

The Driving Force Analysis and Sustainability Evaluation of Land Use Change in Yijihuoluo Banner

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Abstract: YiJinHuoLuo Banner is a county of Inner Mongolia with obvious semiarid monsoon climate. Because of unsuitable land use, such as cultivating marginal land and over pasture, desertification was getting severer and severer before 1974.

Since 1974, People have been doing their best to grow woods, shrubs and grasses for increasing the coverage of vegetation. People have taken suitable and available methods of land management for combating desertification and increasing agricultural production. For example, the conservation tillage is taken for preventing wind erosion in winter season, the grazing is forbidden in early spring season for prevent grassland degradation, wells are digged for irrigation, plastic thin film is used for prolonging growing season, etc.

In recent twenty-six years, land use structure has changed a lot. Woods, shrubs and grass coverage has increased. Desertification has been controlled somewhat. Although the farmland decreased, the total grain yield increased. People's income increased too. In a word, land use is going forward to sustainability.

The main driving forces of land use changes are mining industry development and land tenure. Due to the mining industry development, many farmers get job in coal- mine and do not depend on agriculture for living much more. Therefore, many people give up cultivation of marginal land. At the same time, with current income increasing, the ability of input on land rises. Because the farmers get 30 years land-using right, they care about land protection and like to put much investment on the land.

Keywords: driving forces, sustainability evaluation, land use change, semiarid region

Although climate condition is the main force of desertification, unsuitable land use accelerates the desertification. Desertification is common problem in semiarid region, especially in those poor areas. The poorer of the people, the severer of the desertification, it seems that this is law. How to make land use sustainable in the semiarid and poor region. YiJinHuoLuo Banner is a county of Inner Mongolia, located in the northwestern of China, with obvious semiarid monsoon climate and poor economical condition. This paper analyzes the driving forces of land use change and evaluates the sustainability of land use change in according with the FESLM(Smyth and Dumanski,1993) in YiJinHuoLuo Banner.

1 Natural and sio-economical conditions

1.1 Geographical position

YiJinHuoLuo Banner is between North latitude 38° 56' —39° 49' and east longitude 108° 58' — 110° 25' . It locates in the northeastern of Mu Us sandy -land, which is a famous desertification area in China.

1.2 Topography and geology

YiJinHuoLuo Banner is in the Erodes Plateau; its elevation is about 1,240 m; the slope is getting down from northwest to southwest. In the east, it is hilly and gully region, the main sediment is loess. In the west part,

it is somewhat flat terrain that the bedrock is sandstone dominant. The bedrock is not very consolidated. So the rocks weather easily, it supplies abundant sand (Soil Survey Staff of Yikezhao District, 1989.).

1.3 Climate

The annual rainfall is 358 mm, the evaporation is 2,535 mm, and the humidity is 0.29—0.37. There is 7 years drought in 10 years. Therefore, the agricultural production is not stable. Wind often happens and is strong, especially in winter and spring seasons. The sandy texture of soils is easily eroded. So, this is an area that desertification easily happen. Sandstorm is over 26 days in a year. The sand is not come from outside, it is originated locally (Soil Survey Staff of Yikezhao District, 1989.).

1.4 Soils

With long desertification, the mollic epipedon of virgin Kastozem was blown away. Today the dominant soil is Arenosol, occupying 61.2% of all soils. In low land, there is some saline soils scattered in Arenosol and sand dune. The soil texture is sandy and not good for storing water, this makes drought severer (Soil Survey Staff of Yikezhao District, 1989.).

1.5 Vegetation and land use

Hundreds years ago, the whole region covered with grasses that annual grasses were dominant., and it was sheep's heaven. In those days, nomads grazed their sheep and cattle roamed in the vast steppe. The desertification was not a problem in those days.

The cultivation began in 1697, but it is restricted strictly only to small piece of land. At the end of Qing dynasty(1911), nearly all of the land suitable to farm was plowed. In 1949, there were 82,133 ha. farmlands, occupying 13.73% of the total land. Since the establishing of PRC, cultivation has been taking as an important task, because more and more people need food supply. Especially there were three periods of big cultivation; they were 1955—1956, 1958—1962, 1970—1973(Editing Staff of YiJinHuoLuo Banner Records,1996.).

With long historical influence of climate's change and man's disturbance, biennial or perennial shrubs and mugwort substitute the annual grasses. Now, the perennial grasses are dominant, perennial shrubs and semi-shrubs distribute widely. All of the woods are man made; there is not any natural forest. The woods mainly is poplar and willow. Shrubs occupies large area, most of them is also reforested. The main purpose of reforestation is preventing wind erosion. The woods distribute in the pattern of windbreak, shrubs distribute in sand dune or flat sandy land, and grassland distributes on the flat terrain with very shallow soils or sand dune. The grassland degraded, and its biomass is low and the quality is not good too (Soil Survey Staff of Yikezhao District, 1989.).

Being scared of starvation, people grow crops as possible as they can for storing food in case of drought years. There are 44,269 ha. farmland in 1999. Farmland mainly distributes on the flat terrain and in the river valley. The main crops are grain, including corn and millet.

1.6 Land use and desertification

With cultivation of marginal land, soil erosion is getting severer and severer. Overgrazing also causes grassland degraded. Before 1974, in a word, desertification developed so severe that the production of agriculture and husbandry was greatly influenced, many people had to immigrate outside.

1.7 Socio-economical situation

There was population of 143,949 in 1998. Thereof, 115,108 people lived in rural, depending on cultivation and grazing for living. Cropping is main income for Han people. Grazing is dominant income for Mongolian. Industry and commerce are not developed. Coal mining is the only industry. According to

the statistic data, the gross national product(GNP) was 1,025.32 million ¥ RMB, thereof, 263.32 million ¥ RMB coming from agriculture, occupying 25.68% of the GNP, 451.00 million ¥ RMB coming from industry, occupying 43.99% of the GNP; The net income of farmers was 2,150 ¥ RMB in 1998. In 1998, total grain yield was 91,486 t, every one had 636 kg grain.

2 Methods

Data and material were collected for analyzing the land use changes, and evaluating its sustainability. These data includes meteorological data from locally meteorological station, economically statistics figures from the Statistics Bureau of YiJinHuoLuo Banner. Field tour was conducted for soil, plant and crop survey. Land use data came from the maps of different time charted by land use survey staff. Farmers also were visited for collecting some information about land use, land management methods, land degradation, etc. The former study materials were also collected.

3 Land use changes and its driving forces

Since 1974, land use structure has changed a lot. People also have been doing their best for combating desertification.

3.1 Land use changes in recent 25 years

In 1974, government decided to change the policy that agricultural production focus on the grain production and establish the policy that agriculture production focuses on husbandry, combining agriculture, supported by reforestation. People do their best to grow woods, shrubs and grasses for increasing the coverage of vegetation. Therefore, the coverage of woods and shrubs increased, the sand dune decreased (Fig.1). Farmland also decreased greatly. In 1965, there were 65,400 ha. Farmland; in 2000, there were only 44,103 ha. farmland left.

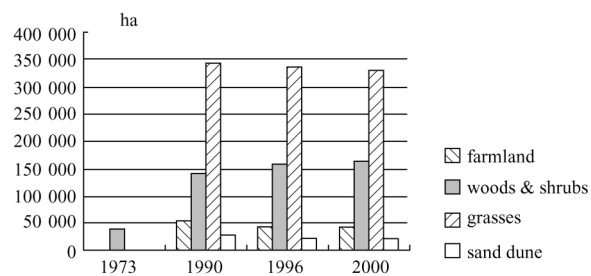


Fig.1 Change of land use structure

Suitable and available methods of land management are taken for combating desertification and increasing agricultural production. For example, the conservation tillage method, like residue cover is taken for preventing wind erosion in winter season, the grazing is forbidden in early spring season for prevent grassland degradation.

With the increasing of vegetation coverage and conservation tillage methods, soil erosion decreased (Fig.2).

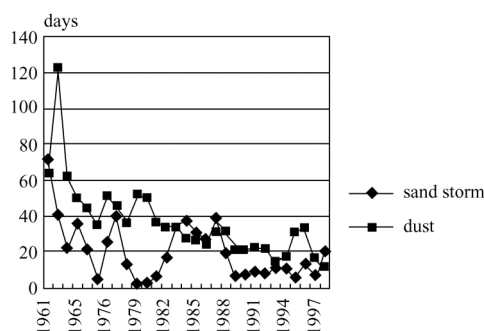


Fig.2 Wind erosion changes

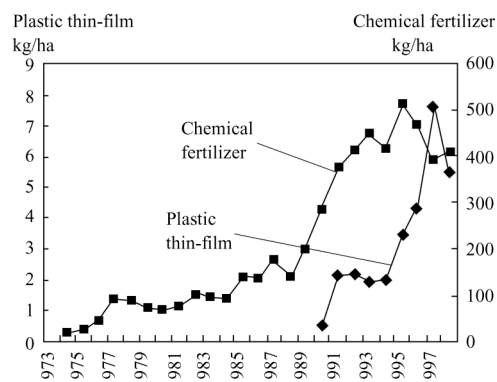


Fig.3 Growth of input on farmland

3.2 The driving forces of land use changes

(1) Awareness rising of the causes of desertification

The desertification gives government and peoples a good lesson. The government and people gradually understand that over-cultivating and over-grazing are the main causes of desertification. They also understand that reforestation is necessary tool to prevent soil erosion and ensure agricultural production, and that an appropriate structure of land use is the basis of comprehensive agricultural development.

(2) Input increasing

Farmers increased input on land for increasing yield of agricultural production, including fertilizer, and plastic thin film (Figure 3). Government also increases investment on the basic construction of agricultural production, like irrigation system. Irrigation makes the production higher and more stable against drought, plastic thin film increases the length of growing period, and fertilizer rises the level of nutrient supply. All of these methods increased agricultural output.

(3) The influence of land tenure

Land ownership or tenure is important factor that influences the land use. In the commune period, all of the land belongs to the commune; people had no interesting to sustainable land use. In 1981, China had taken land tenure reformation; every farmer gets 30 year utilizing right of the farmland that used to belong to the Commune. In 1984, the grasslands was divided and redistributed to the individual farmers, farmers get 30 years using right too. Because farmers get 30 year using right of the lands, they like to put much investment on the land. Therefore, the input of productive material greatly increased, like fertilizer, chemical, plastic thin film, railing material of surrounding grassland, etc. With the input increasing, the unit yields rises rapidly.

(4) The influence of law and regulation

For protecting grassland and woodland, the government establishes a series of law and regulation. For example, the national law does not allow people deforestation; the county regulation restricts grazing in early spring season. These law and regulation have made good effect on preventing land from degradation.

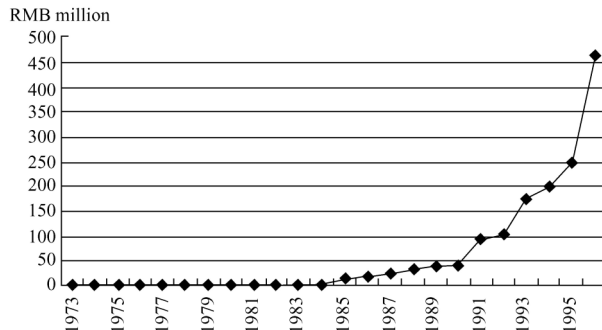


Fig.4 Industry development

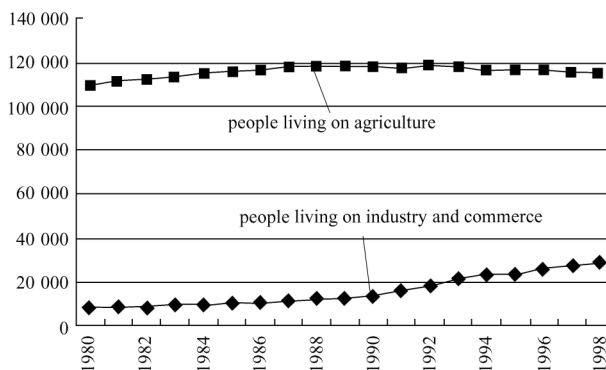


Fig.5 The population change in agriculture, industry and commerce

(5) The influence of industry development

In 1980s, coal mining is developing rapidly in this area. With mining developing, the industrial output has been increasing by times (Fig. 4). More and more farmers get job in coal- mine, they earn a lot of money from mining, and do not depend on agriculture for living much more (Fig. 5). Therefore, many people give up cultivation of marginal land. At the same time, with current income increasing, the ability of input on land rises.

4 Sustainable evaluation of land use changes

4.1 Sustainable evaluation in economical aspect

From 1981 to 1998, the agricultural output increased greatly, including cropping, husbandry and forestry; people's income has increased too (Fig.6). Many farmers build new houses, their living standard rise up greatly. Therefore, the change of land use is sustainable from economical view.

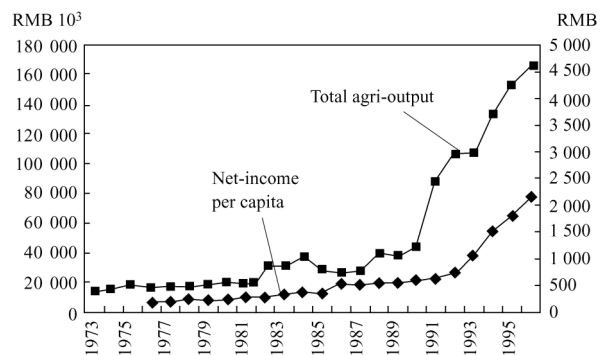


Fig.6 Economical Growth

4.2 Sustainable evaluation in land productivity aspect

The irrigation increases the ability against drought and makes productivity higher and more stable (Fig. 7). Fertilizing increases the soil's fertility. The construction of basic farmland raises both of the productivity and stability of farmland. Therefore, the change of land use is sustainable from the productivity aspect.

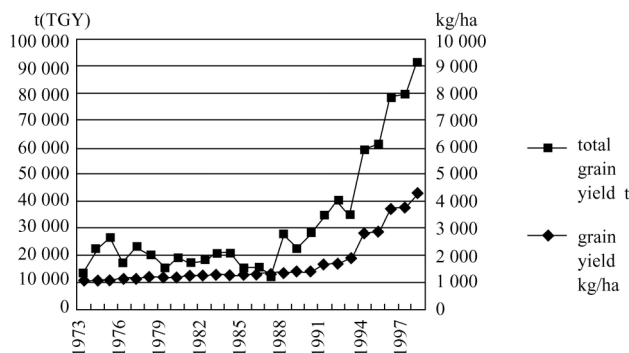


Fig.7 Yield change of farmland

4.3 Sustainable evaluation in ecological aspect

With reforestation developing and windbreak building, green cover is increasing, the number of sandstorm decreasing (Fig. 1 and Fig. 2). People's living condition is improved. Therefore, the change of land use is sustainable in ecological aspect.

5 The comments on sustainable land use

Although the land use is changing to sustainable direction, there still are some unsustainable phenomenons. It is necessary to overcome or resolve these problems for making land use sustainable.

5.1 Appropriate land use structure

Through detail survey and research, the appropriate structure of land use is 3.2% of farmland, 35% woods and shrubs-land, 47.8% grassland in the total land. This structure of land use means that the farmland can produce enough food to feed people, there are extra animal products to sell, and there are excellent woods and shrubs to preventing soil erosion.

5.2 Developing industry

Developing industry is available root for absorbing labors, increasing people's income. With income increasing from industry, people do not depend on agriculture much; they will give up cultivation of marginal farmland, and increase input on agriculture. In return, the improvement of ecological environment found better condition for industry development. So, industrial development is the key to make sustainable development in this marginal region.

5.3 Construction of basic farmland

To change the rainfed farmland into irrigation farmland, build terrace and windbreak belts, and all of these are called basic farmland construction. The yield will rise with basic farmland increasing. Increasing basic farmland is the most available way to withdraw plowing from the marginal farmland and stop the desertification. At present, irrigated farmland only occupies 13.12% of the total farmland; the rest is rainfed farmland. Generally, the yield of irrigated farmland is three times of that of rainfed farmland. Developing irrigation is the first choice of constructing basic farmland. There are abundant ground water resources needing to exploit. If we take the water saving irrigation method, and exploit the water resources, the irrigation farmland will increase greatly.

5.4 Improving grassland and pasture system

There is only small area of cutting grassland in this area. Without cutting grass, there is no enough storage of grass. When the winter comes, sheep are getting thinner and thinner because of shortage of grass. Therefore, the income of husbandry is still low. For increasing the production of grassland, improvement of grassland is necessary. Firstly, to improve the grass, secondly, to grow grass, thirdly to irrigate and fertilize the grass.

It is necessary to change the range grazing to site feeding, at least, to delay grazing period to the season when the grass grows well.

The structure of animal is not appropriate. There are too many pigs that need grains. This makes farmers to grow more crops. It is necessary to decrease the number of pigs and increase the number sheep or cattle. It is also necessary to introduce the new and excellent species for increasing the yield of animal products.

5.5 Appropriate structure of reforestation

Because the climate is semiarid, the most available reforestation is planting the shrub, not the tree, in this region. The most of reforested trees are poplar. Because of the simple structure of trees, insects and other disasters often happens. The poplar wood is not good for timber. The income from forestry is very low; this influences people's activity to grow trees. So, it is necessary to readjust the structure of woods.

5.6 Increasing capital input

The input of agricultural production material still does not meet the requirement of high yield. Although people's income increased in recent years, they are still the poorest persons in China, with long history poverty on the shoulder. It is not easy to increase input and construct basic farmland for farmers depending on their own economic ability. Government should put money or gives loan to farmers, help them to build irrigation system, grassland rail, etc. enrich farmer's ability to struggle to the natural disasters.

5.7 Using modern techniques

For increasing the yield, modern technicians must introduce into agriculture, including new and excellent species, water saving irrigation methods, thin plastic cover, etc.

5.8 Prolonging land using right

It is necessary to delay the contract of land use right to long period. This is important to make people continue increasing land input. It may be the best way to give the people permanent land utilization right.

5.9 Suitable land management

Terrace or contour plowing is the best way to decrease the water erosion. For preventing wind erosion, windbreak is needed, and residue cover is also good way.

Some optimized models of land exploitation and resources utilization should be established by integrating, assembling the successful experiment. Extending these models is an important way to reach the goal of sustainable land use and to combat desertification.

5.10 Education and training

Generally say, the education level is still very low in this region. Many farmers are illiterate. In this standard of education, it is hard to use modern agricultural techniques. Therefore, Developing education is an important task in the 21st century. It is also available method to take training classes. In the training classes, some easy taken techniques should be told to farmers.

5.11 Family planning

Although the rate of population growth decreases since 1977, population growth rate is still high, comparing with the other region. With the population increasing rapidly (Figure 8), the conflicting between people and land resources will be sharpening. Family planning should be carried out for sustainable development. If we did not take the family planning, There would be more people, they needed much food, cultivation would increase, and desertification would not be controlled.

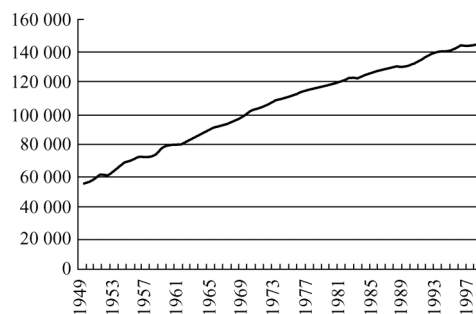


Fig.8 Population growth

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