

# THE POSSIBILITIES AND REALITIES ON THE REMANAGEMENT OF DESERTIFIED LANDS IN THE TRANSITIONAL ZONE BETWEEN THE DRY-FARMING AREA AND THE GRAZING AREA IN NORTH CHINA

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**ABSTRACT:** The desertification process is rapidly developing at present and 61.5% of the land area in the zone are already desertified. Among the desertified lands, 26.9% are seriously desertified, 25% most seriously desertified and 47.4% are the lands where desertification is under way. They are caused by over-reclamation for farming, over-grazing, unreasonable collection of firewood, the destruction of vegetation and the misuse of water resources. Under the ecological environment in semi-arid zone, the degraded environment process possesses the ability of restoring to its original status as soon as the interruption of excessive human activities are eliminated. The fencing- and-self-cultivating method is an effective measure adopted universally in semi-arid zone to cure the desertified lands. The desertified lands can be readjusted and controlled easily if other controlling measures are supplemented. The fundamental ways to control desertification are to utilize rationally the resources, to readjust the existing land use pattern in the transitional zone between the dry-farming area and the grazing area, and to adopt a series of measures that are suitable to local conditions. It is found that the desertified lands in the zone are characterized by the possibilities to readjust, and also that the successful reverse readjustment is becoming a reality in many typical regions.

**KEY WORDS :** desertified lands, the transitional zone between the dry-farming area and the grazing area, remanagement, North China.

## I. DESERTIFICATION

Desertification is a process of environmental degradation leading to the decrease in land productivity in arid and semi-arid zones (including some areas in subhumid zones), and it is a phenomenon of imbalance between human activities and natural resources, namely, the destruction of fragile ecobalance resulting from overuse of sandy land in dry and windy regions. As the sands turn mobile, a desert-like landscape appears. Such process is called desertification process and the lands affected are called desertified lands.

The development of desertification in North China becomes a serious environmental problem in recent years. Such is the case, especially in the transitional zone between the dry-farming area and the grazing area. This zone stretches from the lower reaches of the Nenjiang River in Northeast China to the southeast of the Ningxia Hui Autonomous Region in Northwest China. The reasons for the occurrence of desertification may be concluded as follows: On the one hand, it is because of the fragility of natural condition itself and the possibilities of resource utilization for agricultural and grazing purposes in the areas; on the other hand, it is owing to the frequency of excessive human economic activities under the population pressure, which makes the land capability for supporting people's life develop from bad to worse and the ecobalance becomes out of proportion. As a result desertification expands rapidly. Therefore, to study the possibilities and realities for remanaging the desertified lands in the transitional zone between the dry-farming area and the grazing area is of great significance to both the productive practice and the scientific research.

## II. PRESENT STATUS OF DESERTIFICATION

There are 11,750,000 people (about 40% of the total population in arid and semi-arid zones in North China) in 81 counties and banners in the transitional zone between the dry-farming area and the grazing area where desertification has occurred. And the total land area is approximately 267,000 km<sup>2</sup>, of which the cultivated field amounts to about 4,500,000 ha, and covers 47% of that in arid and semi-arid areas in North China. The desertification process is rapidly developing at present and 61.5% of the land area in the zone are already desertified. Among the desertified lands, 26.9% are seriously desertified; 25.7% most seriously desertified and 47.4% are the lands where desertification is under way. In terms of the geographic location, the desertified lands are located at the area adjacent to the subhumid or semi-arid zones. Their environment characterized not only by the transitional natural landscape but also by the fragility of ecosystem. These two specific features are the major potential factors for causing desertification. The annual precipitation is relative low, generally ranging from 250—500mm, and its variation is generally 25—50%. Geomorphologically, the land is interspersed with undulating de-

pressions and flats or it possesses piedmont plains which are interlaced with sandy plains and beachflats of basins and valley terraces. But the top deposits are mainly composed of loose sand materials, and their depth generally reaches 80—170 metres (at least 5—25 metres). In particular, the windy season is in conformity with the dry season and the blowy day with wind force at 7—8 Beaufort scale ranges from 30—80 days approximately. Therefore, when vegetation is destroyed under the irrational utilization of land, the wind-and-sand phenomenon will easily occur on the land surface under strong wind force, and finally becomes a blow fatal to the maintenance of ecobalance.

Though characterized as mentioned above, this area compared with sand desert and gravel desert in arid zone, possesses a steppe landscape which consists of *Stipa* spp. and beachflats with better water and soil conditions. This area can be used not only as good pasture land for developing livestock but also as a part of farming area. So the land use pattern in the transitional zone between the dry-farming area and the grazing area was formed early in the historical period. The eastern Inner Mongolia, for example, was characterized by both farming system and nomadic economic pattern in the Liao (916—1125 A.D.) and Jin (1115—1234 A.D.) dynasties. After the 18th century, a policy hiring cheaper labourers to reclaim the land was carried out in the Qing (1644—1911 A.D.) Dynasty and made the farming system in the region develop sufficiently. Therefore, such a transitional zone is a result of the interaction of agricultural and grazing economies in an environment with transitive features in the aspect of natural conditions. However, because of the fragility of natural environment, desertification gradually develops during the reclamation of the sandy steppe. For instance, the river side of the Yangxumu River in the south of Horqin Steppe was an excellent grazing field in the Qing Dynasty before 1805, and it was intermittently reclaimed later within a small scale. At the end of the 19th century and the early of the 20th century, a great deal of grazing area was reclaimed in Yangxumu Livestock Farm; and 45.7% of the total land area in the farm had been reclaimed by 1906. The desertified lands were formed gradually. At first there appeared shifting sand spots. Later there appeared shifting sand patches. Finally the present dense shifting sand belts along the north bank of the Yangxumu River came forth within the last 50 years, the unceasing farm-reclamation on steppe made sandy steppe with sparse elms woodland degrade and the landscape with the interdistribution of shifting sand, fixed and semi-fixed sand dunes appear on the surface.

### III. CAUSES OF DESERTIFICATION IN THE TRANSITIONAL ZONE

It is estimated that, on the basis of the analysis of aerial photographs of different periods and the ground observation, the desertified lands in the transitional zone have increased by 3.4 million ha. during the last 30 years. Of them 42.9% is caused by over-reclamation for farming, 31.1% by over-grazing, 22.2% by unreasonable collection of firewood, and the rest is caused by the destruction of vegetation and the misuse of water

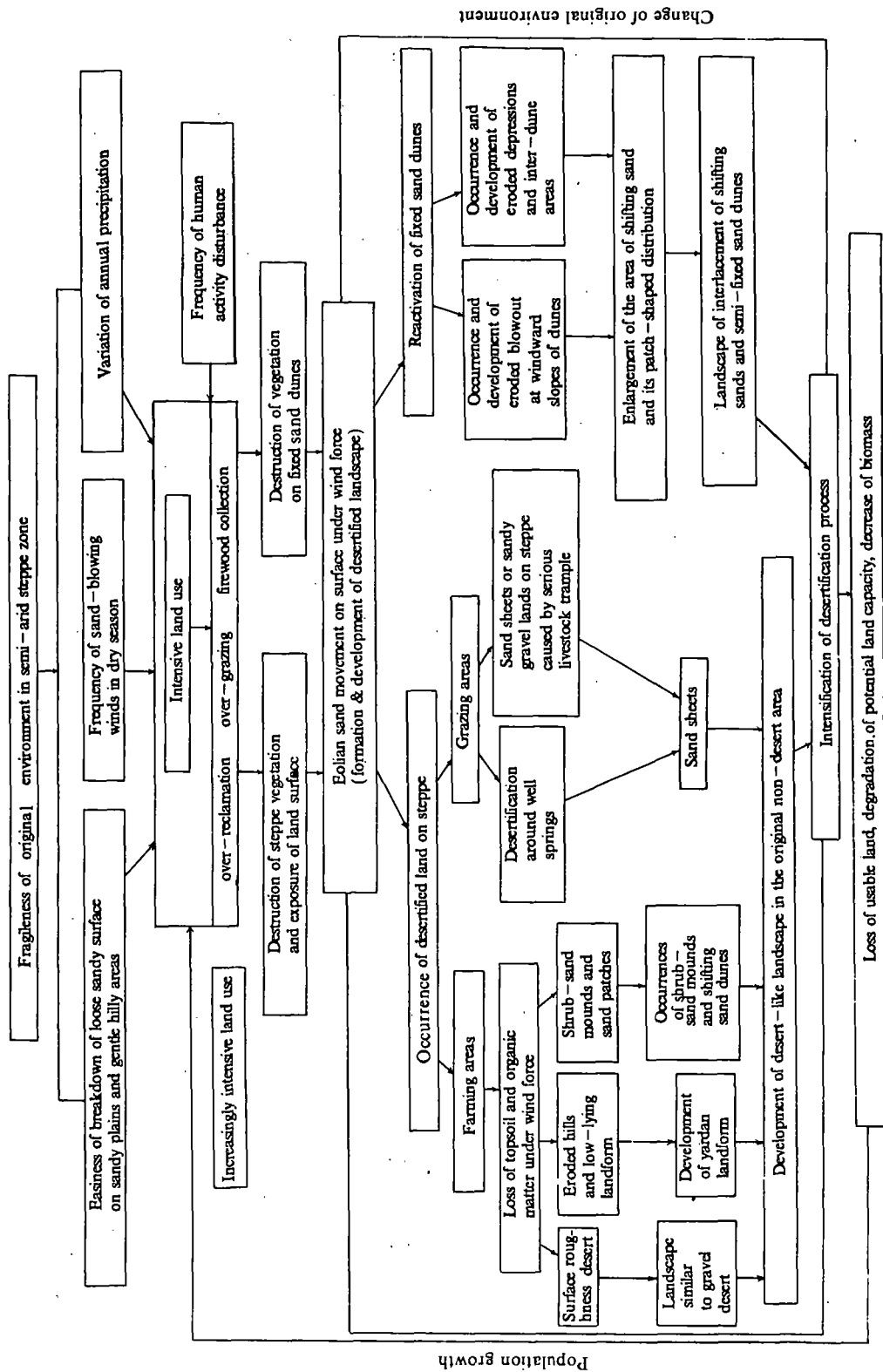


Fig.1 Desertification process in the transitional zone between the dry-farming area and the grazing area in the semi-arid zone

resources. Because of the difference of formation pattern, the development of desertified landscape is also relatively different. Fig.1 is a diagram of the desertification process in the transitional zone between the dry-farming area and the grazing area in the semi-arid zone.

**Table 1 The population growth and desertification(Data of Changhan O·bao, Yulin, northern Shaanxi)**

Year	Population (person)	Reclaimed area(ha)	Firewood collection (10 <sup>4</sup> kg)	Fixed dune (km <sup>2</sup> )	Desertified land composed of shifting sand and semi-fixed dune(km <sup>2</sup> )
1949	340	167	680,000	93.2	2.7
1954—56	410	4,000	820,000	85.1	6.0
1961—63	480	3,330	960,000	77.2	10.0
1975—77	726	4,667	1,450,000	60.1	18.3

Fig.1 shows evidently that the spread of desertification is a bad consequence caused by the achievement of economic development at the sacrifice of ecological environment. During this process, the human population increases unceasingly. The average rate of population growth is 3.08% within last 30 years, and the population density increases from 10 men / km<sup>2</sup> in 1949 to 30—50 men / km<sup>2</sup> in the 1970s. Table 1 shows the situation. The further the economy of the steppe develops, the worse the steppe environment degrades. The content of organic matter in soil, compared with that in early days, generally reduced by 60—80%; the yield of production of farmland decreased by 50—60%; and an obvious change of surface feature appeared. At Xiaobailin of the Western Siziwang Banner in the south of Ulan Qab Steppe, for example, 40% of farmland are eroded, fine clay particles reduced and gravels occur on land surface. Now 48% of the land are occupied by sand mounds with bushes and 12% covered by shifting sand patches. From above-mentioned analysis, it is clear that the desertification process itself is a dynamic process, but the process is characterized by variation with time and space. The variation scale is dependent on precipitation and the intensity of land utilization. Desertification will be intensified greatly and desertified areas will be increased obviously in dry years with little rainfall or in the period of over-reclamation; but the intensity of desertification will be limited and the boundary of the desertified area will be stable or will shrink on certain scale when there is abundant rainfall or the reclamation is less. In the 1950s. For instance, in Chaohai Sum of Horqin Zuoyi Houqi Banner in the south of Horqin Steppe the average annual rainfall was 475.3 mm, the agriculture was combined with grazing in a scientific way, and the area of desertified lands occupied only 8.9% of the total land area of the region. In the 1960s, the reclamation of steppe was on a large scale and a great deal of natural vegetation was destroyed. Besides, in the dry years of

1963, 1965, and 1967—1968, the average annual rainfall was only 351.1 mm. As a result, most of the farmland was abandoned to waste, which is easy to be eroded to cause the development of desertification. The area of desertified lands covered 20% of the total land area of the region, and the yield of production of farmland decreased by 64% in the 1950s(Fig.2).

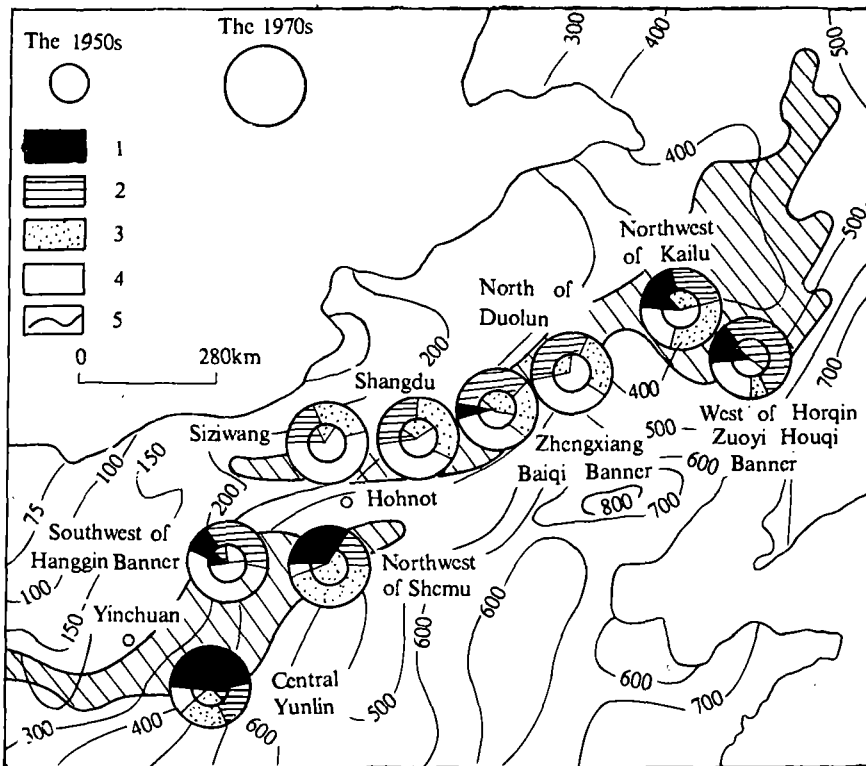


Fig.2 Developmental rate of desertification in different periods in the transitional zone between the dry-farming area and the grazing area in North China. Legend: 1. Most seriously desertified land; 2. Seriously desertified land; 3. Ongoing desertified land; 4. Latent desertified land; 5. Annual precipitation(mm).

In the light of the result of the measurement and calculation analysis of aerial photographs at different stages, it shows that the development of desertification is very fast, and this can be proved by the data in Table 2.

The analysis of above-mentioned data shows that the development of desertification process possesses the following two different salient features: a) In some sandy steppe areas, the development of desertification is indicated by the enlargement of desertified lands, which symbolized wind-and-sand phenomenon. The desertified lands enlarged approximately by 20—30% in the last 20 years. b) In some fixed and undulating fixed sand dune areas, the development of desertification is indicated by the gradual increase in distribution of shifting sands. The areas of shifting sand generally increased by 10—20% in the last 20 years.

According to the developmental degree of desertification and the integrated consideration of regional features, developmental history, and human impacts, the desertified lands in the transitional zone can be classified into four districts: a) The seriously desertified district in the southern part of Horqin Steppe on the south of the Xiliao River: It

**Table 2** Some examples of the development of desertified lands in the transitional zone between the dry-farming area and the grazing area

Region	Year	Areas occupied by different desertified lands (%)			
		Most seriously desertified lands	Seriously desertified lands	Ongoing desertified lands	Latent desertified lands
The area near Mandu in Horqin Zuoyi Houqi, Inner Mongolia	1958	15.0	40.2	6.5	38.3
	1974	20.7	49.8	4.7	34.8
Qaidam village in northwest of Kailu Banner, Inner Mongolia	1958	4.2	7.5	29.8	59.1
	1974	17.7	23.8	35.9	22.6
North of Duolun Plain to Jiahe, Inner Mongolia	1959	0.0	0.0	27.1	72.9
	1977	0.0	32.0	21.7	46.3
North of Zheng Xiangbaiqi, Inner Mongolia	1959	0.0	10.1	38.4	51.5
	1979	3.1	33.7	25.4	37.8
The west of Siziwang Banner Inner Mongolia	1958	0.0	5.0	20.0	75.0
	1977	0.0	18.0	27.0	55.0
Southeast of Hangjin Banner, Inner Mongolia	1956	1.5	18.8	32.0	47.7
	1978	15.1	34.7	15.5	34.7
North of Shenmu, Shaanxi Province	1958	17.8	14.0	64.4	3.8
	1976	33.6	17.8	44.8	3.8
Liuyang village north of Yanchi, Ningxia	1956	7.5	28.0	51.8	12.7
	1978	12.1	34.9	41.7	11.3

possesses a geomorphological landscape with interlaced depressions and sand mounds, and the desertification is caused by the reclamation of fixed, semi-fixed or undulating sand dunes or undulating sandy lands (including the unreasonable collection of firewood, destruction of vegetation, and over-grazing). The distribution of shifting sand patches and the reactivation of fixed sand dunes are its characteristics. b) The ongoing desertified district in the northern part of Horqin Steppe on the west of the Xiliao River and on the north of the Xiliao River and on the north of the Xar Moron River and in the southeastern piedmont of the Da Hinggan Mountains: It possesses a landscape of undulating sandy lands with alkali depressions, small lakes and long ridges, and the

desertification is characterized by the spot-shaped distribution of shifting sands and semi-fixed sand dunes which are caused by over-reclamation of fixed sandy lands. c) The ongoing desertified district in the southern part of Ulan Qab Steppe in Qahar: It possesses gentle hills in beachflats and undulating sandy highlands, and the desertification is characterized by reclamation of steppe, wind erosion and surface roughness of farmlands, and wind abrasion of bush-covered sand mounds. d) The most seriously desertified district in Ordos Steppe and in the north of Shaanxi: It possesses a landscape with valley flood plains, wet beachflats, lake basins and the interlaced areas of shifting sands, fixed sand dunes, and semi-fixed sand dunes, and the desertification is characterized by extensive distribution of shifting sand dunes which are caused by the influence of over-reclamation, over-grazing, and unreasonable collection of firewood in areas of fixed and semi-fixed sand dunes for a long time and by the reactivation of fixed sand dunes.

In consideration of the above-mentioned different regional features, it is very significant and important to readjust and control the desertified lands by applying methods suitable to local conditions.

#### IV. ENVIRONMENTAL CHANGES WHEN DESERTIFICATION IS UNDER CONTROL

As mentioned above, the occurrence and development of desertification is influenced by the environmental fragility. However, under the ecological environment in semi-arid zone, the degraded environment process possesses the ability of restoring to its original status as soon as the interruption of excessive human activities is eliminated. Namely, the environment possesses the feature of ecological elasticity. The fencing-and-self-cultivating method is an effective measure adopted universally in semi-arid zone to cure the desertified lands. The data in Table 3 show the changes after adopting the measure.

Table 3 Changes of desertified lands after adopting the fencing-and-self-cultivating measure

Locality	Conditions before adopting the fencing-and-self-cultivating measure	Period	Vegetation cover after adopting the fencing-and-self-cultivating measure(%)
Al Horqin	Shifting sands	1975—1981	70—80
Duolun	Abandoned cropland	1968—1981	60
Xi Ujimqin	Semi-fixed sandy lands with shifting sands in spots	1976—1981	65
Ulan Odu of Ongiud Banner	Degraded sandy grassland	1972—1981	80—90



The desertified lands can be readjusted and controlled easily if other controlling measures are supplemented. The data in Table 4 show that in the south edge of Horqin Steppe, in the last 660 years the desertified lands were caused by reclamation. Ecologically the environment there possesses the characteristic of self-regaining (annual rainfall is 450—600mm). When additional measures such as shelter belts and others were adopted, the surface features of the desertified lands evidently were changed. The organic matter content in topsoil was increased as shown in Table 5, and the land productivity might be gradually restored. The shifting sand dunes at Dayiqianfeng in Zhanggutai of Zhangwu County, Liaoning Province have been planted as woodland.

**Table 4 Changes of proportions of various surface features in Sanjiazi District, Zhangwu County, Liaoning Province (%)**

Various surface features in Sanjiazi District	shifting sands in patches	lightly eroded areas	Shifting sand spots	Areas without obvious desertification
Before control	44	25	9	22
After control	8	4	6	82

**Table 5 Changes of organic matter content in topsoil of desertified lands (%)**

	Zhanggutai, Zhangwu	South of Duolun	Southwest of Xi Ujimqin
Before control	0.17	0.063	0.121
After control	1.12 or 1.19 (under <i>Pinus sylvestis</i> var. <i>mongolica</i> )	0.821	0.791

The above-mentioned examples indicate that the desertified lands in semi-arid ecological environment possess the possibilities to readjust the land use orientation and to control desertification by using the inherent characteristic of self-regaining ability on the one hand and by adopting man-made suitable measures on the other hand. On the basis of calculation of the ratio of energy output to energy input of farmland in the already desertified areas at different levels, the ratio is generally 1.0—1.5 on the ongoing desertified lands, and 1.0 or less on the most seriously desertified lands. But after adopting control measures, the ratio is obviously increased. For instance, in Xiapifangyingzi of Yongfeng, Taibus Banner, Inner Mongolia, the ratio reached 1.84 and the average production of farmland increased threefold compared with that before the control of the desertified lands.

## V. MEASURES TO CONTROL DESERTIFIED LANDS

Desertification process is caused by negligence of the mutual dependent relationship between the natural environment and the human economic activities, which leads to the plunder utilization of resources. So the fundamental ways to control desertification are to utilize rationally the resources, to readjust the existing land use pattern in the transitional zone between the dry-farming area and the grazing area and to adopt a series of measures that are suitable to local conditions. Each measure is discussed respectively as follows:

1) The first measure is to readjust the existing land use pattern which is not in conformity with ecological principles, that is to say, to change the farming management which is characterized by extensive cultivation and poor harvest and takes grains as the principal and to enlarge the proportion of forestry and grazing to make them beneficial to both ecology and economy. The main points for readjusting the farming structure are to cut down the area of farmland which is influenced by desertification and to practise intensive farming on the beachflats of lake basins and on the river valley plains where the water condition is better. The efficacy of readjusting the desertified lands in some typical regions shows the problem clearly. Huanghua Tala Commune of Naiman Banner, Inner Mongolia, for example, was a sandy steppe and the annual rainfall there is about 360mm. The area of desertified lands developed to occupy 81% of the total land area in the commune due to over-reclamation of the steppe and firewood collection. Since 1970, the land use pattern which centered on dry-farming has been readjusted. Consequently the proportion of forest and forage has been enlarged; the measures such as combination of trees, shrubs and grass, and planting of tree belts, shelter belts and woodlots have been adopted; the basic farmland and fodder farms have been established; the tillage influenced by desertification has been cut down unceasingly, and the measures for fencing-sand-and-cultivating-grass have been integrated with other measures. At present, in the commune, the proportions of agriculture, forestry and grazing lands have been readjusted to 21:52:27. The desertified lands have been preliminarily controlled, the total grain output has been increased 3.36 times, and the desertification process has been under control basically (Table 6).

Table 6 The time required for stopping desertification (year)

Annual rainfall (mm)	Ongoing desertified lands	Seriously desertified lands
400—500	3±	5±
300—400	3—5	5—8
200—300	5—7	8

According to the study on land use in some typical regions, the land use proportion after readjustment varies with the different degree of desertification (Table 7).

2) The second measure is to popularize the livestock breeding system which feed the livestock partly with natural forage, partly with artificial forage. This needs to establish proper artificial grassland and forage farm to supplement the insufficient forage supply on the natural grazing fields. Owing to the combination of livestock breeding and farmland, both straw and green manure can be used as supplemental forage. It possesses very important significance to the development of livestock and also possesses evident function to the increment of economic efficacy. In the counties of the sand areas in Yulin Prefecture, for example, the value created by each man power engaged in livestock breeding is 1.38 times that created by each man power engaged in agriculture.

**Table 7 Land use proportion after readjustment in different desertified regions in the transitional zone between the dry-farming area and the grazing area**

Features of desertification	Typical region	Land use proportion(%)		
		Farming	Forest	Grazing
Ongoing desertification with slight wind erosion and sand accumulation	Jujinhao, Siziwang Banner, Inner Mongolia	61	20	19
Ongoing desertification with wind erosion and surface roughness	Gongjitang, Siziwang Banner, Inner Mongolia	47	27	26
Ongoing desertification with sand mounds, wind erosion and surface roughness trends to be serious desertification	Northwest of Xijingzi of Shangdu County, Inner Mongolia	29	30	41
Serious desertification with interlaced depression sands, fixed and semi-fixed sand dunes	Gurban Hua of Naiman Banner, Inner Mongolia	15	30	55

3) The third measure is to recover the natural vegetation on the desertified lands without productive potential. The method of fencing-sand-and-cultivating grass should be emphasized. Afforestation should be practised on sand dunes. Shrub or grass should be planted in depressions. The farmland protective networks should be established on the beachflats. Also the tree networks should be planted on the alluvial plains of rivers to prevent the basic farmland from being damaged by wind and sand.

The above-mentioned measures can be concluded in one word, that is to establish an ecological agriculture by combining graziery, forestry and agriculture together. Such an agriculture is suitable to the characteristics of the environment and resources in the

transitional zone between the dry-farming area and the grazing area. In such agriculture there are commercialized livestock breeding, protective forestry and self-supporting agriculture. By doing so the desertified lands can be gradually controlled by establishment of biological complex composed of artificial ecosystem and comprehensive protective system. This is the general characteristic of the arrangement skeleton of desertified lands which tally with the interdistribution of shifting sands, semi-fixed and fixed sand dunes with farmlands and livestock farms. Mangkeng village of Yulin County in Mu Usu sandy land at the south edge of Ordos Steppe, for instance, shows the feasibility of above-mentioned measures to combat desertification and to readjust land use pattern.

Mangkeng village is located in a beachflat surrounded by shifting sands and semi-fixed sand dunes and desertification was serious. Since 1970, the village started to rearrange positively the farmland in beachflats and to construct fundamental croplands and irrigation canals. The cultivated area was reduced by 49% as compared with that before the implementation of the desertification combating project, but the average annual output of grain harvest in the period from 1975 to 1979 was increased by 74% as compared with that in the period from 1965 to 1969. The per unit area yield increased by 20.7%. The average per capita income of agricultural population in 1980 increased by 81% over that in the period from 1965 to 1969. At present 58% of the shifting sand areas of the village has been turned into good fields. Therefore, more croplands can be evacuated to enlarge the proportion of the forest and grazing areas and to achieve the purpose of improving the ecological environment and the local economy.

To synthesize above analyses, it is found that the desertified lands in the transitional zone between the dry-farming area and the grazing area are characterized by the possibilities to readjust, and also that the successful reverse readjustment is becoming a reality in many typical regions. Moreover, it should be pointed out that human population growth and the average annual birth rate have to be controlled in order to prevent desertification. In addition, it is very important and necessary to reinforce the education for combating desertification and to work out some policies and regulations suitable to the regions with the problem of desertification conditions in the transitional zone between the dry-farming area and the grazing area.

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