Regional Agricultural Drought Adaptation and Its Policy-driven Forces in Agriculture-pasturage Ecotone of Northern China-----Taking Xinghe County in Inner Mongolia as an Example

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ABSTRACT: In recent decades, global climate change has become the focus of international attention. It is essential to develop and implement effective adaptation measures. Agriculture-pasturage ecotone has existed for long time. People who live in Agriculture-pasturage ecotone of Northern China have developed a successful adaptation to drought. This paper aims to identify the policy-driven forces of drought adaptation in the Agriculture-pasturage ecotone of the Northern China, And a case study was also carried out. The results show that, the following four adjustments, including adjustment on the land use structures, on industrial structure, on production structure in agriculture, and on income structure, have contributed a lot to the drought adaptation in this area. The results could provide basis for drought adaptation strategy decision-making in the future with the situation of the global climate change.

***Keywords*: agriculture drought adaptation, policy-driven forces, agriculture-pasturage ecotone of Northern China.**

1. INTRODUCTION

In recent decades, global climate change has become the focus of international attention. For the human socio-economic systems, that how to adjust their behaviour in order to better mitigate and adapt to climate change and the related climate change impacts has become the focus. It is essential to develop and implement effective adaptation measures so that climate-related risks and opportunities might support development objectives within local and policy decision-making processes (Adger et al., 2006; IPCC, 2007b). IPCC (2007) defines adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploits beneficial opportunities". And some people have made some meaningful attempts, for example, UNDP published the adaptation policy framework (APF) in 2005. But for climate change adaptation, there is still a long way to go.

Agriculture-pasturage ecotone of Northern China (Fig.1), located in the arid and semi-arid climate type areas, has always been in a situation of frequent drought, almost once every year. But people who live here have developed a successful survival strategy to adapt to the frequent drought. Meanwhile, the global climate change has posed Northern China an obvious drought tendency. In this situation, researches on the drought adaptation of these drought-prone areas, such as the Agriculture-pasturage ecotone of Northern China, will help to build a better adaptive strategy to coop with the increasingly obvious situation of warming and drying trend in northern China. Of course, drought adaptation is influenced by many factors. This paper tries to probe into the problems in policy-driven forces of drought adaptation and takes a pilot study on the policy strategy of drought adaptation in Xinghe County of northern China, in order to provide experience and guidance for Chinese to equip them better to adapt the warmer and dryer climate.

2. THE MODEL FOR DROUGHT ADAPTATION IN HISTORICAL PERIODS

Agriculture-pasturage ecotone has existed for a long time. And its modern position covers the ecotone between the farming area of northeast and north China, and pastoral areas of natural grassland ecotone in northwest, extending northeast to the southwest with an area of $69\times10^4 km^2$. It is in arid and semi-arid climate type regions and annual rainfall is 250-500mm, just located in the tail-end of monsoon dry, in existence with a lot of land resources ecological security problems, is a weak strip. With the changes in the strength of the southeast monsoon, monsoon sink area is also changing, which has a direct effect on the regional climate changes of precipitation and temperature. In order to adapt the uneven distribution of precipitation in time and space scale and the attendant frequent drought, people in these areas had developed some adaptive models which proved to be successful, that is, the alternative model and the staggered distribution model of agricultural and animal husbandry.

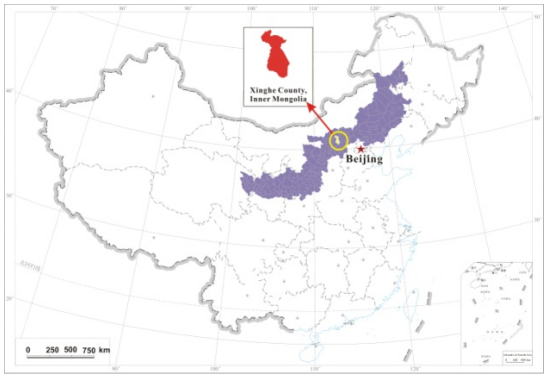

Fig. 1: Location of Agriculture-pasturage Ecotone of Northern China

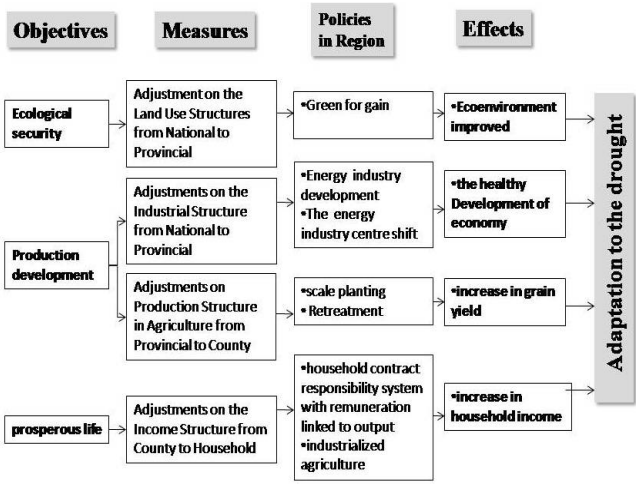

Fig. 2: the framework of drought adaptation strategies in Agriculture-pasturage ecotone in northern China

The alternative model for drought adaptation means that people could choose agriculture or livestock production according to the temporal precipitation amount fluctuation. And this type of drought adaptation model also had left deep impression in history. Shi (1989) found there was an obvious periodicity of about 2000-year in precipitation fluctuations in the time scale of 104 in agriculture-pasturage ecotone of northern China. Farming in this region is a typical rain-fed agriculture, and the layout of agricultural and livestock production conditions constrained by water amount greatly. The variation of precipitation and other climatic factors played a key role in the alternative of dry farming and animal husbandry development in the region. And some important events also have an close relationship with the 2000-year periodicity fluctuation, such as the rise and fall of material culture of the Holocene in northern China, the migration of economic & culture center, and the alternative of farming and animal husbandry, and so on. According to the historical materials of Ordos region in Inner Mongolia, ,Shi (1989) found that along with the 2000-year variation, there was an obvious alternative development series of agriculture and nomadic cultures, and this was an inevitable result of harmonizing between the precipitation and agricultural and livestock production. For this reason, we could say the alternative arranges of agriculture and livestock production is adaptation to the climatic fluctuation, especially in the rainfall fluctuation.

The staggered distribution model means that people could choose the agriculture or livestock production according to the spatial difference of precipitation. Because of topography, the water was also redistributed in spatial and had great regional disparity. The flat area are often good for farming because of the better moisture condition, while the mountain hilly area was developed as grazing livestock area (Wang,1989). Therefore, the land use patterns takes on a staggered distribution. In summary, the alternative and staggered distribution model of agriculture and livestock production for drought adaptation is the results of people in ancient to adapt to the drought environment.

3. DROUGHT ADAPTATION STRATEGY FROM NATIONAL TO LOCAL IN AGRICULTURE-PASTURAGE ECOTONE OF NORTHERN CHINA AFTER 1978

Agriculture-pasturage ecotone in northern China is an eco-sensitive area, also eco-barrier for eastern China, and a conservation area of some major river in northern China. But it has always been severely affected by drought unfortunately. Moreover, unreasonable human activities accelerate the deterioration of ecological environment in the recent decades. In the situation of warming and drying trend in Northern China, government, from national to local, issued a series of policies to promote the region to better adapt to stimulate the development of production, life and eco-civilization .All of those have contributed a lot to the drought adaptation in this area. The following selection should only be explained on the following aspects (Fig 2).

3.1 Adjustment on the Land Use Structures from National to Provincial

The biggest problem of agriculture-pasturage ecotone in northern China is the ecological degradation. So it was very important to strengthen the ecological construction in this area for the sustainable development of regional economy. And the first thing is changing the unreasonable land-use structure conditions. Its ecological functions of green ecological barrier for East China, agriculture-pasturage ecotone in northern China must practice the policy of returning farmland to forest and grassland.The policy of returning farmland to forest and grassland was made by the Chinese State Council in 1999, with the purpose to concede the farmland to forest or grass, most of which are the slope land, the desertification infertile farmland, usually they are serious soil erosion, and low in production, including the land of ecological importance. At the same time, the implementation of subsidy policies and tax incentives reversed. It has made some great achievements in ecological construction and environmental conservation since the project implementation.

While returning farmland in large area, some small lands are converted for farmland, so it has developed a pattern of “large area for ecological, small area for food production”. As the grass vegetation has a broad ecological adaptation, it could adapt the dry environment over a long period, and its demand for water and heat coordinate easier, especially it could slow growth in the dry season and have a bumper harvest, using the relative abundance of autumn precipitation and heat. Therefore, the project - returning farmland to forests or grassland-not only promote ecological restoration ,but also promote the drought adaptation in the region, by reducing the loss risk of agricultural production systems caused by drought.

3.2Adjustments on the Industrial Structure from National to Provincial

The agriculture-pasturage ecotone in Northern China is rich in coal and oil. And the biggest energy base of the country is located in the region. All of this gives the local a priority to develop energy industry. And what’s more, it could make up the agriculture loss caused by the drought disaster. Since 1981, the Chinese government has paid more attention to exploit the abundant coal resource and oil of the central and western. The national coal industry development key move on the west had started truly, what attracts many famous heavy plants to move in.

From 1979 to 2008, government from national to Inner Mongolia, for example, has issued a series of policy to stimulate the development of coal industry. Such as policies aiming to accelerate the development of township coal mines, policies to collect efforts, from national, collective to individual, to exploit the coal resource, and policies to encourage development of big enterprises . Of the policies from national to provincial, often have rendered great service also has had. But there is no denying that the development of the coal industry has laid the basis for the energy industry's dominance of the secondary industry, and the economy has successfully stepped on the expressway. It proved to be successful that the losses caused by the drought disaster can be rectified by exploiting the underground energy.

3.3Adjustments on Production Structure in Agriculture from Provincial to County

Each crop has requirement regarding water and heat conditions. Agricultural production in agriculture-pasturage ecotone in northern China depends on natural rainfall. The crop growth is restricted by the water factor heavily. So some drought-resistant crop should be planted in this area as much as possible. At the same time, agricultural production schedule for planting should early or late for dry season, as far as possible to avoid drought risk.

In Ulanqab City ,for example, before 1994, 70% of the farmland was planted for early spring crops, wheat and oat, but during the cropping season in the first half of the year, there is not enough water for crops’ growth, so this kind of plant pattern is contrary to the regional climatic characteristics of drought. And as the result, 60% of farmers live in poor. In order to change the unreasonable planting practice, in 1994, Ulanqab City decided to adjust the crop planting structure, and to develop the adaptive planting practice instead of the traditional conflict ones to avoid the drought risk. Some of the effective ones included increasing the planting area of the drought-resist crops and retreating from the early spring crops, such as wheat and oat and so on .And at the same time, they had succeeded in planting corn and promoted to plant on large scale. Since 1994, the provincial government of Inner Mongolia has implemented several big projects to promote the dominant crops plant in large-scale, such as the double-million hm^2 of potatoes and 125 million hm^2 of corn, and so on. Through the adjustment on the crop planting structure, it can not only increase food production, but also could reduce the relative disaster loss. Both could do fever for keeping production stable and reducing the vulnerability of food production systems, improve the ability to resist agricultural drought and construct the adaptability to drought.

3.4Adjustments on the Income Structure from County to Household

The diversification of household income is helpful for the family to recover from the disaster (Ellis F, 1998; Francis E, 2000; Slater R, 2002). And increasing the income diversity of the household is also an effective risk transfer strategy (Guvele, 2001).By instituting the household contract responsibility system with remuneration linked to output and promoting industrialized agricultural operations, farmers have greater enthusiasm for production and the productivity of labor has made great progress. And as an result, more and more surplus laborers were released to work in other departments. And the process of urbanization and the rapid development of town economy call for more and more labors, which makes a large number of farmers migrate into cities. Therefore, the proportion of Income from working in cities or towns of total income increases gradually. This is important to enhancing their drought adaptation.

In Inner Mongolia for example Since 1978, along with the development of market economy, great changes have taken place in employment structure, farmers’ income show an tend of diversification and de-agriculturalization. The earned income, represented by the income from working in cities or towns, becomes an important source of farmers’ household, instead of the traditional single agricultural production.

4 CASE STUDY: AGRICULTURAL DROUGHT ADAPTATION POLICY-DRIVEN ANALYSIS IN XINGHE COUNTY

Xinghe county which is located in 40 ° 26 N ~ 41 ° 26N, 113 ° 21E ~ 114 ° 07E, the middle of farming-pastoral ecotone of northern China(Fig 1), is a typical rain-fed agricultural areas with more than 90% of its arable land are dry land (Wan, 2008). Drought disaster is the most serious natural disaster to agriculture and animal husbandry of Xinghe County .In 1970s-1980s, large

areas of deforestation and land reclamation led to gradual deterioration of ecological environment and poverty has not been fundamentally changed. According to statistics, Xinghe County has arable land 115,800 ha, of which there is 36,800 ha land in 6 ~ 15 ° slope, 19,300 ha in 16 ~ 25 ° slope, 6,200 ha in 25 ° slope and above. Most of these slope lands are infertility and severely erosion by wind and water which lead to low and unstable grain yield, only 45 kg per mu. It is a good way for regional poverty alleviation and ecological construction to return the land to grass and change from agriculture to farming. After 1978, Xinghe County government explored a new way adapted to the natural environment according to local conditions. Returning the land to forest and grass was taken as breakthrough in the development process and three aspects were focused on in order to promote economic development and the coordination among nature society and environment. Since 1994, Xinghe County implemented the strategy "green for gain" to return the inappropriate land to forest or pasture according to local conditions. It also changed from dualistic structure of grain and economy in the past to triad structure of grain, economy and grass by carrying out the combination of tress, bushes and grass.

First, ecological status markedly improved and soil erosion and desertification has been effectively contained in Xinghe County with 12.7% forest coverage rate by returning farmland to forest and grassland and adjusting land use of the whole county. All these activities helped liberate the labor force engaged in agricultural production, increase labor output and create new income opportunities.**Second**, the county industrial structure adjustment was promoted through ecological restoration which changed the traditional situation of agriculture domination(Fig.3), increased the proportion of animal husbandry industry, changed grain dominated into animal husbandry dominate and improve comparison profits. On the other hand, the internal industrial structure adjustment of agriculture improved the proportion of rural secondary and tertiary industry population and non-agricultural population. So we should improve agricultural and livestock products, develop services and increase farmers' income from non-agricultural industries and promote rural surplus labor moving to the second and tertiary industries. **Third**, high yields and strong drought resistance, especially the crop varieties' plant proportion of high useful underground biomass; it is helpful for food ecosystem to improve the ability of defending against natural disasters in the arid and semi-arid areas. Country government increased the area of potatoes between the middle and latter half of the 1970s and the end of 1980s. Especially for after 1998, the government strengthened the adjusting step of agricultural enterprise structure and took the potatoes as the leading industry in the country. The crop plant structure of Xinghe country has great changes in the past 30 years for the reason of adjusting crop plant structure and improving the proportion of high quality crop variety and non-food crop farming (Fig.4). This crop plant structure change improves the water resources utilization of Xinghe country rained field and has important role of stabilizing food production and enhancing human's adaption of arid areas.**Fourth**, the implementation of ecological engineering of Grain for Green have liberated the rural labor force, and increased labor output and created new income opportunities. On the other hand, the development of township enterprises have broken the natural economic structure of traditional planting and breeding industry as well as the production of single food, optimized the rural economic structure, promoted the combination of planting, breeding, processing, agriculture, industry and business, improved the level of comprehensive utilization of resources, flourished the rural economy, increasingly diversifying income sources of farmers, increasing income diversity of household, making up the loss of income in agriculture caused by drought through other income so as to meet situation of drought region better.

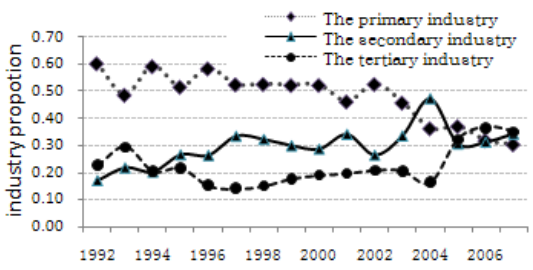

Fig. 3: the adjustment of the industrial structure (1992-2006)

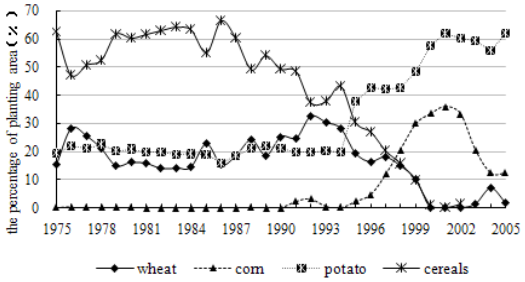

Fig.4: the adjustment of the planting structure (1975-2005)

5. CONCLUSIONS

Agriculture-pasturage ecotone has existed for long time. The alternative model and the staggered distribution model of agricultural and animal husbandry proved to be successful in the region, and they are the results of people in ancient to adapt to the drought environment. the biggest problem of agriculture-pasturage ecotone in northern China is the ecological degradation, and the first thing is changing the unreasonable land-use structure conditions. Taking advantage of the chance to carry out the "green for gain" project, the governments, from national to local, focus the following four adjustments, that are, adjustment on the land use structures, industrial structure, production structure in agriculture, income structure. All of those have contributed a lot to the drought adaptation in this area.

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