Sustainable Development and Ending Poverty in Bashang : With the Observations for Thirty Years (B Case)

2. External Effects of Wind Erosion in Bashang

A research project conducted in the end of last century studied on the relationship of duststorms and desertification (Liu et al. 2003). The results of this study show that there exists strong relationship between airborne dust and desertification:

1) In soil of drifting sand dunes, there are relatively fewer fine particles, since most of fine particles have gone with strong winds historically, as a direct result of soil coarsening.

2) In top soil of the typical grassland, there are a certain amount of fine particles which are possibly blown into the air when grassland vegetative cover is getting degradation.

3) In soil of cultivated land, there are a certain amount of fine particles, which are much more possible to get blown into the air during farmer ploughing in spring, becoming a source of duststorm. However, perennial vegetative cover can effectively protect top soil from wind erosion after returning ploughing farmlands back to grasslands.

Clearly, ploughing farmlands and degraded grasslands are main source of dust storm. Loss of top soil by wind erosion has both on-site and off-site negative effects. On-site, crop production decreases when nutritious top soil blown downwind. Off-site, fine soil particles can be carried a long distance by strong winds, resulting in dust pollution.

A recent ecological evaluation conducted by Wang and Pei (2018) shows that from 1980 to 2000, the effects of wind erosion control in Bashang was getting weaker and the desertified area increased, caused not only by weather but also by human agricultural activities.

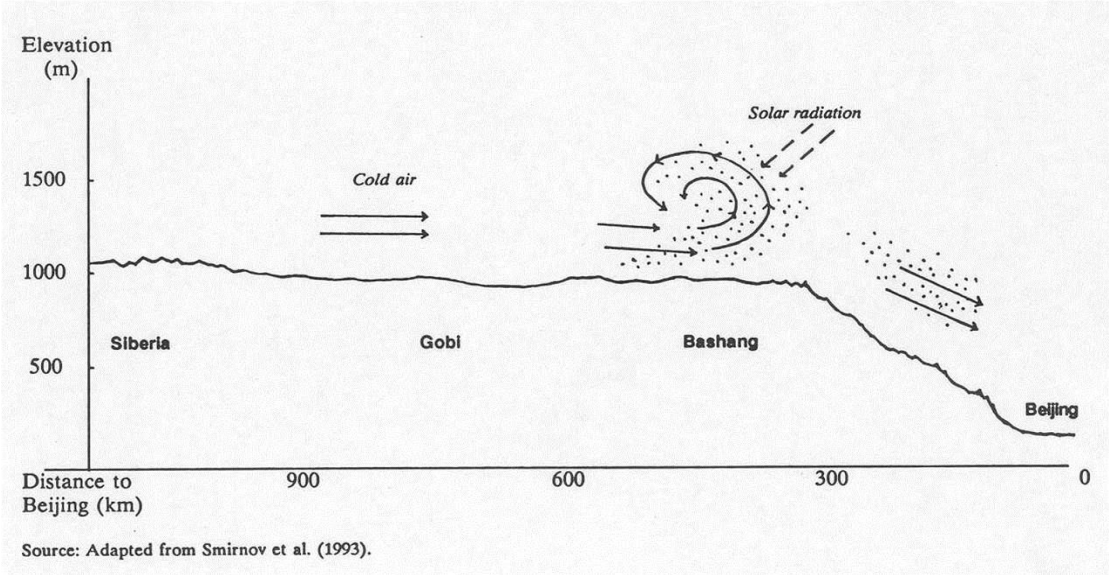
2.1 Downwind External Effects

From Bashang to Beijing, it is about 200 km (124 mi). During the past century, in Bashang, a considerable part of grassland has been cleared to farm, and the remaining rangeland has been overgrazed. Consequently, a large amount of top soil has been eroded by wind, and the desert scattered in northern Bashang is expanding. The most serious erosion occurs in spring when the fields are ploughed and the land surface is left without vegetative protection. The dominant soil texture in Bashang is loam. The predominant size of loamy soil particles is from 0.06 mm to 0.002 mm (2μm) which can be blown high into

the air and carried a great distance with winds (Holy 1980), polluting Beijing and other downwind regions.

Research on dust transportation also suggests that Bashang be the important dust source of windblown-dust pollution in Beijing. (Liu et al. 2003) With a wind speed equaling 10 m/s, Schutz's (1979) theoretical model on Saharan dust indicates that for dust particles with sizes from 0.1 to 20 μm, only about one-fourth of them remain in the air after the first 600 km. The maximum concentration of dust (the worst duststorm) can be reached at about 200 km from the dust storm source, which is the distance from Bashang to the northern edge of Beijing. Satellite data obtained in the USSR/US dust experiment in Middle Asia also show that a vigorous duststorm generated a dust cloud as long as 400-500 km (Smirnov *et al*. 1993).

Figure 2-1 Illustration of geographic allocation and duststorm generation



Source: Adapted from Smirnov et al. (1993).

Figure 3-1 illustrates why Bashang considered to be the main source of duststorms in Beijing. Adapted from Smirnov et al. (1993), the figure also illustrates the generation process of duststorms. Therefore, wind erosion control in Bashang and the nearby degraded grasslands in the Inner Mongolia Plateau should be the key for downwind ecological improvement in regions of Beijing, Tianjin and Hebei province.

2.2 The On-Site Benefit-Cost Analysis

Three main causes of wind erosion have been identified (Troeh et al. 1990). The first cause is strong winds, the second is that the soil surface is bare, and the third is that the soil is loose, finely divided, and dry. Correspondingly, three policy options are considered. (Hu et al. 1995)

Option I is the construction of tree belts to serve as wind breaks. This option has

already been partially adopted in the Bashang region. A tree belt, about 100 meters wide, was constructed by the central government during the 1980s. However, the costs of this "green great wall" are high and its effectiveness is questioned. Planting thinner but closer tree windbreaks has been proposed as an alternative, and has been practiced in the Northern China Plain.

Option II is converting crop production to perennial **forage production.** The perennial forage residues would protect the soil surface year around with an effective vegetative cover. The forage can be harvested and laid in, providing a forage source for confined livestock production.

Option III is the adoption of a **conservation tillage** farming system that includes crop rotations and residue (stubble) retention. Field experiments in this region have shown that such a crop rotation (wheat, Huma, oats and alfalfa) can increase soil moisture and thus reduce erosion. Leaving more crop residues on the soil surface also provides better protection during the winter and spring.

It is not realistic that all cropland in the Bashang region should be placed into forage production, though that was the system that generated the highest societal benefit per hectare. If the entire Bashang region switched to forage production, there would result grain shortages in the area, with subsequent price increasing for grain. This analysis suggests that 1) some current cropland should be converted to forage production and 2) land that remains in crops should be farmed in ways that reduce soil erosion, 3) rangeland should be grazed under a conservation program and livestock densities should be controlled according to grass stock levels and soil erosion situations.

A cost-benefit analysis investigates specific changes in farming practices aimed at reducing wind erosion from cropland in the Inner Mongolia Plateau. In the study, Hu et al. (1995) estimate the total revenue and total costs to the farmer of implementing the three erosion control methods in Bashang.

Benefit-Cost Analysis is based on the following wind erosion equation proposed by Woodruff and Siddoway (1965), the potential average annual wind erosion amount, E, is determined by:

$$E = f(I, K, C, L, V)$$

where, I is the soil erodibility index

K is the soil ridge roughness factor

C is the climate factor

L is the field length

V is the vegetative factor

Data on crop and forage production, conservation techniques, and livestock production were obtained from a report based on field studies conducted by agronomists and engineers in the central Bashang region (Guyuan Ranch 1985). Costs of crop production and afforestation were taken from a survey of farmers in Hebei province made by the Department of Agricultural Economics at the Hebei Agricultural University from 1984 to 1986 (Ma and Hu 1986).

Based on present value net benefit analysis, the on-site economic ranking is:

Conservation tillage > Forage production> Tree belts

Therefore, conservation farming is the best. Clearly, the current system of farming is sub-optimal, both in terms of the on-site returns and from society's perspective. The local government should encourage adoption of soil conserving practices. However, it must first consider why farmers have not already adopted conservation farming practices, given that they generate higher on-site returns.

There are at least three main reasons why such practices are not already more widespread in 1980s. First, farmers are not informed about techniques for soil conservation and their benefits. Second, farmers in this region are extremely poor, and have limited access to credit. They cannot afford, in the short run, to dedicate the resources needed to buy and plant trees, plant forage and buy lambs, or to allow land to lay fallow. Third, land tenure in China is not as secure as in western countries. A farmer who is not sure he will continue to hold the harvest rights to a plot of land will be less willing to make investments in land improvements such as planting tree belts or green manure. These problems suggest a strategy to encourage adoption of technical extension accompanied by subsidies and small loans to farmers, along with stability in land tenure.

2.3 Valuing Downwind External Effects

Estimating the potential value to Beijing residents of dust reductions is not easy. As true for most environmental goods, an organized market for air quality does not exist. Techniques for valuing air pollution reduction fall into two categories: indirect market methods such as hedonic pricing approaches, which infer values from actual choices, and direct questioning methods such as the contingent valuation (CV) method.

A common method of studying windblown dust effects is to use meteorological data on visibility (Lee et al. 1993). Although a reduction in dust pollution will have many other different beneficial effects such as reduced health impacts and reduced soiling of clothing and buildings (Watson and Jaksch 1982), the focus of their study is only on the improvement in visibility that will occur. Other effects are not investigated due to the limitation of available data. To the extent that survey respondents include in their stated

value for a visibility improvement other benefits that they would also enjoy if air pollution were reduced (Berger et al. 1987), the stated values will measure more than just the value of the visibility improvement.

A survey was conducted in Beijing by students of Peking University at 1996 with a survey question of Willing To Pay（WTP）of Beijing residents as follows:

> *Beijing ranks very high in air pollution among the large cities in the world. To improve air quality in Beijing, the municipal and central governments have made great efforts, such as using nature gas to replace coal to provide utility, afforesting upwind regions. To further reduce suspended particulate by 50%, what is the maximum willingness to pay (WTP) for your family per year?_____. Or, you may choose a value that is closest to your willingness to pay from the following numbers.*
>
> *0, 5, 10, 20, 30, 40, 50, 70, 100, 200, 300*
>
> *400, 500, 600, 700, 800, 900, 1000, 1500, 2000*

Based on the 1996 survey results, the concerns of Beijing residents on environmental problems was ranked as in Figure 2-2.

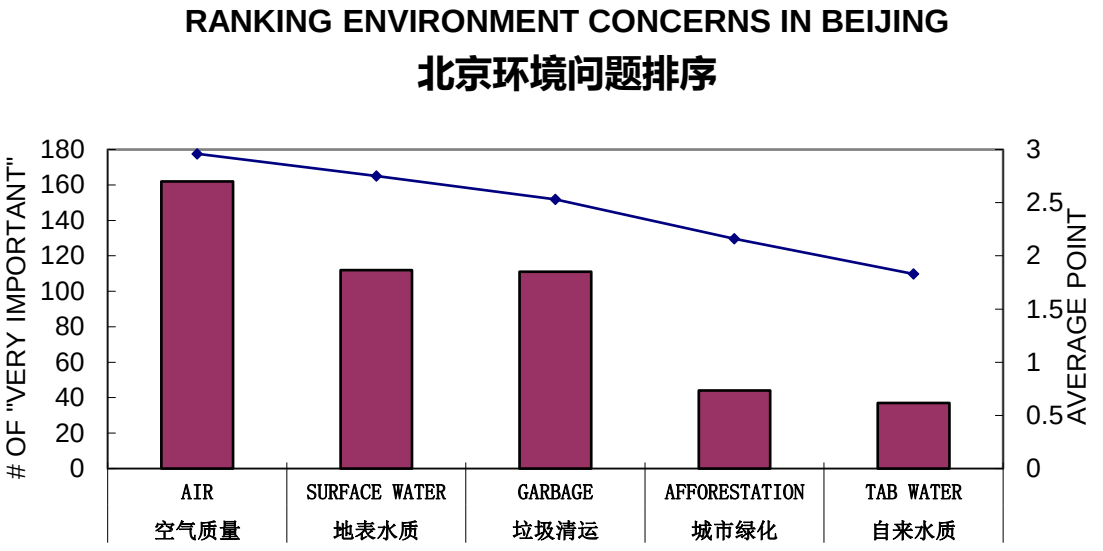


Figure 2-2 Rank of environmental concerns of Beijing residents

Clearly, air pollution is the top environmental concern of Beijing households. The average WTP of Beijing residents for dust reduction is 157 yuan/year. This value of downwind external effects can be used to estimate the benefits of dust reduction, and to rethink of the decision analysis on erosion control in Bashang.

The benefit-cost analysis including external effects can be calculated by including the downwind benefits, then the economic ranking of three options has a change, in

comparison with the rank in Section 2.2.

Forage Production > Conservation Tillage > Tree belts

Where, forage production replaced conservation tillage become the best option. The new rank explains that the best wind erosion control plan should provide the best land surface protection to reduce the chance of duststorms. An analysis in Section 2.2 included only on-set benefits and costs showed that conservation tillage and crop rotation gave the highest returns. However, forage crops provide much better ground cover, and therefore reduce soil erosion much more effectively. Inclusion of the off-set benefit into the analysis shows that a forage/livestock operation provides the highest total benefit to society.

Farmers in Bashang have financial difficulties to fight with the severe wind erosion. Benefit- cost analysis provides a foundation for government policy making of wind erosion control.

2.4 How to Return Farmlands to Grasslands or Forestlands ?

How to return farmlands to grasslands or forestlands in Bashang?

1) Government regulation: Abandon farming in Bashang

Forest Law of the People's Republic of China, implemented on 1 January 1985

Item 1 of Article 19: prohibit destroying forest for reclamation and destroying forest for quarrying, sand and earth mining as well as other actions related to forest destruction.

Grassland Law of the People's Republic of China, implemented on 1 October 1985

Article 10: strictly protect grassland vegetation, forbid reclamation and devastation. Limited reclamation carried out by grassland users should have their applications approved by above county-level people's government. To those that have already been reclaimed and resulted in grassland desertification and serious soil erosion, the above county-level people's government should limit the time to have the affected areas closeup, order rehabilitation of vegetation and abandon farming for grazing.

Are farmers responsible for the wind erosion? In fact, farmers in Bashang are also victims of the wind erosion. Since soil erosion results in decreasing production, they are harmed by more frequently occurred duststorms.

Farming is the way of living for the poor farmers so that simply ban would not work. They have financial difficulties to fight with the severe wind erosion. Implementation is related to distributional effects. From society's perspective, some current cropland should be switched to forage production, and livestock grazing rangeland should be regulated.

But, for this wind erosion problem with interregional distributional effects, who should pay the costs is by no means a simple question.

Since the middle 1980s, the China central government organized a large-scale Poverty Alleviation program in order to transform from traditional relief style to sustainable development style. In 1994, the State Council announced a working plan of Poverty Alleviation to product enough food and clothing for more than 80 million poor farmers within 7 years from 1994 to 2000. (The State Council of China, 1994)

All the 4 Bashang counties in Zhangjiakou city are considered the Poor Counties according to the national standard. In 2000, the rural annual income per capita in Bashang was 1189 yuan, which is only 52.7% of the average rural annual income per capita in China. With the increasing pressure of population and economic development, the worsening ecological environment in Bashang was getting more and more attention nationally. (Long 2004)

In the Outline of Poverty Alleviation and Development in Rural Areas of China（2001-2010）, Bashang was again considered one of the national key regions of poverty alleviation, including 956 thousand rural population at 3079 villages in 4 counties.（Bi et al. 2013）

Prohibiting farmers' farming would not only infringe on their presumptive right to farm, but also deprive their means of making a living. Since Bashang is one of the poorest regions in China, a simple ban or tax is not practicable. Subsided conservation programs are the policy tools often considered. Distributional effects in the Bashang region should be further analyzed.

2) Government Compensation: Poverty alleviation through government subsidized development program

Most of Bashang region is administrated by Zhangjiakou city, which has been military important place for a long time in ancient China. In 1969, Zhangjiakou was determined by the central government as “the North Gate of Beijing” and carried out the Close Door policy until 1995. During that time period, investment to construction of industrial, transportation and energy projects was put into very restrictive control. As a result, Zhangjiakou missed the best time of rapid economic development and investment on infrastructure construction during the initial stage for China’s reform and opening-up. In comparison with other regions of Hebei province, the widen gaps exist not only in economic development and infrastructure construction, but also in mindset of local resident lacking opening-up and meeting market demand.（Zhang et al.2011）

Without abundant financial support, it is very difficult to put the program for returning

cultivated land to grassland into practice. In fact, in 1980s, with the support of central government, a program of tree belts was conducted in North China, which was considered "the Green Great Wall", to prevent top layer soil from erosion.

In the spring of 2000, North China suffered 12 duststorms. Premier Zhu Rongji inspected Hebei and Inner Mongolia. Soon the central government launched the Beijing-Tianjin Sandstorm Source Control Project. The first phase of the project was designed to carry out from 2002 to 2017, with proposed total costs of 55.8 billion yuan. The project involved 75 counties in Beijing, Tianjin, Hebei, Inner Mongolia and Shanxi, covering the desertification lands of 458 thousand square kilometer. The implementation of the project was regulated by the State Bureau of Forestry. (Beidu Encyclopedia 2016) Under a great pressure of frequent duststorms in the beginning of this century, the project was planned and carried out in a hurry, before conducting careful investigations.

The launch of the Beijing-Tianjin Sandstorm Source Control Project provided a good opportunity to return farmlands to grasslands or forestlands in Bashang. However, in practice, to restore ecological balance in Bashang by no means a simple task. For decision makers it is necessary 1）to coordinate multiple disciplinary research, 2）to cooperate different government agencies，3）to understand not only technical factors, but also social economic factors, including institutional reform.

2.5 Evaluation of Return Farmland to Forestland or Grassland Program

A number of studies were conducted to evaluate the effectiveness of the ecological and environmental protection programs financially supported by the central government. Most of researchers agree it is necessary to conduct the projects to protect environment and to restore ecological balance. The also generally recognized the ecological effectiveness of the projects. However, there were still some problems related to the efficiency of projects and regulation and implementation at the rural grass-roots level.

In an early study on evaluation of the Return Farmland to Forestland Program in Zuozi county of Inner Mongolia, Gao Runhong pointed out that there was tendency of relying on administrative approaches to conduct the program. Program managers mainly paid attention to the forestland statistics, and ignored the local special natural and social economic situations. As results, the program was arbitrarily put into practice without field surveys and careful designs by specialists. Most famers did not understand the importance of the program and carelessly carried out the program. Therefore, the effectiveness of the program in the long run would be decreased. (Xu and Qin 2004)

Nan（2005）of Capital Normal University conducted a study in Guyuan County on returning cultivated land to forestland or grassland. Nan's research suggests that erosion control in Guyuan County has been accelerated due to the increase of national investment.

From 2000 to 2003, the total afforestation area of Guyuan County was 80,000 ha, of which 10,300 ha was converted from farmland, and the preserved afforestation area reached 69,300 ha. The forest coverage rate increased from 5.6% in 1987 to 18.3% in the early 2000s.

Jiang（2006）of Beijing Forestry University also studied the project of returning cultivated land to forestland or grassland, based on their field investigation in Guyuan county in December, 2004. Table 2-1 summarized their statistic information on the project implementation.

Table 2-1 Return Farmland to Forestland or Grassland in Guyuan（ha）

Year	Total area	Return farmland	To forest	To grassland
2000	2000	1000	1300	700
2001	2000	1000	1557	443
2002	13333	6667	13333	0
2003	19333	9667	19333	0
2004	11000	6000	11000	0
总计	47667	24333	46524	1143

Source: Statistic Bureau of Guyuan County.

Researchers of Beijing Forestry University interviewed 94 households in 9 villages. Among them, 89 households joined the returning farmlands project, and in which 86 households completed the sampling Survey. One of the survey questions asked respondents to evaluate the project effect to household income. There were 31 respondents who chose “much better”, 49 “better”, 6 “no change”, and 0 “worse”. Totally, 93% rural households recognized the project with better or much better income effects.

According to the related policy in Guyuan, farmers returning 1 mu farmland (equivalent to 667 m2) would receive a subsidy of 140 yuan each year for 5 to 8 years. In a good year in Bashang, 1 mu farmland could produce 50 kg grain that was worthy of 70 yuan at the price of 1.4 yuan/kg. So, the net income of 1 mu grain product was 50 yuan, less the cost of 20 yuan for seeds, fertilizer, and other inputs.

Therefore, farmers joined the project would receive 140 yuan subsidy, much higher than their earning of 50 yuan from producing grain at 1mu farmland.

Nan (2005) of Capital Normal University expressed concern about the sustainable development after returning cultivated land to forest. Farmers’ approve of subsidies for returning farmland is mainly a short-term effect. Due to the lack of long-term incentive mechanism, when the subsidy period is over, if the farmers' production conditions are not improved and their income sources for living are not guaranteed, the re-cultivation and

overgrazing will reappear. In addition, the implementation of this project mainly depends on the government financial subsidies and regulation, so the long-term ecological and environmental benefits may not be guaranteed if the continuous maintenance and funds of the forest & grass construction project could not be put in place.

Two field studies in Guyuan and adjacent Inner Mongolia in 2005 and 2006 showed that the pursuit of formalism was not the exceptional cases. The Bingshanliang Mountain is located between Guyuan and Chicheng in Zhangjiakou. Figure 2-3 demonstrates the results of reforesting on the grassland at the peak of the mountain.

Figure 2-3 Reforesting on the grassland at the peak of Bingshanliang in Guyuan (2006).

Forestation at an altitude of more than 2000 meters obviously violates the natural law. It is not only difficult for seedlings to survive, but also harmful to the ecological balance. Forestation here destroys the naturally formed alpine meadow which has a good effect on resisting wind erosion. This administrative policy of "digging a hole and giving 5 yuan" without giving any thought to geographical conditions is typical formalism.

The research of Han (2007) of Hebei Agricultural University suggest that there are several problems in returning cultivated land to forestland in Hebei Province, such as lack of assessment, supervision, and supporting policies, insufficient maintenance funds and not long enough compensation period. Those problems could increase the possibility of re-cultivation.

Based a follow-up investigation on afforestation, Pang and Wu (2018) believe there need more investment in Bashang area, where it is an important water source and natural

ecological barrier of Beijing and Tianjin. However, ecological construction investment is seriously inadequate and there is a big gap between the input capacity and actual demand. For example, the current government standard in afforestation project is 500 yuan / mu, but the actual cost of afforestation is more than 1500 yuan / mu. Shortage of funds has seriously affected the enthusiasm of grassland ecological construction project, some of the conservation areas are worsening. Under this circumstance, Hebei Province should establish an interregional ecological compensation mechanism with Beijing and Tianjin, aiming at pursuit of mutual beneficial win-win results and common development.

Cui and Wang (2006) of Beijing Forestry University concluded that the compensation was inadequate. In the long run, farmers would feel like losers because that returning farmland to forestland cannot be fully compensated in two aspects. On the one hand, compared with farmland products, the previous grain subsidy and the future cash subsidy are relatively too low. On the other hand, there is a widespread concern about the sources of household income after the subsidy is stopped eight years later. An investigation of farmers' choice after the subsidy stopped in Guyuan County showed that, among 86 rural households, 11 households chose "re-cultivation", accounting for 12.8%; 25 chose "no maintenance", accounting for 29.1%; 30 chose "strengthen maintenance", accounting for 34.9%; 3 chose "tree species conversion", accounting for 3.5%; 6 chose "no consideration", accounting for 7%; 3 chose "change to livestock production", accounting for 3.5%; the other 8 households did not answer, accounting for 9.2%.

The frost-free period is short in Bashang, so that trees grow slowly. The forestation requires longer time and appropriate geographical conditions. Tree species such as oriental arborvitae can survive in Bashang, but its forestation generally takes more than 20 years. Farmers have no economic benefits in 8 years, as a result, those who have returned farmland to forestland are worried about their income reduction after the project subsidies stopped in future.

In order to let saplings survive and grow up under the perennial drought and less rainfall conditions, it is necessary to provide corresponding irrigation projects at the same time of returning farmland to forestland. However, the local governments do not have sufficient financial sources to keep supporting the construction of the projects. As a result, it is common to see saplings dying on hill slopes facing south.

It was calculated that, in 2003, the necessary maintenance input for the project of returning farmland to forestland in Hebei is more than 17 million yuan. However, neither central government nor local government have a budget for the maintenance, hence the project managers fell into the predicament of "cooking without rice". At the same time, insufficient management budgets also lead to difficulties in project operations such as design, inspection and approval, subsidy payment and so on.

Even if the project of returning farmland to forestland currently is ecologically effective, it is still possible to re-cultivate the forestland when the crop prices rise and food supply is short. In addition, lack of confidence for future returns of commercial forest, backward technology, and low level of management are also the reasons for farmers' re-cultivation.

Pang and Wu (2018) also find that the subsidy fund of the Beijing-Tianjin duststorm source control project for grassland conservation is far less than the actual input. The gap severely hurts farmers' enthusiasm of grassland conservation. It is worthy of recognizing that some conservation grassland will be grazed again without timely financial input.

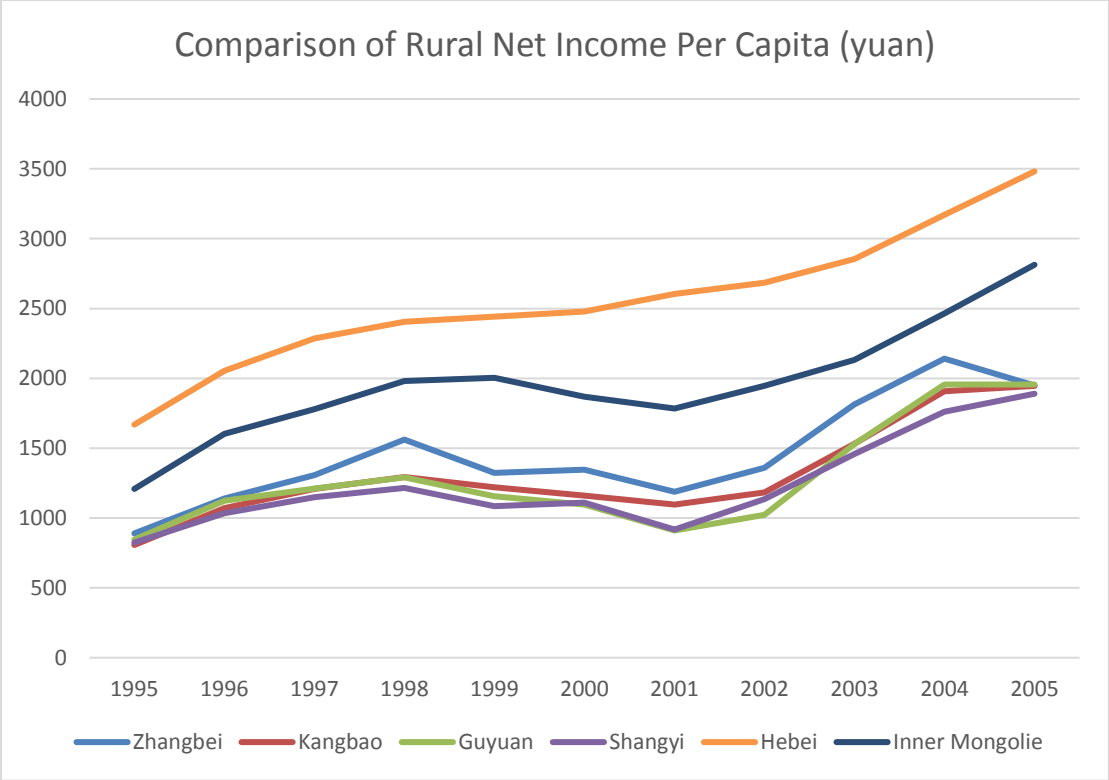


Figure 2-4 Comparison of Rural Net Income Per Capita
Source：Hebei Economic Statistic Yearbook (1995-2005)

From 1995 to 2005, the overall growth trend of farmers' per capita net income in Bashang counties was similar, and the initial growth of the project of returning farmland to forestland was remarkable. However, the growth rate slowed down in 2015 and the gap was widened between Bashang counties and Hebei Province & neighboring Inner Mongolia. In the early 2000s, from the perspective of economic development, the farmers in Bashang still not found the way to get rid of poverty through sustainable development.

Both Cui and Wang (2006) and Han (2007) suggested that it is necessary to adjust industrial restructure and to transfer surplus labor in the conservation projects conducting areas. Jiang (2006) reported their questionnaire study on farmers' future earning plans in

Guyuan: in their sample of 86 households, 37 households chose “rely on animal husbandry”, accounting for 43%; 16 chose “leave to work”, accounting for 18.6%; 23 chose “produce vegetables”, accounting for 26.7%; 4 households chose “business management”, accounting for 4.7%; 6 households did not consider it, accounting for 7%.

The project of returning farmland to forestland takes farmers much working time in the first few years. After completing this project, farmers will have nothing to do most of the time. With the limitation of natural resource and climate conditions, some farmers would develop animal husbandry, but restricted by factors such as funds, technology and product sales, it is difficult to expand scale within a short period of time. If the surplus labor force cannot be promptly employed, there may also have some concerns on public security.