.2.7 Trend of Stable Water Supplied Pasture Area and Number of Water Sources in the Plan

(6) Calculation of Construction Cost

1) Standard Specification

Average number of livestock in a herd is assumed to be about 500, and it is used in examination of the specification of the Engineering well. 2.5 tons of water is needed for 500 livestock animals and it takes about 40 minutes to supply it when pump capacity is 1.0*l*/s. Thus this pump capacity can be set as standard specification because within 1 hour it has an appropriate numerical value. Moreover, standard capacity of the water storage tank is 2.5 tons so that 1 herd can be fed water.

However, it is necessary to examine the strategy to lower waste time for livestock waiting around the well such as the installation of one more feed water tanks or large storage tank, etc. for the herder group that has a large scale of livestock and require high water supplying capacity.

In the plan, the intention of each herder group as user should be used to make well facilities specification, because cost sharing is required of the herders. Thus, the specification of each well should be decided according to their request and by confirming their willingness to pay for the increased rehabilitation cost.

i) Production Wells and Shallow Wells

Production Wells and Shallow Wells are classified as "Tube Wells" although there are differences in well depth and its yield. In the Socialist period, there were differences between them: for example, a pump house was built only on the Production Well since it had mounted pumps. However, these wells will not be distinguished in the plan.

Table 5.2.31 Standard Specification of Production Well and Shallow Well

| | Specification | Note |
|---|---|---|
| Pump | Submergible pump with a capacity of 1.0 *l*/ sec. | Consider the difficulty in repair in local area, the quality assured products will be selected |
| Generator | It should have enough generating capacity about 2 to 2.5 times the required capacity of pump. | Selection of the product is depending on the availability of diesel in *Soum*.<br>It is better to install same types one in *Soum* from the viewpoint of operation and maintenance. |
| Feed Water Tank | 9m longer,<br>it is made by cement and blocks or Iron | It should be examined to put larger or one more feed water tank according with pump capacity and storage tank capacity when number of livestock is large. |
| Water Storage Tank | 2.5$m^3$ capacity | About 3-4 $m^3$ capacity large-scale tank installation is examined on the well which has high capacity, a large scale of livestock is gathered in summer, the well has many users and the workload of operator is quite high. |
| Pump House | It is needed to protect the facilities and to improve well utilization. | When Protection Box is constructed in the change, it is assumed the structure takes the generator easily and the exhaust of generator will not go inside to be the cause of breakdown. |

ii) Shaft Wells

Table 5.2.32 Standard Specification of Shaft Wells

| | Specification | Note |
|---|---|---|
| Pump | Drainage pump | Pump and a feed-water tank are connected each other with a flexible hose for preventing freezing of remaining water within it in winter. |
| Generator | It should have enough generating capacity about 2 to 2.5 times the required capacity of pump. | Selection of the product depends on the availability of diesel fuel in *Soum*.<br>It is better to install only one type in one *Soum* from the viewpoint of operation and maintenance. |
| Feed Water Tank | 7m longer. It is made by cement and blocks or Iron | |
| Water Storage Tank | No need due to small capacity of well | |
| Protection Box | It will be constructed to cover the well by blocks etc. | It is assumed the structure takes the generator easily and the exhaust of generator will not go inside to be the cause of breakdown.<br>The adjustment with surrounding herders is important since the well is covered by it. |

iii) Traditional Wells

6 m depth is recommended even though average depth in recently constructed Traditional Wells is only 3 m. The structure is stone masonry and wooden cover is set in the top.

The feed water tank is expected to be only 4 m long based on water supplying capacity by hand-drawing.

It will be mainly constructed / rehabilitated by herders. However, it is important to provide training since *Soum* government or *Bag* governor has to support its construction positively and establish the cooperative relationships.

2) Cost Calculation

i) Construction Cost

The unit construction cost is calculated based on the experience in Pilot Study. The cost includes the construction cost of pump house, feed water tank and water storage tank.

Note 1) The construction cost for Production Wells and Shallow Wells requires 10% additional from the average construction cost in pilot study, and USD 2,000 for pump house and USD 500 for both tanks are also included.

Note 2) In the cost of Traditional Well, it is assumed that it will be made by herders.

ii) Equipment Cost

The equipment cost is also calculated according to the water level based on the experience in Pilot Study.

iii) Total Rehabilitation or New Construction Cost

Total Rehabilitation or new construction cost is the sum of construction cost and equipment cost.

Table 5.2.33 Total Rehabilitation or New Construction Cost for one Well (USD)

| New Construction | Total Cost | Construction Cost | Assumed Depth | Equipment Cost | Assumed Depth |
|---|---|---|---|---|---|
| Production Wells | 12,720 | 11,160 | H=100m | 1,560 | W.L.=40m |
| Shallow Wells | 9,130 | 7,900 | H=20m | 1,230 | W.L.=20m |
| Traditional Wells | 200 | 200 | | | |

| Rehabilitation | Total Cost | Construction Cost | Assumed Depth | Equipment Cost | Assumed Depth |
|---|---|---|---|---|---|
| Production Wells | 7,280 | 5,720 | H=100m | 1,560 | W.L.=40m |
| Shallow Wells | 5,840 | 4,610 | H=20m | 1,230 | W.L.=20m |
| Shaft Wells (Pump set) | 3,580 | 2,500 | - | 1,080 | - |
| Traditional Wells | 200 | 200 | | | |

Note) It is assumed that the well depth is 100 m and water level is 40 m for Production Well, and that the well depth is 40 m and water level is 20 m for Shallow Well.

iv) Cost Calculation

The total cost is calculated using the above unit costs. Total cost of first well development plan is USD 5,569,000 in *Dundgobi*, USD 4,518,000 in *Dornogobi*, USD 5,409,000 in *Umnugobi*.

Table 5.2.34 Total Cost of First Well Development Plan (USD)

| *Aimag* | Type of works | Amount | Unit Cost | Total in each type of works | Subtotal | Total |
|---|---|---|---|---|---|---|
| *Dundgobi* | New Construction | | | | | |
| | Production Well | 93 | 12,720 | 1,183,000 | 3,693,000 | 5,569,000 |
| | Shallow Well | 263 | 9,130 | 2,401,000 | | |
| | Traditional Well | 543 | 200 | 109,000 | | |
| | Rehabilitation | | | | | |
| | Production Well | 117 | 7,280 | 852,000 | 1,876,000 | |
| | Shallow Well | 52 | 5,840 | 304,000 | | |
| | Shaft Well (with Pump) | 201 | 3,580 | 720,000 | | |
| | Traditional Well | 375 | 200 | 75,000 | | |
| *Dornogobi* | New Construction | | | | | |
| | Production Well | 144 | 12,720 | 1,832,000 | 3,102,000 | 4,518,000 |
| | Shallow Well | 132 | 9,130 | 1,205,000 | | |
| | Traditional Well | 323 | 200 | 65,000 | | |
| | Rehabilitation | | | | | |
| | Production Well | 66 | 7,280 | 480,000 | 1,416,000 | |
| | Shallow Well | 26 | 5,840 | 152,000 | | |
| | Shaft Well (with Pump) | 219 | 3,580 | 784,000 | | |
| | Traditional Well | 300 | 200 | 60,000 | | |
| *Umnugobi* | New Construction | | | | | |
| | Production Well | 114 | 12,720 | 1,450,000 | 3,911,000 | 5,409,000 |
| | Shallow Well | 260 | 9,130 | 2,374,000 | | |
| | Traditional Well | 435 | 200 | 87,000 | | |
| | Rehabilitation | | | | | |
| | Production Well | 103 | 7,280 | 750,000 | 1,498,000 | |
| | Shallow Well | 71 | 5,840 | 415,000 | | |
| | Shaft Well (with Pump) | 93 | 3,580 | 333,000 | | |
| | Traditional Well | 350 | 200 | 70,000 | | |

v) Equipment for Traditional Well Construction

The Traditional Well should be developed by herder's own activities. However, it will not reach the required level voluntarily, but rather it is only increasing by positive participation by *Bag* governor and *Soum* government. Thus, the system requires the continuous support of the *Soum* government. Because the shortage of Traditional Wells may be recognized as a problem in the region, herders may also look for a solution.

Table 5.2.35 Total Cost

| | *Dundgobi* | *Dornogobi* | *Umnugobi* |
|---|---|---|---|
| Number of *Soums* | 16 | 14 | 14 |
| Number of Pumps | 48 | 42 | 42 |
| Unit Price (USD) | 400 | 400 | 400 |
| Sub Total (USD) | 19,200 | 16,800 | 16,800 |
| Grand Total (USD) | | 52,800 | |

The supporting system will be set up so that 3 drainage pumps are placed in each *Soum* and they will be lent to herders at a convenient cost. The equipment will be managed with *Soum* well funds described later by *Soum* government, and the *Aimag* government will monitor their activities.

(7) Examination of Economic Efficiency

Improvement of water supplying condition is necessary to mitigate the overgrazing problem for stabilizing livestock farming and to improve it by the development in unused and low used pasture. However, it is essential that the well has to be maintained continuously by users themselves. The comparison with necessary operation and maintenance cost and the benefit of well was carried out with the following assumptions to make clear the conditions by which herders can feel its benefits and maintain the well continuously.

1) Prerequisite Conditions

i) Model Herders Group

The condition of herder group to examine is assumed as below.

The model group is 2 *Khot Ailes* consisting of 5 families, breeding 2,000 livestock in sheep units in total now. They will start to use one engineering well to stabilize their livestock farming.

ii) Number of livestock

Only 2,000 livestock (in sheep units) can be bred before project (with our Project Case) with limit in carrying capacity. It will be increased until 2,500 (with Project Case) due to increasing of water supply efficiency by Engineering well (water supply efficiency is changed from 0.8 in Traditional Well to 1.0 in Engineering well).

Annual growth rate of livestock is set as 30% based on the actual trend from 1994 till 2002. Moreover, 100 livestock are consumed as their food and the livestock over the carrying capacity limitation is sold. However, herders sold only limited livestock in the beginning of the Project since they focused on the goal to increase livestock.

iii) Benefit by Installation of Engineering Wells

Benefit of installation of Engineering wells is: 1) to increase the number of livestock by developing the unused pasture, 2) to stabilize water supply for the livestock, 3) to increase weight of livestock (reduction of water supplying time links to increase of feeding time), 4) to reduce labor of supplying water for livestock (surplus time to be distributed to the other useful works), and 5) overall to reduce the risk of livestock farming. The study shall be focused on the countable effects of increasing number and weight of livestock among these.

Concretely, benefit consists from the sales income of livestock products and livestock itself. The composition ratio of each type of livestock and actual sales price in *Soum* in *Dornogobi Aimag* in 2003 is used in the calculation.

Table5.2.36 Conversion of Actual Number of Animal into Sheep Unit

| Type of Livestock | General Composition Ratio in *Dornogobi* | Conversion Rate into Sheep Unit | Converted Composition Ratio | Number in Sheep unit in case 1,000 total | Number in animal in case 1,000 in Sheep Unit |
|---|---|---|---|---|---|
| Camel | 3.5 | 5 | 17.50 | 98 | 20 |
| Horse | 9.3 | 6 | 55.80 | 311 | 52 |
| Cattle | 4.6 | 6 | 27.60 | 154 | 26 |
| Sheep | 39.6 | 1 | 39.60 | 221 | 221 |
| Goat | 42.9 | 0.9 | 38.61 | 216 | 240 |
| Total | | | | 1,000 | 559 |

iv) Marketing Income of Livestock Products

Based on the experience of rural survey carried out in *Dornogobi Aimag*, the livestock product market income is assumed to be 15% of the average value of own livestock amount appraised. It also is assumed to be 3% of the expected increase of added value by improving of water supply ratio with project. Therefore, the market income of livestock products per sheep unit is Tg 2,335 in Without Project Case, and Tg 2,405 in With Project Case.

Table 5.2.37 Sales Income of Livestock Products

| | Number of animals equal 1,000 Sheep Units | Unit Appraisal Price (Tg) | Total Appraisal Price in 1,000 Sheep Units (Tg) | Market Income of Livestock Products per Sheep Unit (Tg) |
|---|---|---|---|---|
| Camel | 20 | 150,000 | 3,000,000 | 15% |
| Horse | 52 | 40,000 | 2,080,000 | |
| Cattle | 26 | 80,000 | 2,080,000 | |
| Sheep | 221 | 25,000 | 5,525,000 | |
| Goat | 240 | 12,000 | 2,880,000 | |
| Total | 559 | | 15,565,000 | 2,334,750 |

Market income of livestock product per sheep unit in Without Project Case: Tg 2,335

Market income of livestock product per sheep unit in With Project Case: Tg 2,405

The potion of cashmere is dominant in the increase of market income of livestock products when the number of livestock is increased. Therefore, the increase of income by cashmere is calculated from share of goats in the increased livestock number.

Increase of income by cashmere per increased sheep unit: Tg 1,872

v) Income of Sold Livestock

Market income is also determined by sold livestock, which is equivalent to increased livestock over the carrying capacity limitation. Unit price is assumed to be the same as above appraisal price, and 30% of it is discounted to avoid duplication of income in accounting for the above market income of livestock products. Therefore, income of sold livestock per sheep unit is set as Tg 10,896 in Without Project Case.

Income of disposed livestock per sheep unit in Without Projects Case: Tg 10,896

vi) Effect of Increasing Weight of Livestock

Increasing weight of sheep and cattle among five animals is considered as a benefit when these are disposed. It is assumed that increasing portion by improvement of water and pasture is 3%, selling price is Tg 1,000 per kg. It is also assumed that carcass weight of sheep on average is 19 kg (42% of live weight), and cattle are 6 times sheep. Based on the above-mentioned assumption, income from disposed livestock per sheep unit in With Project Case is set as Tg 11,046 considering the effect of increased weight.

Table 5.2.38 Effect of Livestock Weight Increase (2,000 sheep unit)

| | Number of Animals in Case 1,000 in Sheep Unit | Unit Appraisal Price(Tg) | Effect of Increasing Weight | | Modified Unit Appraisal Price (Tg) | Total Appraisal Price in 1,000 Sheep Unit (Tg) | Income of Disposed Livestock per Sheep Unit (Tg) |
|---|---|---|---|---|---|---|---|
| | | | (kg) | (Tg) | | | |
| Camel | 20 | 150,000 | | | 150,000 | 3,000,000 | Reduction Ratio 70% |
| Horse | 52 | 40,000 | | | 40,000 | 2,080,000 | |
| Cattle | 26 | 80,000 | 3.42 | 3420 | 83,420 | 2,168,920 | |
| Sheep | 221 | 25,000 | 0.57 | 570 | 25,570 | 5,650,970 | |
| Goat | 240 | 12,000 | | | 12,000 | 2,880,000 | |
| Total | 559 | | | | | 15,779,890 | 11,046 |

Income of disposed livestock per sheep unit in With Projects Case: Tg 11,046

vii) Production Cost

The result which was examined the model-production cost of herders household according to the livestock possession scale is shown in Table 5.2.39. Based on this result, the production cost per livestock is estimated at Tg 1,400 (equivalent to Tg 700 in sheep unit). Although production cost per livestock is reduced slightly when number of livestock is increased by project implementation, it is assumed that reduce ratio is 5%. Production cost per livestock is Tg 665 in With Project Case.

Table 5.2.39 Average Production Cost (Tg)

| Item | Herders with 100 heads | Herders with 200 heads |
|---|---|---|
| Taxes | 7,760 | 21,750 |
| Fodder | 26,390 | 48,750 |
| Migration | 60,000 | 84,000 |
| Veterinary services | 45,880 | 84,750 |
| Fuel | 0 | 30,000 |
| TOTAL | 140,030 | 269,250 |
| Cost/head | 1,400 | 1,346 |

2) Benefit

The project benefit is calculated with above assumed income and cost. The annual benefit is generated from 2nd year, but accumulated benefit is issued from 3rd year.

Table 5.2.40 Benefit by Project (Tg)

| Year | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| Annual Benefit | -1,478,000 | 107,000 | 4,618,000 | 4,618,000 | 4,618,000 |
| Accumulated Benefit | -1,478,000 | -1,371,000 | 3,247,000 | 7,865,000 | 12,483,000 |
| Year | 6th | 7th | 8th | 9th | 10th |
| Annual Benefit | 4,618,000 | 4,618,000 | 4,618,000 | 4,618,000 | 4,618,000 |
| Accumulated Benefit | 17,101,000 | 21,719,000 | 26,337,000 | 30,955,000 | 35,573,000 |

3) Cost of Well Construction, Operation and Maintenance Cost

i) Cost of Well Construction

Actual construction cost of well varies but herder's contribution is set as almost the same amount as new construction or rehabilitation in the existing rule. Thus, the cost of well construction adopted is only Tg 500,000 as herder's contribution amount in this calculation. It is paid in 1st year.

ii) Equipment Cost and Operation and Maintenance Cost

It is assumed that the working life of generator is 5 years and of pump is 10 years. Renewal cost is calculated in each working life period as Tg 600,000 (USD 500) for generator and Tg 1,200,000 (USD 1,000) for pump. The initial installation cost is not added since it is carried out by the project. Moreover, 3% of total equipment cost is counted as maintenance cost.

4) Relation of Operation cost and Pumping Capacity

The operation cost is calculated by each pump's capacity then the relation between capacity and economy of operation is analyzed. The unit requirement water volume is assumed 5 *l*/s per day per livestock. Running hours of pump is determined by capacity and total required amount of water, and then operation cost is calculated from it.

Fuel cost Tg800/*l*, Fuel consumption rate 1.0 *l*/hour, Operation period 105 days

5) Relation of Benefit and Pump Capacity

The relation between the pump capacity and benefit was determined with above-mentioned assumptions. The operation cost exceeds the benefit until 2nd year in the single annual balance in all capacity classes. Accumulated balance is also subtracted as 0.3 *l*/s or less until year third.

Table 5.2.41 Relation of Pump Capacity and Benefit (Annual) (Tg 1,000)

| Pump Capacity(*l*/s) | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th |
| 0.3 | -3,007 | -1,048 | 3,336 | 3,336 | 2,736 | 3,336 | 3,336 | 3,336 | 3,336 | 1,536 |
| 0.4 | -2,755 | -764 | 3,652 | 3,652 | 3,052 | 3,652 | 3,652 | 3,652 | 3,652 | 1,852 |
| 0.5 | -2,602 | -594 | 3,841 | 3,841 | 3,241 | 3,841 | 3,841 | 3,841 | 3,841 | 2,041 |
| 0.6 | -2,502 | -480 | 3,968 | 3,968 | 3,368 | 3,968 | 3,968 | 3,968 | 3,968 | 2,168 |
| 0.7 | -2,429 | -398 | 4,058 | 4,058 | 3,458 | 4,058 | 4,058 | 4,058 | 4,058 | 2,258 |
| 0.8 | -2,375 | -338 | 4,126 | 4,126 | 3,526 | 4,126 | 4,126 | 4,126 | 4,126 | 2,326 |
| 0.9 | -2,333 | -290 | 4,178 | 4,178 | 3,578 | 4,178 | 4,178 | 4,178 | 4,178 | 2,378 |
| 1.0 | -2,299 | -252 | 4,221 | 4,221 | 3,621 | 4,221 | 4,221 | 4,221 | 4,221 | 2,421 |

Table 5.2.42 Relation of Pump Capacity and Benefit (Accumulated Year) (Tg 1,000)

| Pump Capacity(*l*/s) | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th |
| 0.3 | -3,007 | -4,055 | -719 | 2,617 | 5,353 | 8,689 | 12,025 | 15,361 | 18,697 | 20,233 |
| 0.4 | -2,755 | -3,519 | 133 | 3,785 | 6,837 | 10,489 | 14,141 | 17,793 | 21,445 | 23,297 |
| 0.5 | -2,602 | -3,196 | 645 | 4,486 | 7,727 | 11,568 | 15,409 | 19,250 | 23,091 | 25,132 |
| 0.6 | -2,502 | -2,982 | 986 | 4,954 | 8,322 | 12,290 | 16,258 | 20,226 | 24,194 | 26,362 |
| 0.7 | -2,429 | -2,827 | 1,231 | 5,289 | 8,747 | 12,805 | 16,863 | 20,921 | 24,979 | 27,237 |
| 0.8 | -2,375 | -2,713 | 1,413 | 5,539 | 9,065 | 13,191 | 17,317 | 21,443 | 25,569 | 27,895 |
| 0.9 | -2,333 | -2,623 | 1,555 | 5,733 | 9,311 | 13,489 | 17,667 | 21,845 | 26,023 | 28,401 |
| 1.0 | -2,299 | -2,551 | 1,670 | 5,891 | 9,512 | 13,733 | 17,954 | 22,175 | 26,396 | 28,817 |

6) The Case with Considering *Dzud* Damage

Based on the above calculation, the case considering the *Dzud* damage is also made.

It is assumed that the *Dzud* damage happens every five years (3rd year and 8th year) and it causes death of 20% of livestock but it is mitigated to 10% by the project. In this case, benefit is greater from 3rd year in 0.5 *l*/s or more wells, and from 4th year in less than 0.5 *l*/s wells.

Table 5.2.43 Relation of Pump Capacity and Benefit (Annual: with *Dzud* damage) (Tg 1,000)

| Pump Capacity(*l*/s) | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th |
| 0.3 | -3,007 | -1,048 | 2,849 | 6,777 | 2,736 | 3,336 | 3,336 | 2,849 | 6,777 | 1,536 |
| 0.4 | -2,755 | -764 | 3,165 | 7,093 | 3,052 | 3,652 | 3,652 | 3,165 | 7,093 | 1,852 |
| 0.5 | -2,602 | -594 | 3,354 | 7,282 | 3,241 | 3,841 | 3,841 | 3,354 | 7,282 | 2,041 |
| 0.6 | -2,502 | -480 | 3,481 | 7,409 | 3,368 | 3,968 | 3,968 | 3,481 | 7,409 | 2,168 |
| 0.7 | -2,429 | -398 | 3,571 | 7,499 | 3,458 | 4,058 | 4,058 | 3,571 | 7,499 | 2,258 |
| 0.8 | -2,375 | -338 | 3,639 | 7,567 | 3,526 | 4,126 | 4,126 | 3,639 | 7,567 | 2,326 |
| 0.9 | -2,333 | -290 | 3,691 | 7,619 | 3,578 | 4,178 | 4,178 | 3,691 | 7,619 | 2,378 |
| 1.0 | -2,299 | -252 | 3,734 | 7,662 | 3,621 | 4,221 | 4,221 | 3,734 | 7,662 | 2,421 |

Table 5.2.44 Relation of Pump Capacity and Benefit (Accumulated Year: with *Dzud* damage) (Tg 1,000)

| Pump Capacity(*l*/s) | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th |
| 0.3 | -3,007 | -4,055 | -1,206 | 5,571 | 8,307 | 11,643 | 14,979 | 17,828 | 24,605 | 26,141 |
| 0.4 | -2,755 | -3,519 | -354 | 6,739 | 9,791 | 13,443 | 17,095 | 20,260 | 27,353 | 29,205 |
| 0.5 | -2,602 | -3,196 | 158 | 7,440 | 10,681 | 14,522 | 18,363 | 21,717 | 28,999 | 31,040 |
| 0.6 | -2,502 | -2,982 | 499 | 7,908 | 11,276 | 15,244 | 19,212 | 22,693 | 30,102 | 32,270 |
| 0.7 | -2,429 | -2,827 | 744 | 8,243 | 11,701 | 15,759 | 19,817 | 23,388 | 30,887 | 33,145 |
| 0.8 | -2,375 | -2,713 | 926 | 8,493 | 12,019 | 16,145 | 20,271 | 23,910 | 31,477 | 33,803 |
| 0.9 | -2,333 | -2,623 | 1,068 | 8,687 | 12,265 | 16,443 | 20,621 | 24,312 | 31,931 | 34,309 |
| 1.0 | -2,299 | -2,551 | 1,183 | 8,845 | 12,466 | 16,687 | 20,908 | 24,642 | 32,304 | 34,725 |

## 5.2.4 WELL OPERATION AND MAINTENANCE

The following activities are required to get the operation and maintenance system to secure the sustainability of the constructed wells.

- The general activities to heighten herder's ownership in all well construction processes.
- For *Soum* government to establish the *Soum* Well Fund to support herders operation and maintenance.
- To constructed the maintenance system at the *Soum* level with *Soum* Well Fund.

(1) For General Activities to Heighten Herder's Ownership through Well Construction Process

The following activities are to be carried out:

- To organize the herder group

  To organize the herders, who (will) use the well, into a group, and establish cooperation system among herder on well utilization.

- Introduction of well use contract

  Aiming to clarify the maintenance responsibility, a contract to secure the well utilization is to be signed between herder group and *Soum* government before its utilization. This contract will be based on the decree issued by *Soum* governor and the herder group's members list should be attached to it.

- Introduction of herder's contribution

  Herder group should contribute some construction cost when they submit an application for well construction and before starting construction work. It will be effective to heighten their ownership and through it their willingness to use the well can be clarified.

- To establish Herder's Well Fund (Internal Operation and Maintenance Fund)

  To secure sustainable well utilization, operation and maintenance funds have to be saved in the group. Hence, opening a bank account for saving is set as a regulation to submit an application for well construction.

The *Soum* government will carried out these activities to organize herder group. Therefore, it is necessary to develop a procedure to organize the group and *Soum* government's capacity.

The process of well construction is summarized as below figure.

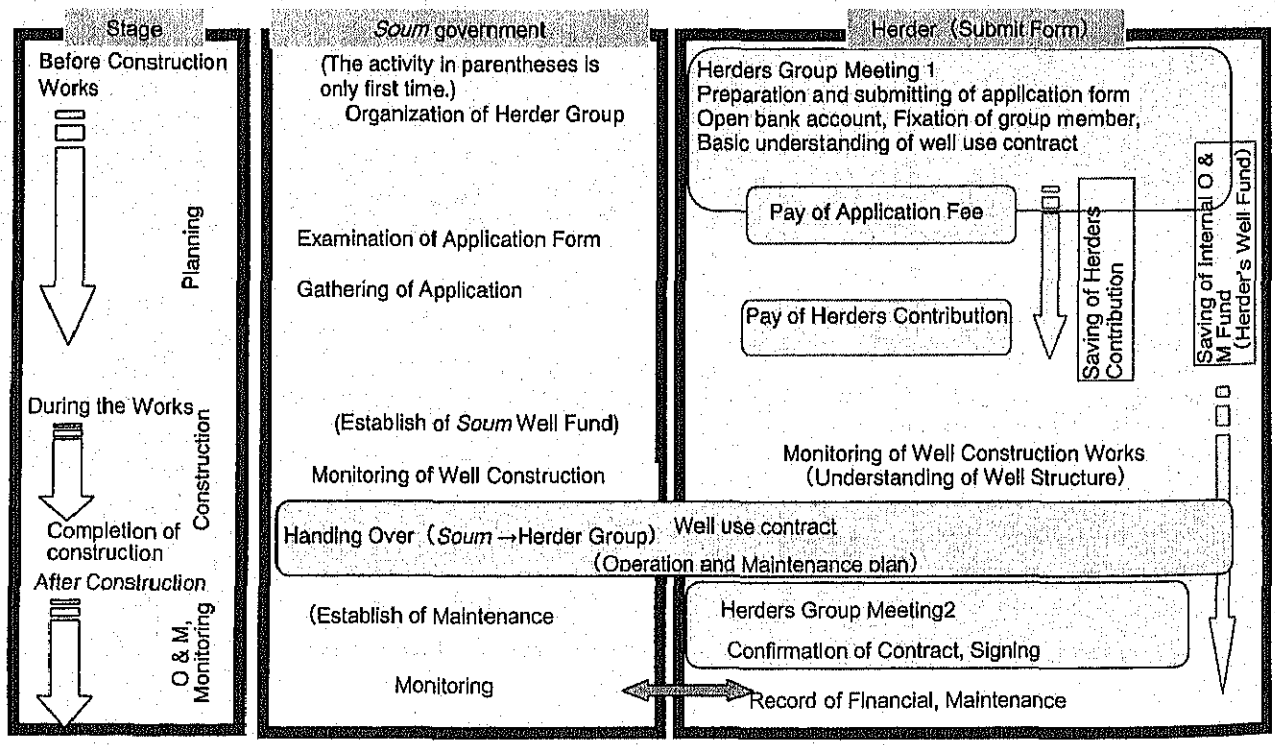


Fig.5.2.8 Process of Well Construction (Role of *Soum* Government and Herder Group)

(2) Establishment of *Soum* Well Fund

At present the *Soum* government gives the herders well use rights and delegates its operation and maintenance to them. However, the budget for supporting herder's well operation and maintenance is not usually prepared by the *Soum* government or *Aimag* government. Although the herders are compelled to save funds for the case of breakdown of the equipment such as pump, generator etc., but sometime they can't pay the repairing or renewal cost due to insufficient savings amount accumulated at that date. "*Soum* Well Fund" is established in each *Soum* so that *Soum* government has the capacity to cope with such situations.

This fund is established by herder's contribution; herders pay money tacked on small amount for contribution to the well construction to each *Soum*, and then *Soum* government utilize this small amount of money for the Fund. About USD 1,000 is minimum requirement to establish the *Soum* Well Fund, because it is necessary to buy a stock of spare-parts for *Soum* government or to loan them to repair the equipment in the beginning.

The *Soum* Well Fund has to report their activities to the public once a year to maintain transparency and to continue the activity of the fund.

1) Outline of *Soum* Well Fund

Objective: Well use development in the whole *Soum* in the future

Activities: Monetary support for the herders groups as shown below.

- Repair and renewal of a pump and generator of the well used at present
- Rehabilitation works and new construction of the Traditional Wells in the *Soum*
- Survey of well rehabilitation and rehabilitation works for the engineering wells in the *Soum*
- Other activities necessary for the wells in the *Soum*

2) Implementation System

*Soum* Well Fund shall be operated under the following system.

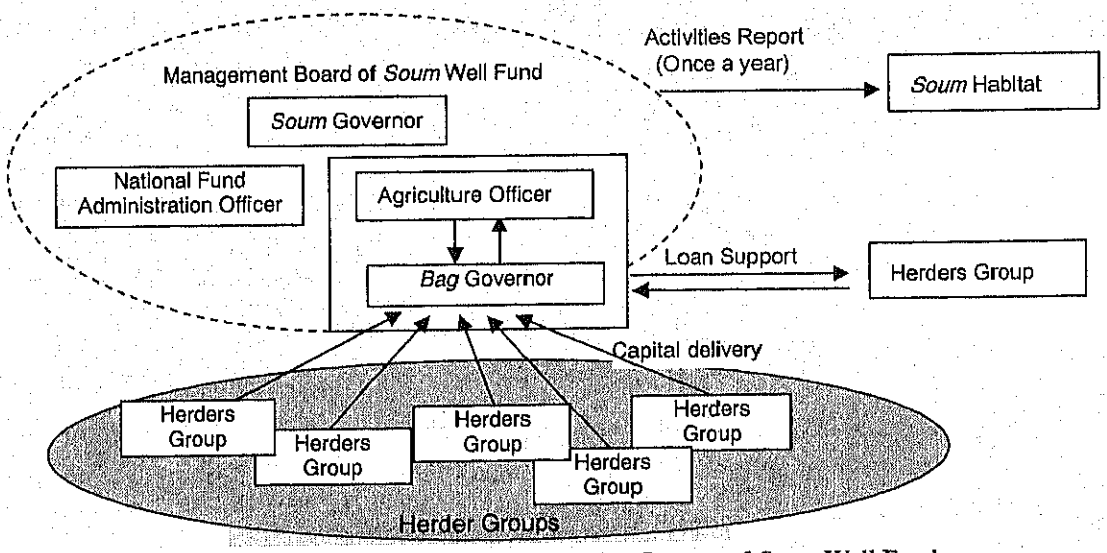


Fig.5.2.9 Implementation System of *Soum* Well Fund

(3) Establishing Well Maintenance System

The herder group has to solve any trouble when it is happens on their well. However, it is difficult for them to solve it only by themselves and support of experts is necessary.

The local well construction company has maintained their constructed wells continuously until recently. However, it seems that the participation in well maintenance by local well construction company is declining because the company to construct wells is selected by bid now.

Each herder group has to take full responsibility to maintain the operation and maintenance of wells in the future. Thus, a supporting system has to be established in which *Soum* government and *Aimag* government give support for operation and maintenance activities and, through it continuous well maintenance management can be done.

Especially, many generators had troubles in the Pilot Study and the following matters are necessary activities to establish for the well management system as experienced in the Study.

1) Execution of Operation and Maintenance Training for Herders

Operation and maintenance training have to be carried out with more than two herder participants in each group when they start to use the well. There are many troubles happening during the beginning of utilization and herders makes it worse since they are not familiar with machine maintenance but tries to make repairs it their own way. Due to that, it is better to make training for well utilization again after about half a year after starting operation.

2) Training to Promote *Soum*'s Engineer in Charge of Well Equipment Management

It is most important for proper well operation and maintenance that an experienced engineer solve the trouble existing in addition to the herder and so the herder can easily consult about the troubles of machines. Therefore, a training seminar needs to be carried out to educate an engineer in each *Soum* in charge of well equipment (generator) management. The *Soum*'s engineer has to be selected from persons who have technical attainments.

This training is very important since the *Soum*'s engineer will become the key person in the well maintenance system locally. Therefore, to heighten the interest of *Soum* government and *Aimag* government, this training should be carried out by their local budget.

3) Stock and Procurement of Spare Parts in *Soum*

It is impossible to buy spare parts for generator or other equipment in *Soum* Centre and also *Aimag* Centre. Therefore, the spear parts will be stocked in *Soum* government office financed by the *Soum* Well Fund. Trained *Soum* engineer or *Soum* government should manage these spare parts and sell it to herders.

It will be able to become a privatized small business when the number of the same kinds of wells increases.

4) Contract with Local Well Construction Company to Support Well Maintenance

In this system, it is necessary to get the assistance of a well expert who can deal with the problems which the *Soum*'s engineers cannot and also who can negotiate with equipment suppliers in *Ulaanbaatar*. The well expert in agriculture agency in *Aimag* government is a suitable person on the administration side. However, it is better to use a well construction company because they can use their specialty in supporting to *Soum*'s engineer and in the negotiation with suppliers.

Therefore, it is necessary to establish the maintenance system so that it is included in the bid of well construction or procurement of its equipment. The contract should be to maintain the constructed well or to follow up the supplied equipment with local well construction company.

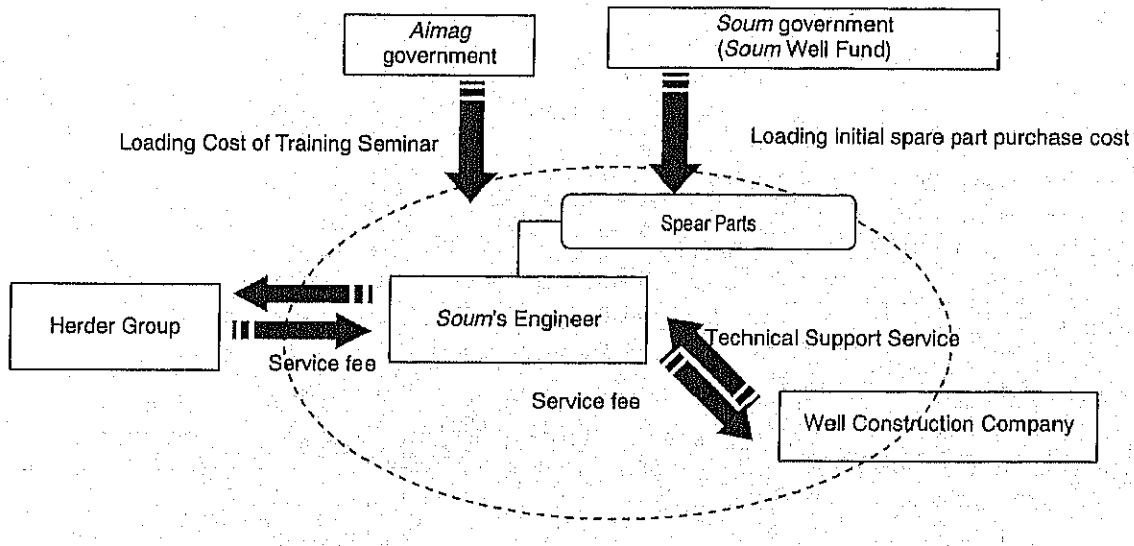


Fig.5.2.10 Well Equipments Maintenance System

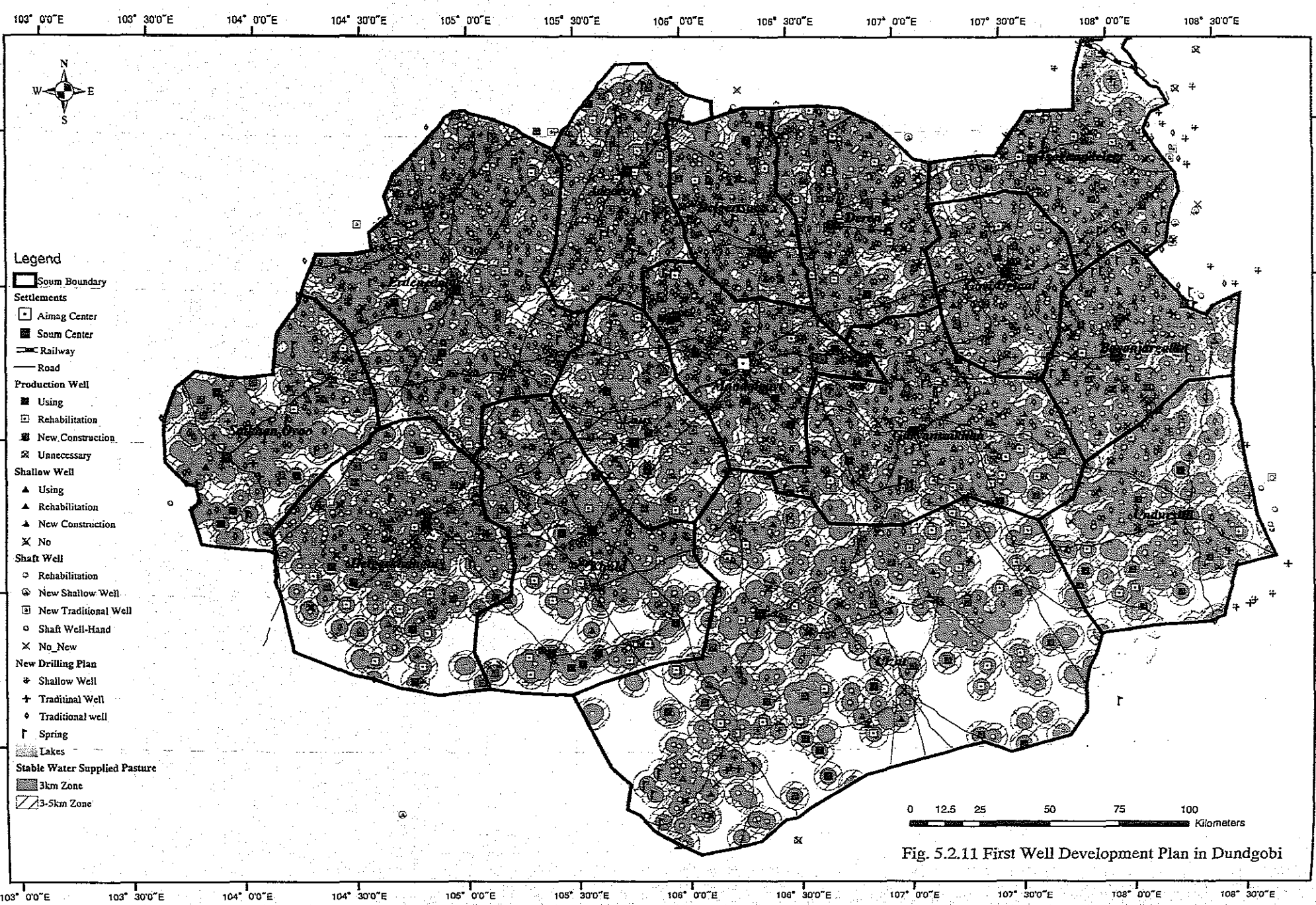


Fig. 5.2.11 First Well Development Plan in Dundgobi

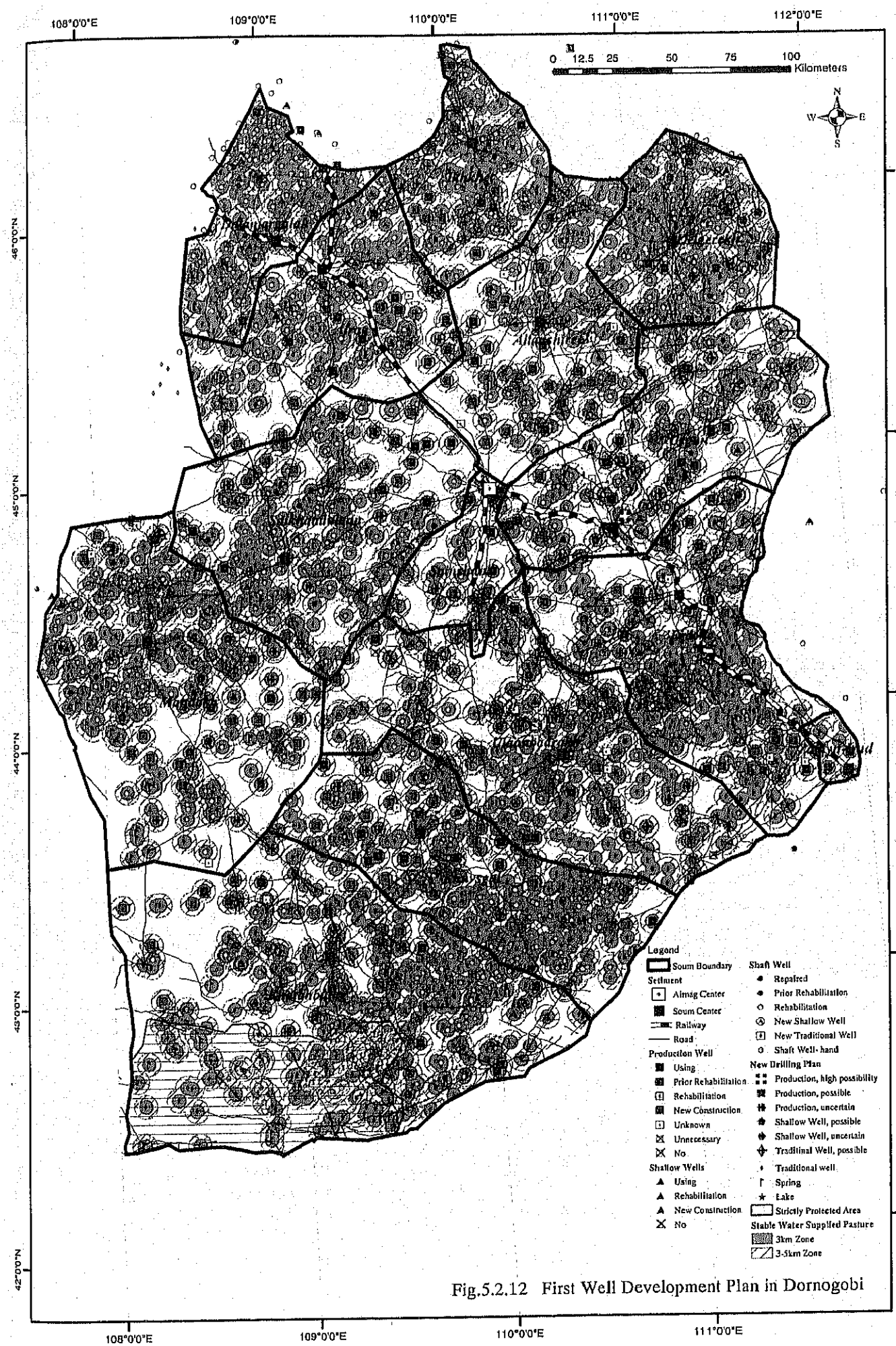


Fig.5.2.12 First Well Development Plan in Dornogobi

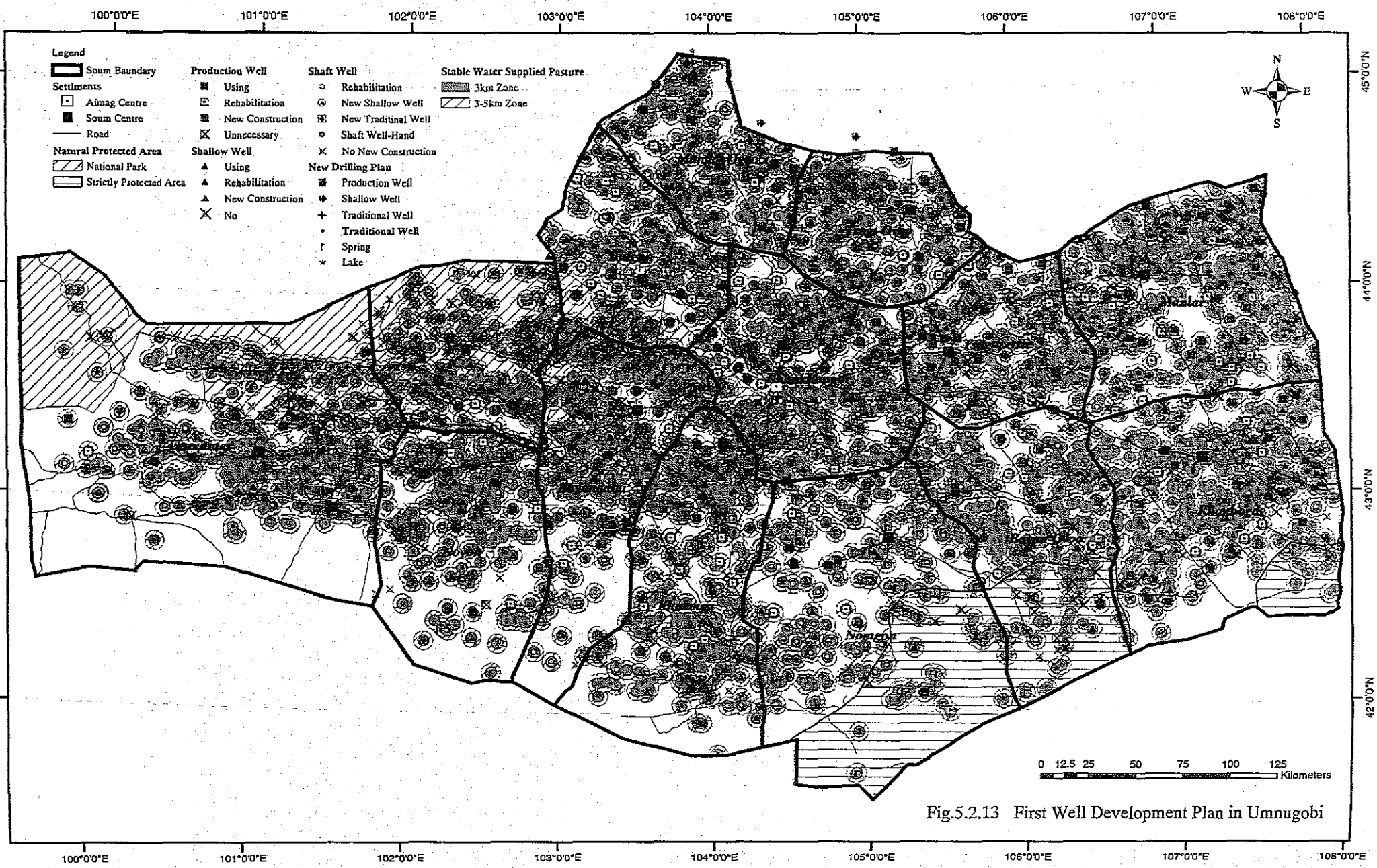


Fig.5.2.13 First Well Development Plan in Umnugobi