

## Practical Study on Farming Development to Overcome Poverty in Livestock Farms in Keerqin Sand Land, Inner Mongolia, China

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### Abstract

In villages in Keerqin Sand Land, Inner Mongolia, China, desertification has been progressing severely for 30–40 years, resulting in poverty of the livestock farmers. A demonstration study has been carried out to increase the income and raise the villagers' living standard through the prevention of desertification and the development of integrated farming combining animal husbandry and agriculture. Guidance on farm management was given to farmers in 5 model farms. In addition, Japanese voluntary helpers (JVH) have attempted to fix the moving sand dunes in close collaboration with the villagers to motivate the farmers to promote afforestation. Results of surveys on the development of these model farms and the effects of JVH work are as follows: 1) *Development of model farms* Effects of fences on model farms were so remarkable for controlling overgrazing that farmers harvested a large amount of hay. Since the production of maize, soybeans and rice with irrigation was successful, farmers obtained a high yield of grain which was consumed in their homes, sold to the market or used as feed for the animals. Consequently, the income of the model farmers was 3–5 times higher than that of the average village farmers. 2) *Collaboration for the establishment of the "village forests"* Collaboration was extended for the establishment of village forests, which were completed in 1998, and planting of apricot gardens began in 1999. 3) *New land use system* Reform on the land use system was promoted to utilize pastures collectively. It is considered that the collaboration extended by the authors and JVH based on a farmer participatory system contributed to village development by fostering a "self-help" approach among the farmers. Strategies to prevent desertification and for rural development are presented.

**Discipline:** Grassland / Animal industry

**Additional keywords:** afforestation, desertification, farm management, model farms, sustainable farming

### Introduction

Desertification is progressing in the arid and semi-arid regions of the world where the ecosystems consist of grasslands with a predominance of livestock farming. Though the ecosystems in these regions are fragile, livestock farming does not necessarily lead to desertification. If sustainable farming could be implemented, desertifica-

tion could be prevented and sustainable livestock farming could be achieved. The basic principle of sustainable livestock farming is grazing with a moderate stocking rate compatible with the carrying capacity of the region.

#### 1) Strategies against desertification

They are as follows<sup>4)</sup>: (1) The livelihood of the inhabitants should be secured in the process of prevention of and recovery from desertification. Farmers should

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maintain an appropriate number of animals for their living. (2) Desertification of land and poverty of farmers create a vicious circle; therefore both must be solved together. (3) In order to produce a sufficient amount of animal feed, productive land which can withstand environmental stress should be utilized intensively, while poor land which is fragile or degraded should be protected without use or conserved with light use to let the vegetation regenerate naturally. (4) To supplement the shortage of income from livestock farming, irrigation agriculture should be introduced and integrated farming should be promoted. (5) The eventual objective is to motivate the villagers to make efforts for village development through self-help.

### 2) Farming technologies

In a preliminary study on several selected farms conducted during the period 1983–1989, Wei et al.<sup>11)</sup> identified the farming technologies which might improve the farm economy and living standard of the farmers in the desertified Wulanaodu region. These included: (1) Intensive production of grain and forage crops in small fields through irrigation with well water. (2) Establishment of farm forests around fields and houses for protection from wind and drifting sand. (3) Feeding of sheep inside a stall in winter for protection from cold and (4) Planting of vegetables and fruit trees to improve the eating habits of the farmers. These technologies contributed to the increase of the rate of reproduction and decrease of the mortality of sheep and goats, as well as to the increase of farmers' income.

Attempts had been made to extend these technologies, but the farmers were not interested. Consequently, the possibility of disseminating these technologies required further studies. In order to evaluate and identify the problems associated with the extension of these technologies to ordinary farms, the authors have conducted studies on model farms since 1993.

### 3) Collaboration of Japanese voluntary helpers (JVH)

Collaboration in tree planting motivated the villagers to promote village forest construction. In order to change the villagers' attitudes, JVH, whom the authors invited, attempted to fix moving sand dunes (Figs. 1, 2) and proceeded to the construction of village forests in close collaboration with the villagers.

## Characteristics of surveyed region

The region surveyed was Wulanaodu, Nashihan district, Chifeng City, Inner Mongolia, China, in the western Keerqin Sand Land (Fig. 3). The climate is continental,

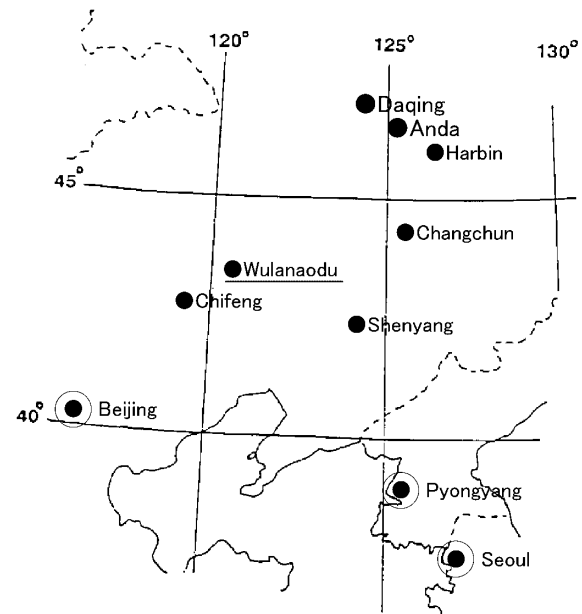


Fig. 3. Study site, Wulanaodu village

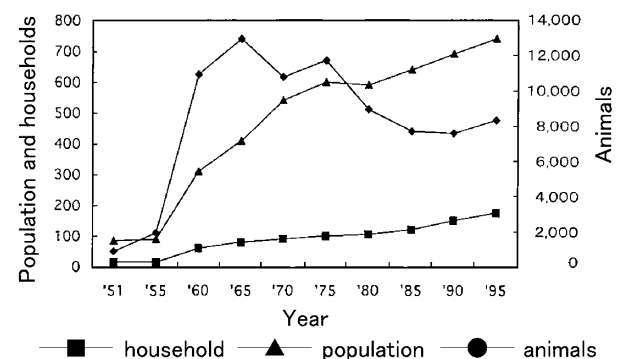


Fig. 4. Population, number of animals and of households in Wulanaodu village

semi-arid temperate with a mean annual temperature of 6.4°C, and total annual precipitation of 300–350 mm distributed mostly in summer. The area has experienced severe drought and damage to animals every 5–10 years since 1970. Strong winds prevail and cause serious erosion and sand drift. Topography includes sand dunes (consisting of fixed, semi-moving and moving sand dunes), sand lands and lowlands. Sand accumulation tends to occur in sand dunes and sand lands, while salinity tends to occur in lowlands. Both phenomena reflect serious desertification. The inhabitants implemented collective livestock farming during the period 1951–1981, and they have initiated individual farming since 1981. The number of inhabitants in Wulanaodu village is 759. The number of households is 189. The number of animals is as follows: cattle 1,610, goats 2,551, sheep 668, camels 59, and horses 201. The trend of population, number of animals and number of households is depicted in Fig. 4.



**Fig. 1.** Japanese voluntary helpers (JVH) making preparations for the sowing of *Caragana*, a legume shrub, on a moving sand dune



**Fig. 8.** Maize and forage grass in irrigated field surrounded by poplar trees (Mr. G, a model farmer, right)



**Fig. 2.** *Caragana* which had been sown 6 years ago by JVH grew up and fixed moving dunes



**Fig. 9.** Maize field and abundant vegetation in the protected pasture of Mr. D, a model farmer



**Fig. 5.** Recovery of vegetation (left side) through the control of grazing by the construction of a fence



**Fig. 10.** Villagers, authors and JVH irrigating water after planting trees on a hill with an ovoo

The scale of animal husbandry in Wulanaodu village is small compared to that of other regions where the main activity consists of livestock farming based on natural pastures. This fact is due to the desertification in the region leading to poverty. Mean income per capita in a year is about 700 yuan (1 yuan is equivalent to about 0.125 US\$, or less than 1 US\$ per day), and the village is located in one of the poorest districts in China. Nearly half of the households have no electricity, and only a small percentage of pupils complete compulsory education.

### **Injury associated with desertification**

#### *1) Injury caused by sand dunes*

The major problem in the village is associated with the moving sand dunes over a distance of 3–5 m in a year which destroy roads, houses, productive pastures, fields, etc.

#### *2) Injury to pasture production*

Both sand accumulation and salinity which are caused primarily by vegetation degradation lead to a considerable reduction of forage production. The biomass which had amounted to 2.2–3.0 t/ha in the 1950s, decreased to 0.7–1.5 t/ha in the 1980s, namely a decrease of 34–50% during a 30-year period<sup>7)</sup>. People indicated that since there had been plenty of forage even in winter, it was not necessary to make hay 30–40 years ago<sup>5)</sup>.

#### *3) Injury to livestock*

The influence of desertification on livestock farming is serious in many aspects<sup>8,9)</sup>. Undernourishment of animals exerts adverse effects on animal health, and on the production of milk and meat, and also leads to the abortion of pregnant goats, which is a serious problem in severely desertified districts. The villagers mentioned that animals are vigorous in summer, fat in autumn, lean in winter, and die in spring, when the shortage of forage is most serious. The rate of mortality reached 7–8% in the spring of the worst year. As a result, the income from animal husbandry decreased and the poverty of the farmers increased<sup>6)</sup>.

### **Guidance on improved technologies in model farms**

Improved technologies were introduced and the effects on 5 model farms were surveyed. The authors visited them twice a year and observed the use of improved technologies, land use, livestock and crop production, income, etc. In addition, meetings were held

with the members of all the model farms, public officials, heads of villages, etc. to discuss the impact of introduced technologies, as well as the situation of farm management of neighborhood farms once a year<sup>4)</sup>. During the meetings, the authors became acquainted with farmers' knowledge and were able to understand farmers' needs. On the other hand, the authors emphasized the importance of grazing with a moderate stocking rate for the conservation of pastures and growth of animals as well.

#### *1) Basic principles of guidance<sup>4)</sup>*

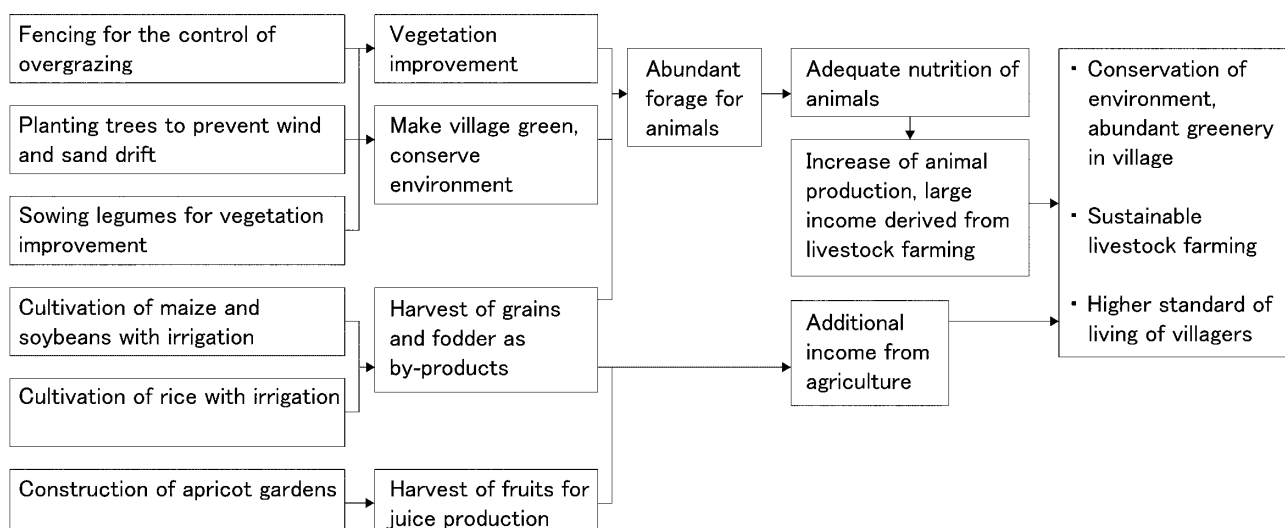
They were as follows: (1) Do not increase the number of animals, instead increase the amount of feed per animal head, so as to promote the growth of animals and increase the price of animals at selling. (2) Utilize fertile lands such as lowlands intensively, so as to increase forage production. On the other hand, degraded lands, such as sand lands and sand dunes, should not be used or used moderately, in order to protect the land and secure recovery. (3) In order to supplement the shortage of income from stock farming, crop farming should be introduced with irrigation, and integrated farming should be promoted.

#### *2) Recommended technologies*

The following 4 technologies were recommended on model farms by covering half of the necessary expenses to introduce the technologies (i.e. sinking of a well: 300 yuan, irrigation pump: 1,000 yuan, fence: 650 yuan/ha, etc.). (1) Fence: building of a fence around pastures to prevent overgrazing. (2) Tree planting: planting of trees to protect crop fields and pastures from strong wind and drifting sand. (3) Sowing of legume plants: introduction of legume plants such as *Astragalus* sp. and *Hedysarum* sp. for pasture improvement, and (4) Crop cultivation with irrigation: cultivation of maize and/or soybeans through irrigation with well water. When a large amount of water is available, cultivation of rice plants enables the use of the by-products of these crops as roughage or fodder for the animals.

#### *3) Evaluation of introduced technologies*

These technologies were evaluated on model farms: (1) Fence: degraded vegetation recovered owing to fencing. Mr. K, for instance, harvested a 20% larger amount of hay after fencing (Fig. 5). Hay is a valuable feed in winter. (2) Tree planting: in every model farm, 1,000–4,000 poplars or willows were planted every year. In some of the farms, apricot, a fruit tree was planted. The effects of planting remain to be determined: effects on land conservation and farm economy will be evaluated in future. (3) Legume sowing: seeds were sown in the pas-



**Fig. 6. Process of preventing desertification and alleviating poverty through planting of trees and livestock and crop farming in desertified Wulanaodu village**

tures. However, the results were not always successful depending on the amount of rainfall. Therefore, this practice may not be suitable for extension. (4) Cultivation of grain crops with irrigation: in all the model farms, 2–3 wells were constructed for irrigation and cultivation of maize and/or soybeans. Effects were remarkable and contributed to the production of grain for self-consumption and for sale. Most of the farmers plan to cultivate a larger area of maize to earn a higher income. Rice was cultivated only in the district where the model farm of Mr. A is located. As abundant underground water is available in this area, rice is grown in most of the farms. Mr. A is interested in rice production because it is a valuable cash crop, important food and its production is stable where enough water is available. He consumes rice at home, though if he sells it in the market, the product of a 0.3 ha of rice field fetches a value of 6,000 yuan, equivalent to 10 head of cattle. The process for achieving targets through these technologies is shown in Fig. 6.

#### 4) Comparison of farm management between model farms and ordinary farms

Area of crop fields, number of animals, and income from stock farming and crop farming of model farms in 1994 and 1998 are shown in Table 1. (1) Number of animals: number of animals in terms of sheep units (index rates of sheep and goats: 1, cattle: 5 and horses: 6) in the villages was 70 per household, while that of model farms was 206, or 2.9 times the number of the former. (2) Mortality of animals: the mortality rate was 3–4 % in the ordinary farms while less than 1% in the model farms. (3) Abortion of goats: it occurred in the spring of 1996 in most of the farms. The rate of abortion in model farms was 20–25% while 40–60% in some of the ordinary farms. (4) Breeding efficiency of cattle: mean calving number in 3 years was 1 in the ordinary farms, while 2 in the model farms. (5) Income: the mean income in the ordinary farms was 2,584 yuan per household, while that of model farms was 17,400 yuan or 6.7 times that of the former. The much higher income in the model farms is

**Table 1. Area of crop fields, number of animals and income derived from livestock and cropping in model farms**

Farm	Area of crop fields (ha)		Number of animals (sheep units)		Income in 1998 (yuan)		Total income (yuan)		Rate of cropping income to total income in 1998 (%)
	1994	1998	1994	1998	Livestock	Cropping	1994	1998	
K	0.4	0.8	300	295	15,600	2,800	16,000	18,400	15
A	0.7	1.0	147	115	6,100	7,400	9,300	13,500	55
D	0.7	2.6	184	165	8,200	5,000	13,100	13,200	38
W	0.3	2.0	239	140	13,000	3,000	21,400	16,000	19
G	2.2	1.6	274	265	18,000	8,000	18,200	26,000	31
Mean	0.9	1.6	224	196	12,200	5,200	15,600	17,400	32



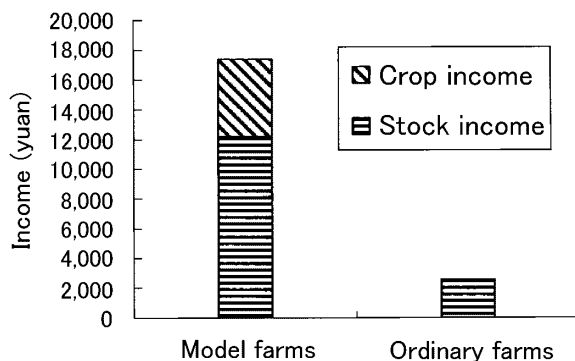


Fig. 7. Comparison of mean income between model farms and ordinary farms

due to a larger income from stock farming, in addition to the income from crop farming. Comparison of mean income between these farms is shown in Fig. 7. The income of stock farming per sheep unit was 37 yuan and 59 yuan in the ordinary farms and model farms, respectively. Higher income in the model farms than in the ordinary farms was due to the higher price of animals associated with a large liveweight caused by vigorous growth with abundant feed.

#### 5) Characteristics of farm management in model farms

They are as follows<sup>6)</sup>. (1) Mr. G (Fig. 8): he is a pioneer of integrated farming and an advanced stock farmer. He placed emphasis on developing crop farming with irrigation and achieved great success with this technology, getting the highest income in the village. His leadership as village headman will be mentioned later. (2) Mr. A: the area where he lives is markedly desertified and he can not rely upon stock farming for living. He mentioned that rice production was the most reliable activity for farms in the desertified region. (3) Mr. D: he built a fence around all of his pastures, fixed 3 ha of semi-movable sand dunes with apricot trees, etc., and planted 5,500 poplars and willows. Thus he actively promoted the conservation of grasslands. He cultivated 2 ha of maize (Fig. 9), and 0.7 ha of soybeans through the use of 2 irrigation wells. He promoted actively integrated farming of stock and crops. As a result, 38% of his income was derived from crop production. (4) Mrs. K and W: they succeeded in cultivating maize and plan to increase the area of their maize fields for earning more money. The construction of a fence around the pastures enabled the vegetation to regenerate and they harvested a large amount of hay.

#### Villagers' motivation for environmental conservation

The authors' ultimate objective was to motivate the

villagers to make efforts independently to prevent desertification, develop farming and achieve a comfortable living standard. To achieve these objectives, the authors and JVH have extended their collaboration to the villagers for planting trees, and have recommended the use of improved technologies with financial aid since 1993. Although the duration of these activities is not sufficiently long to assess the impact, the following results were obtained.

#### 1) Mongolian traditional consciousness

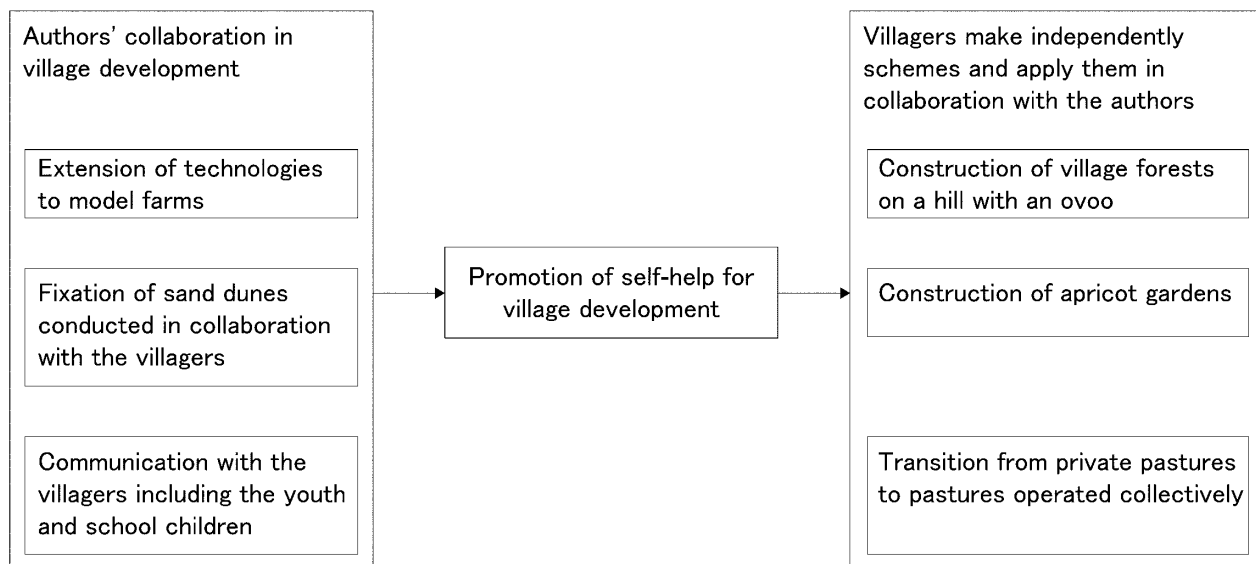
According to the Mongolian belief, successful stock farming is determined by heaven, not by human activities based on science and technology. Moreover, they were dismayed by the severe desertification, and considered that they could not control the process. Almost all of them had given up efforts to address the desertification problem. Scientists at the Institute of Applied Ecology had recommended villagers such technologies as planting trees, fencing of pastures, and sand dune fixation in the 1970s<sup>11)</sup>, but no one followed the recommendations. Villagers had little awareness of the importance of environmental conservation for farming development.

#### 2) Change of villagers' attitude toward construction

One of the model farmers, Mr. G, was elected village headman in 1996. Out of recognition of the authors' collaborative activities, he mentioned "let us make efforts for village reconstruction together with the Japanese who help us so actively". He made a number of plans, including planting trees on a hill with an ovoos (Fig. 10) (a holy place where Mongolians pray to heaven) as a symbol of village development, construction of water works and irrigation facilities for crop cultivation, and a school to educate the young who did not finish secondary school, etc. However, he died early in 1997. After the death of Mr. G, the tree planting projects were implemented by the secretary.

#### 3) Improvement of the pasture management system

The collective stock farm in the village closed in 1981, when lands and animals were distributed equally to every farmer. Thereafter, private farm management was initiated. However, during the past 16 years, serious problems in farm management arose in the village, as many farmers became very poor while a few farmers became rich, and fights among farmers occurred frequently about the boundary of their pastures<sup>12)</sup>. In order to address these problems, the village secretary decided in 1998 to divide 189 households in the village into 8 groups, and each group would manage their pastures collectively, though animals were owned privately and man-



**Fig. 11.** Process of authors' and JVH's collaborative activities to promote the villagers' awareness of the need for self-help for preventing desertification and for rural development

aged separately<sup>1)</sup>. Under the new system: (1) Farms in the groups could become specialized either in stock farming or crop farming. (2) Since farms in the groups were allocated a large area of pasture, it became possible to utilize it with a rotation system by dividing the pasture into 3–4 paddocks, for instance, the spring-summer paddock, the autumn-winter paddock and the reserve paddock which they would not use. It is considered that the new pasture management system may contribute to the regeneration of degraded pastures which were associated with traditional disorderly grazing. (3) Assistance to the poor farmers could be extended under the leadership of the group chief. Though it has been only 2 years since the reform was implemented, farmers in each group recognized the benefits of rotation grazing for vegetation regeneration. In addition, the farmers were glad that fights among farmers had stopped. The process of villagers' awareness of village development in connection with the authors' collaboration is depicted in Fig. 11.

## Discussion

Before the initiation of the authors' collaboration in 1993, attempts at extension of agricultural technologies had been made by Nan et al. in the 1970s. Furthermore, a preliminary demonstration study had been conducted by Wei et al.<sup>11)</sup> during the period 1983–1989. However, the villagers' motivation to village development did not occur until the authors' project started in 1993. Strategy of authors' collaboration was based on a bottom-up approach instead of a top-down approach which was

adopted in the collaboration with the scientists the Institute of Applied Ecology. It appeared that the authors' collaboration was effective to motivate the villagers to environmental conservation and economic development, and that the progressive village leader Mr. G promoted village development, stimulated by the participatory approach of the authors' activities. Ishiyama<sup>2)</sup> who studied methods of control of desertification through afforestation and agricultural development in the Sahel (Africa), emphasized the benefits of the participatory approach with the local people in the scheme. He classified the participation system into 5 types from the top-down type to the bottom-up type, which is most suitable for international collaboration. The approach adopted by the authors appears to belong to the latter type, since planning was made with village leaders through close communication, and tree planting and water works were conducted together with the villagers.

The authors' objectives of collaboration were not only aimed at the recovery of the vegetation but also at the improvement of the economy through agricultural development. Similar objectives were considered by Tao et al.<sup>10)</sup> and Liu et al.<sup>3)</sup> in Keerqin Sand Land, as well as Goto et al.<sup>1)</sup> in Niger. Such a comprehensive approach may enable to prevent desertification and promote rural development as well.

Crop production under irrigation was highly evaluated by the authors and Liu et al.<sup>3)</sup>. However, attention should be paid to avoid excessive reliance on irrigation agriculture, due to the risk of salt accumulation in arid regions. In addition, grazing at a moderate intensity

based on natural grasslands is the best way to utilize resources in the region.

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