China Ecosystem Services and Poverty Alleviation Situation Analysis and Research Strategy

Ningxia Case Study

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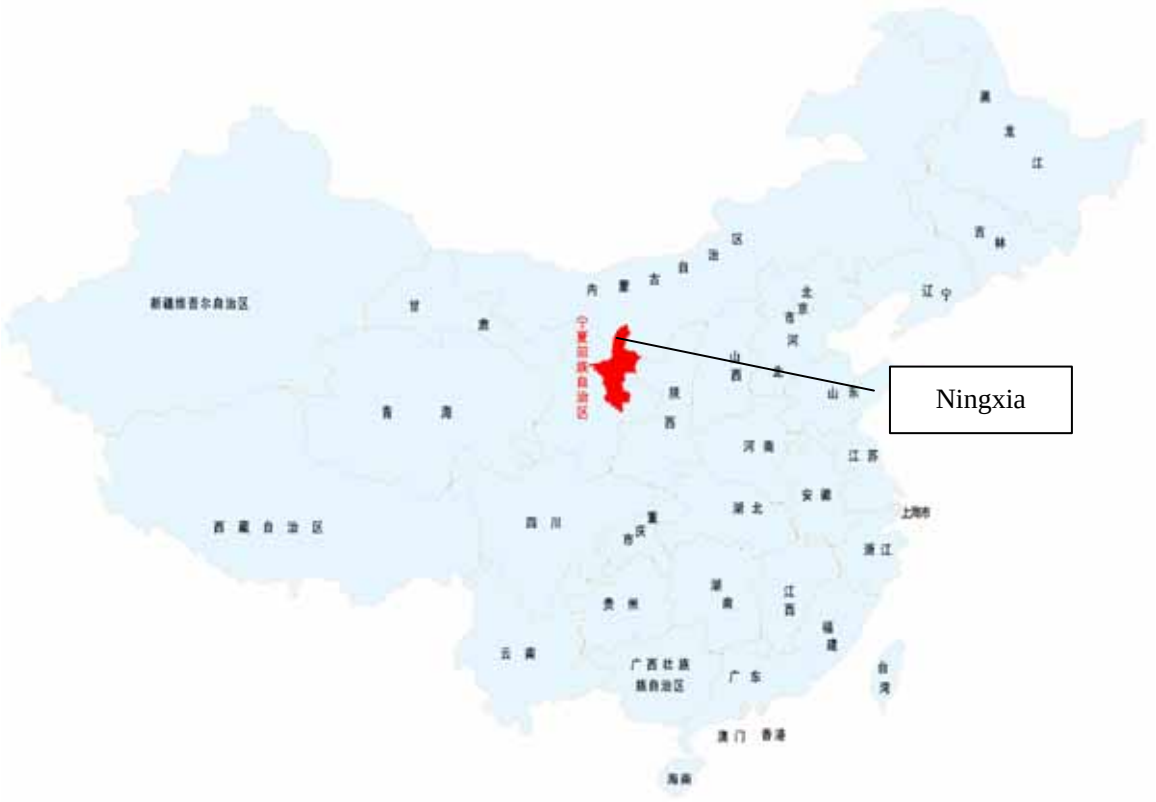
Current Situation Analysis and Strategic Study on the Eco-system Service and Poverty Reduction in China – Case Study in Ningxia

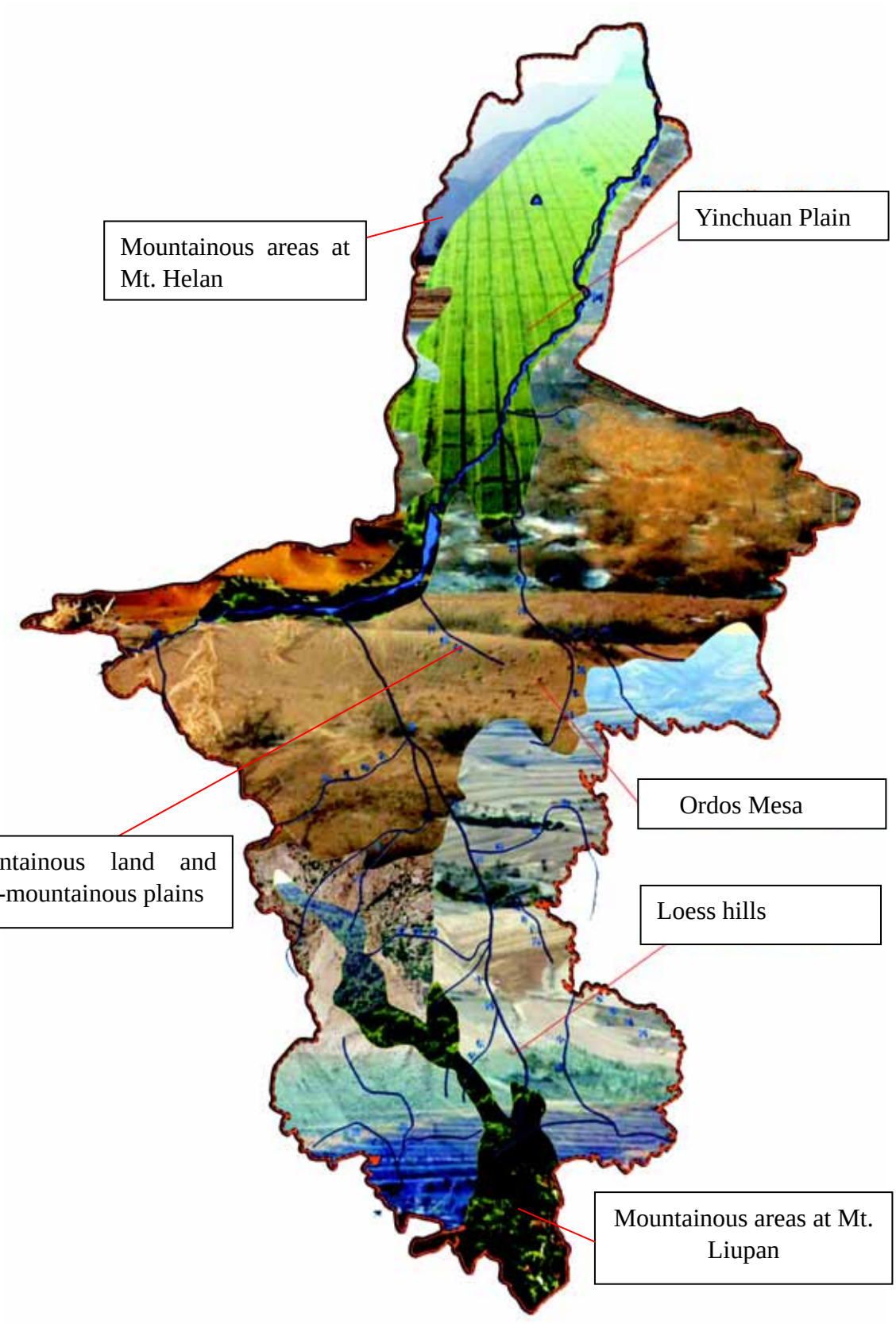
The poverty reduction through ecological construction (PREC) is a new measure of poverty reduction by means of improving ecological environment and infrastructure to upgrade the production and livelihood conditions for sustainable development of the poverty-stricken areas. The Ningxia Hui Autonomous Region (hereafter as Ningxia) is located at the upper and middle reaches of the Yellow River at the eastern part of northwest China. It neighbors Gansu Province at the south, Shaanxi Province at the east and the Inner Mongolia at the northeast.

Ningxia stretches 45~250 km from east to west and 465 km from south to north with a total area of 66,400 squ. km. With topography declining from south to north, Ningxia is composed of 6 geomorphic units from south to north, namely mountainous areas at Mt. Liupan, loess hills, inter-mountainous plains, Ordos Mesa, Yinchuan Plain and mountainous areas at Mt. Helan. Of the above, mountainous areas cover 8,179 squ. km (12.3%), plains cover 13,897 squ km (20.9%) and hills cover 19,679 squ. km (29.6%).

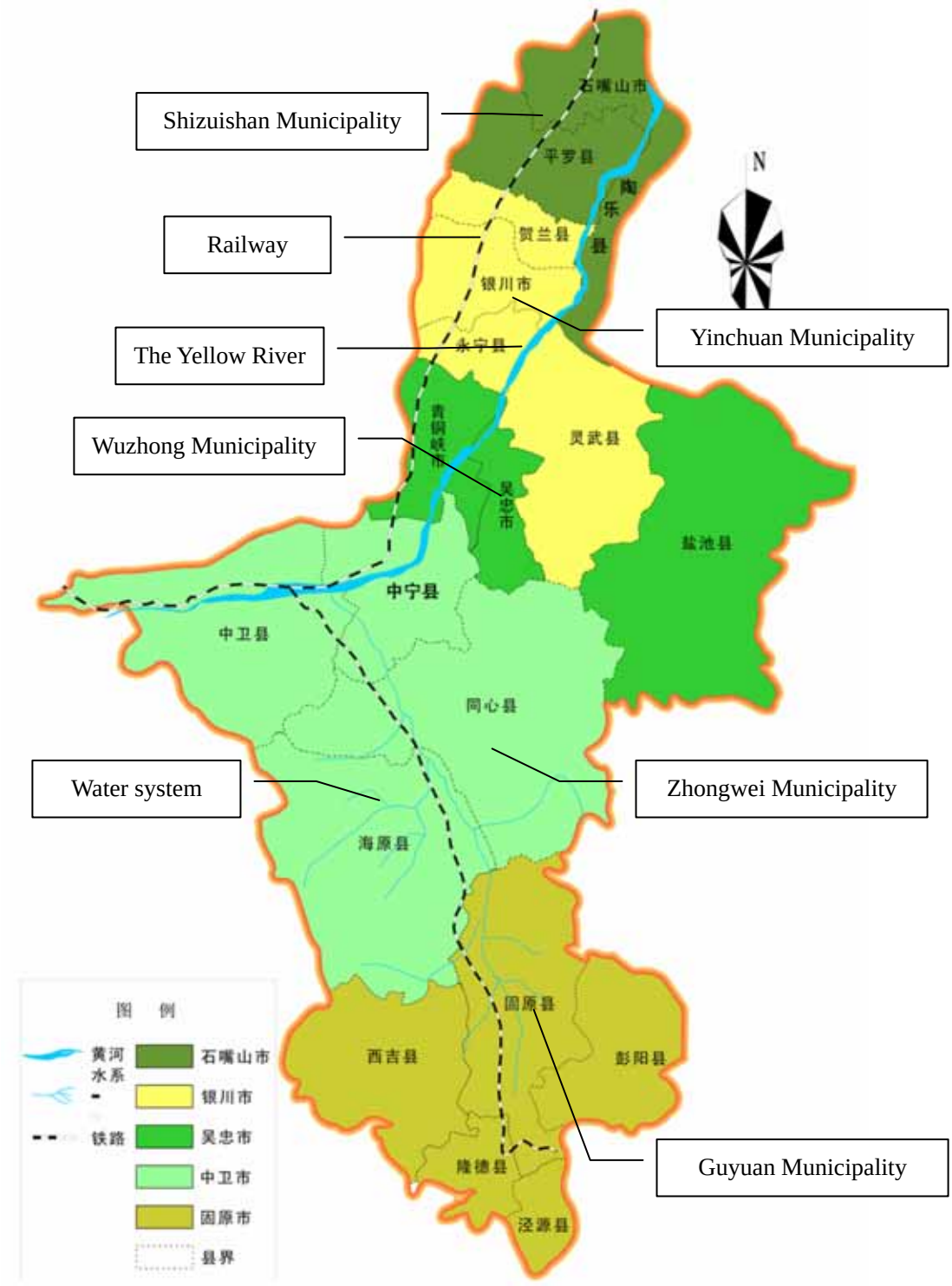
Map of Ningxia's Location in China



Ningxia is composed of 22 counties in 5 municipalities. By the end of 2006, the total population amounted to 6.04 million people, including 3,839,000 rural people (63.2%).

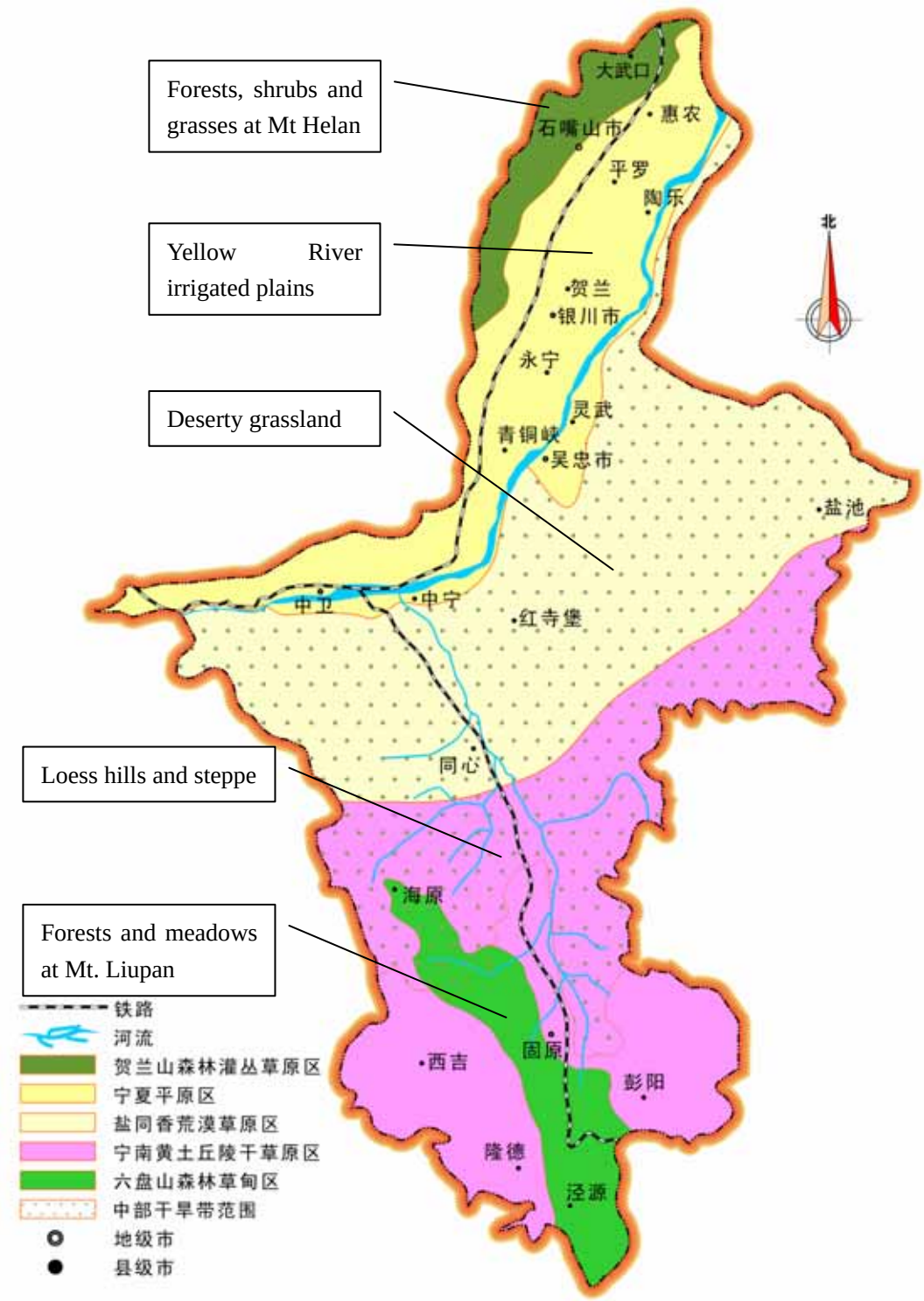


Map of Geomorphic Types in Ningxia



Map of Ningxia's Administrative Regionalization

In the terms of geomorphic types and economic development, Ningxia can be divided into 3 districts, namely the Yellow River Irrigated District (YERID) at the plains at the north, dry and desertified district (DDD) at the central part and mountainous and loess hilly district (MLHD) at the south.



Map of Regionalization of Ecological Functions

MLHD is composed of mountainous areas at Mt. Liupan and loess hills. It amounts for 31.3% of Ningxia territory. Due to high elevation, the annual precipitation at the mountainous areas at Mt. Liupan at the southern part varies from 600 to 800 mm. In spite of the fact that this is a place with the richest precipitation in Ningxia, due to high mountains, deep valleys and thin layer of infertile soils, the development of agricultural production is rather laggard. Over the loess hills of high erosion at the semi-arid areas at the northern part, slope farmland amounts to more than 70% of the cultivated land. There is also some fertile and flat farmland at valley beds. Some of the farmland is access to irrigation by reservoirs, tube wells or rivers. This is the capital farmland. The annual precipitation here varies from 400 to 600mm, 60% of which is concentrated from July to September mostly in the forms of heavy rains. The problems of rainstorms and floods are serious and more than 90% of the land suffers from water erosion and soil loss.

DDD is at the margins of Ordos Mesa and Tenggri Desert. It covers 45.4% of Ningxia territory. Due to the limited precipitation less than 300 mm/year, this piece of land suffers from intensive evaporation and land desertification, but this place is rich in sunshine. Around 72% of Ningxia's natural grassland is distributed at this district. Due to dryness, around 88% of the land suffers from erosion. This is the most difficult place in Ningxia in ecological construction and poverty reduction. However, most of the land is relatively flat and not far from the Yellow River, it is a place very suitable for lift irrigation from the Yellow River.

YERID is the most important place of agricultural production in Ningxia. It covers 23.7% of Ningxia territory. It is composed of the alluvial plans along the Yellow River and the diluvial piedmont of Mt. Helan. Lofty Mt Helan and its good vegetation serve as a natural protector of the irrigated plains against the cold currents and desert aggression from the northwest. The Yellow River flows 397 km through 12 counties in Ningxia. Through the development of irrigation agriculture for more than 2000 years, over 400,000 ha of productive farmland have been built. Thanks to the fertile soils, rich resources of sunshine/heat and well-developed gravity irrigation, this district has become one of the national important producers of grains. Although the farmland at this district is less than one third of Ningxia's total, its grain production and agricultural output value is above two thirds of Ningxia's total and its GDP is close to nine tenths of Ningxia's total. This is a land of honey and milk.

Chapter 1. General Situation of Ecological Environment and Economic Development in Ningxia

1.1. General Features of Ecological System

1.1.1. Ecological Types

Ningxia is located at the transitional zone between the eastern monsoon region and northwestern dry areas and between the Loess Plateau and the Ordos Plateau. There are varieties of ecological types such as forests, grasslands, deserts, water surfaces, farmlands and urban areas. Under the control of arid and semi-arid climate, deserty grassland and steppes are major ecological types. Grasslands cover around half of Ningxia's territory.

1.1.2. Climatic Features

Ningxia is an inland place. The climate is featured with clear division between seasons, long and cold winter, short and hot summer, plentiful sunshine, limited precipitation and short frost-free period. The annual mean temperature is -0.7~9.9℃. The mean temperature in July (hottest) is 24℃; while it is minus 9℃ in January (coldest). The temperature difference between night and daytime is 12~15℃. The frost-free period lasts around 150 days. The annual sunshine is 3000 hours, and it is one of the places in China with the most plentiful

sunshine resources. The annual precipitation amounts to 289mm/year, which declines from south to north varying from 800 to 180mm. The water surface evaporation amounts to 1296 mm/year (44 times the precipitation), which increases from south to north varying from 800 to 1600 mm/year. The climate in Ningxia keeps the same tendency of the global warming-up in recent years. From 1961 to 1987, the variation of the extreme low temperature was 1.5℃, while it was 2.4℃ from 1988 to 2003. Of the 4 years' abnormal downward bias of extreme low temperature in recent 40 years, 3 years was in the periods with clear climate warming-up with frequent droughts, big winds and sandstorms.

1.1.3. Present Situation of Natural Resources

Farmland: By the end of 2006, the farmland in Ningxia amounted to 1.1 million ha, including 402,000 ha of irrigated and 698,000 ha of rain-fed. The per capita farmland availability was 0.187 ha (the 4th place in China).

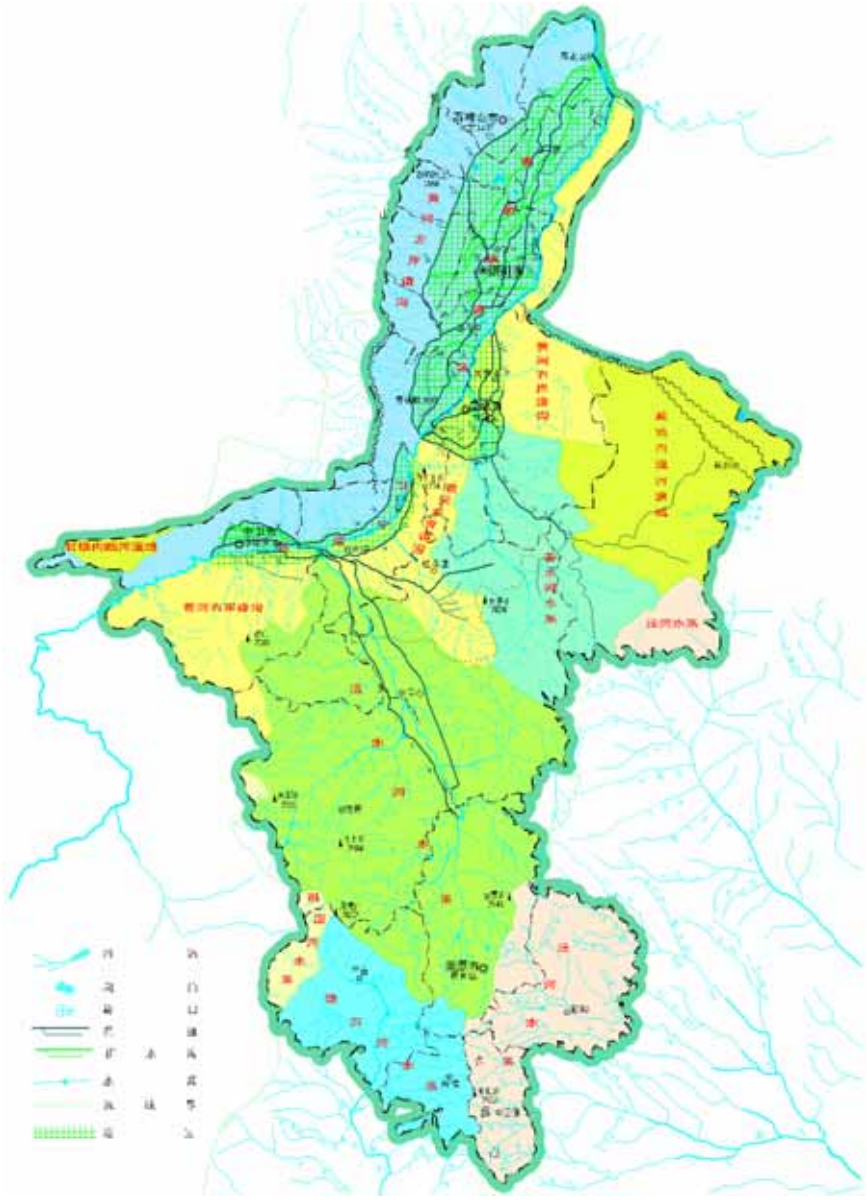
Soils: Ningxia's agriculture has a long history. Of the varieties of soils, grassland soil and deserty soil are the major types. With the decline of precipitation and the increase of accumulative temperature from south to north, the vegetation changes from forest grassland to steppe to deserty grassland and desert, and the eluviation and organic matter accumulation in soils gradually declines. The soils from south to north are in an order of heilu soil, serozem soil and deserty soil. Due to the high underground water table and historic irrigated farming, the soils at northern Ningxia are fluvo-aquic soil, irrigation-silting soil, alkali soil, salty soil and swamp soil. At Mt. Liupan and Mt. Helan, there is subalpine meadow soil and grey cinnamon soil. Around 95.6% of Ningxia territory is covered by soils (or 4,949,500 ha).

Water Resources: The local water resources totals to 1163 million m^3, including 949 million of surface water and 214 million of underground water. The Yellow River is the most important water source for Ningxia, irrigating the northern part. In a normal year, Ningxia is allowed to use 4 billion cubic meters of Yellow River water. In addition to the availability of 150 million cubic meters of underground water, the per capita water availability is 706 cubic meters (around one third of national average). The comprehensive quantity of water resources, the modulus of water resources and the water availability per hectare of farmland in Ningxia amounts to 0.042%, 7.1% and 2.9% of national average, respectively. Ningxia is a typical place of water shortage.

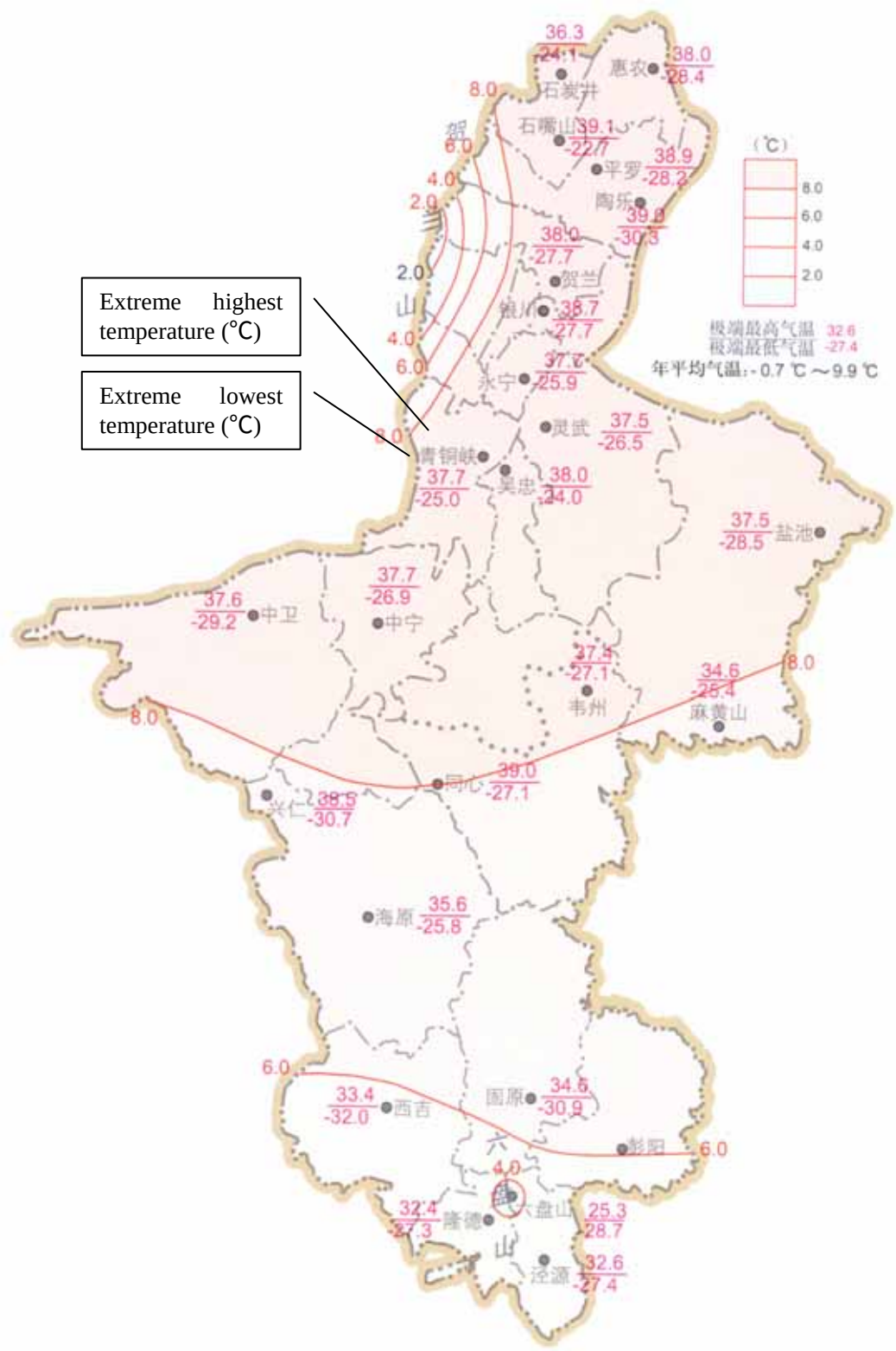
Vegetation: The natural vegetation in Ningxia is composed of that of forests, shrub-lands, meadows, grasslands and wetlands. From south to north, the distribution is forest grassland, steppe, deserty grassland and desert. Under the control of arid and semi-arid climate, grasslands cover 47.24% of Ningxia territory, and grassland vegetation amounts for 79.5% of natural vegetation. Grasslands are distributed mainly at the desertified land at central Ningxia. In 2006, Ningxia had 2,274,300 ha of grassland, including 2,198,960 ha of natural grassland.

Impacted by precipitation, the grasslands from south to north are meadow grassland, steppe and deserty grassland. Deserty grassland and steppe with very low vegetation coverage amounted for 55.1% and 24.0% of the grasslands, respectively. In accordance with the survey of forest resources in 2006, Ningxia had 606,430 ha of forest land, and the natural forests were mainly distributed at Mt. Helan, Mt Luoshan and Mt. Liupan. The forested land, shrub land, young forests and nurseries covered 121,490 ha, 104,550 ha, 365,090 ha and 2800 ha, respectively.

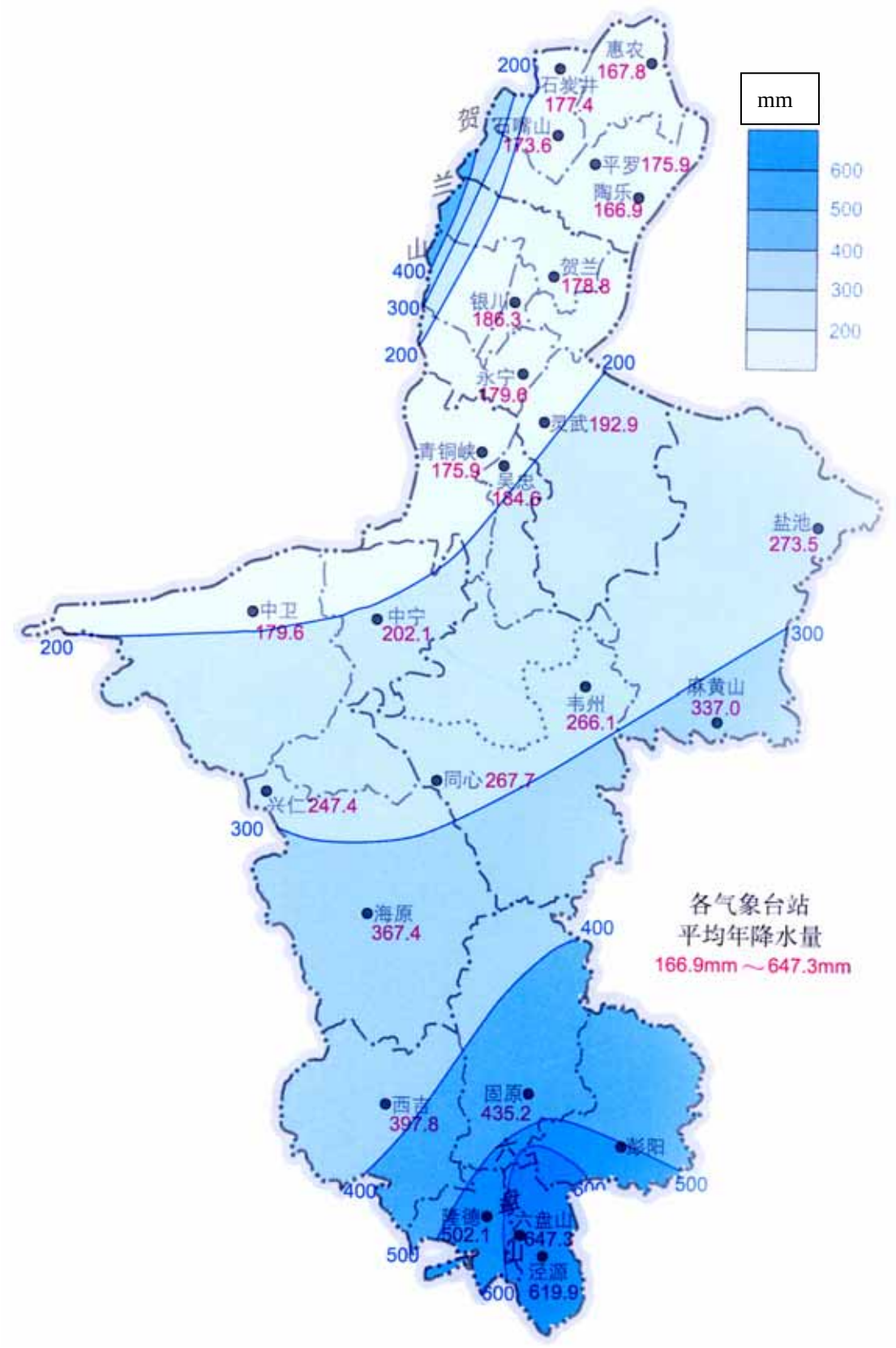
Wetland: The wetlands in Ningxia are mainly distributed in the irrigated plains of agriculture. Ningxia has 256,000 ha of wetlands (3.85% of Ningxia territory).



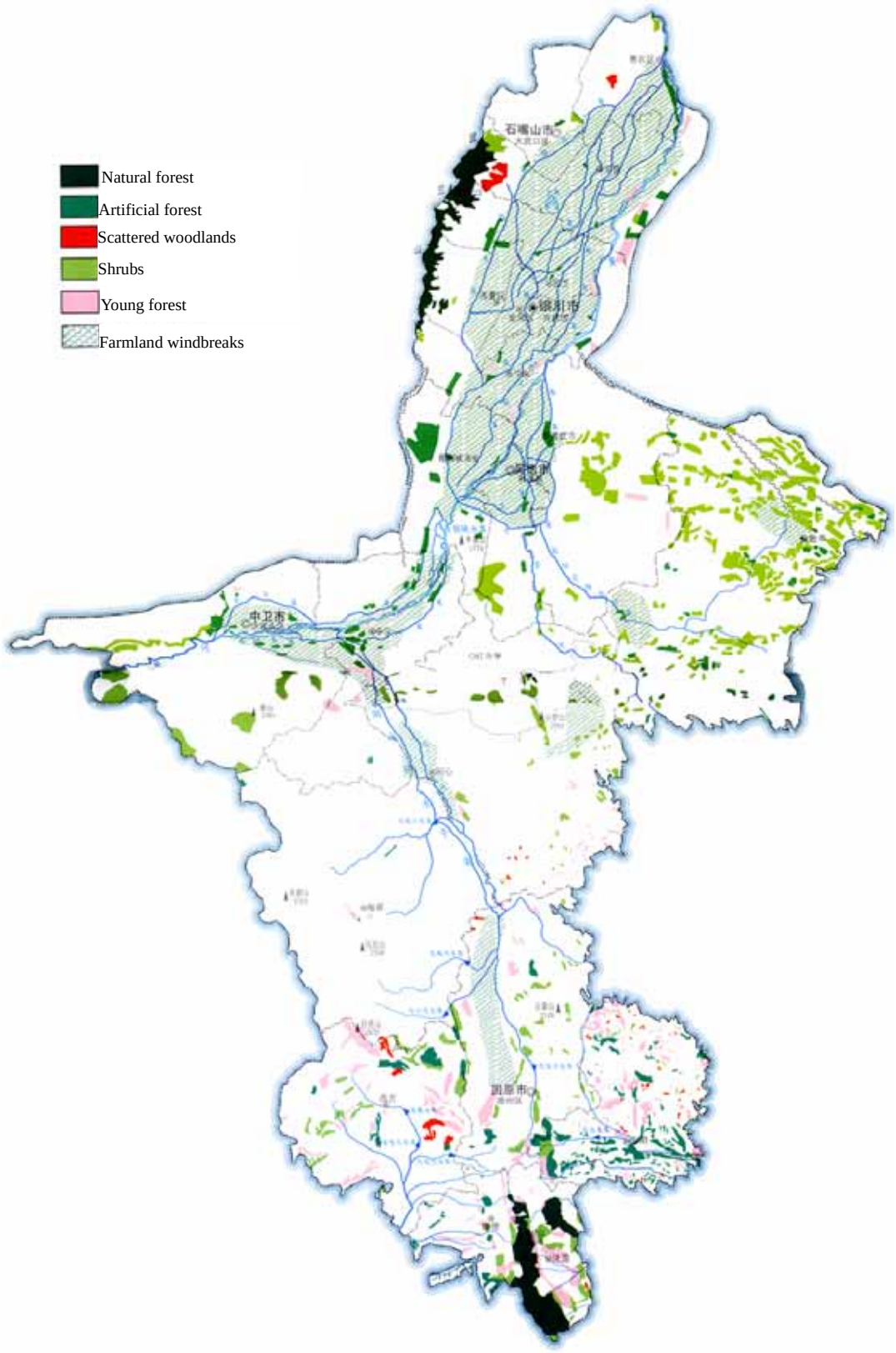
Map of water system



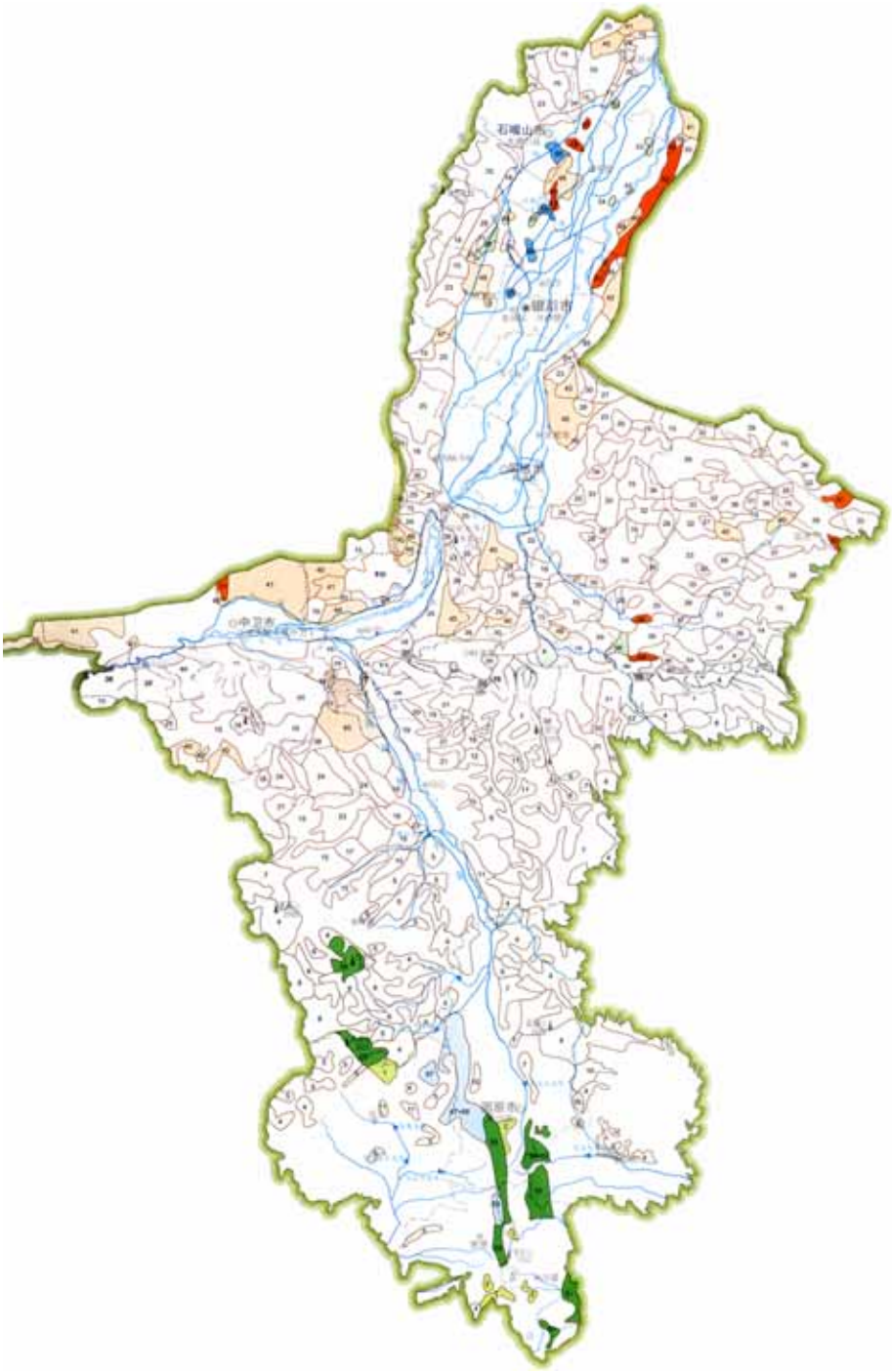
Map of Climate Features



Map of Precipitation



Map of Forest Distribution



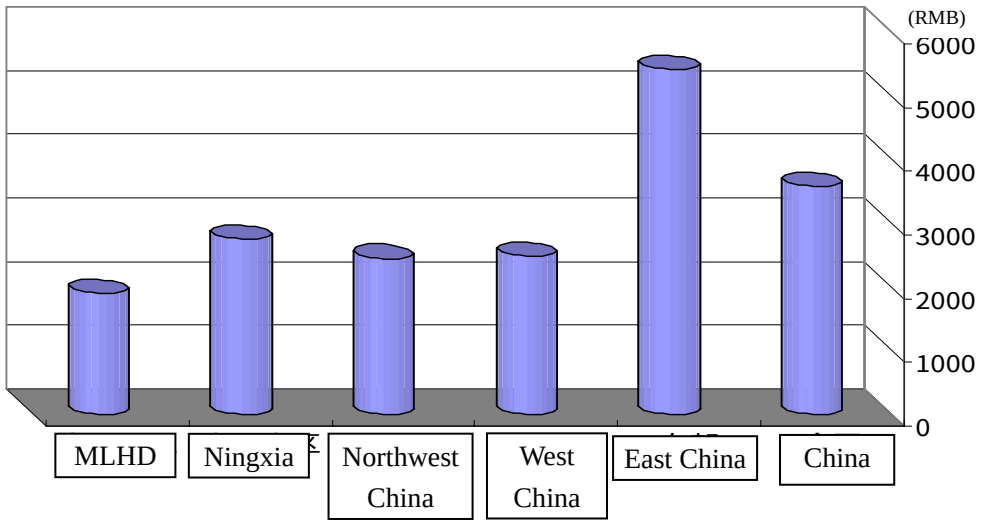
Map of Grassland Distribution

Code	Type	Code	Type
1-3	Meadow grassland	53-57	Wetland meadow
4-14	Steppe	58-64	Mountain steppe
15-39	Deserty grassland	65-66	Swamp
40-48	Grassy sandland	67-69	Shrub meadow
49-52	Dry desert	70-71	Shrub grassland

1.2. General Features of Poverty

In 2006, the annual net income per rural capita in Ningxia was RMB 2760, which was equivalent to 77%, 84.5% and 37.6% of the national average, Henan Province in central China and Zhejiang Province in southern China, respectively.

Comparison of per Rural Capita Annual Net Income between Ningxia and China (2006)



According to National Statistic Bureau, the lines of absolute poverty and low income are RMB 683 and 944 of the annual net income per rural capita, respectively. Following the above lines, there were 65,000 people of absolute poverty (3%) and 293,000 people of low income (13.5%) in Ningxia in 2006. This was above national average. Ningxia's poverty-stricken people are mainly distributed in DDD and MLHD (namely, Xiji, Yuanzhou, Longde, Jingyuan and Pengyang counties in Guyuan Municipality, Yanchi and Tongxin counties in Wuzhong Municipality and Haiyuan County in Zhongwei Municipality). These 8 counties cover 38,900 km^2 with total population of 2.56 million people (42.6% of Ningxia's total). These places are among the poorest areas at national level, and are specially supported in the national program of poverty reduction.

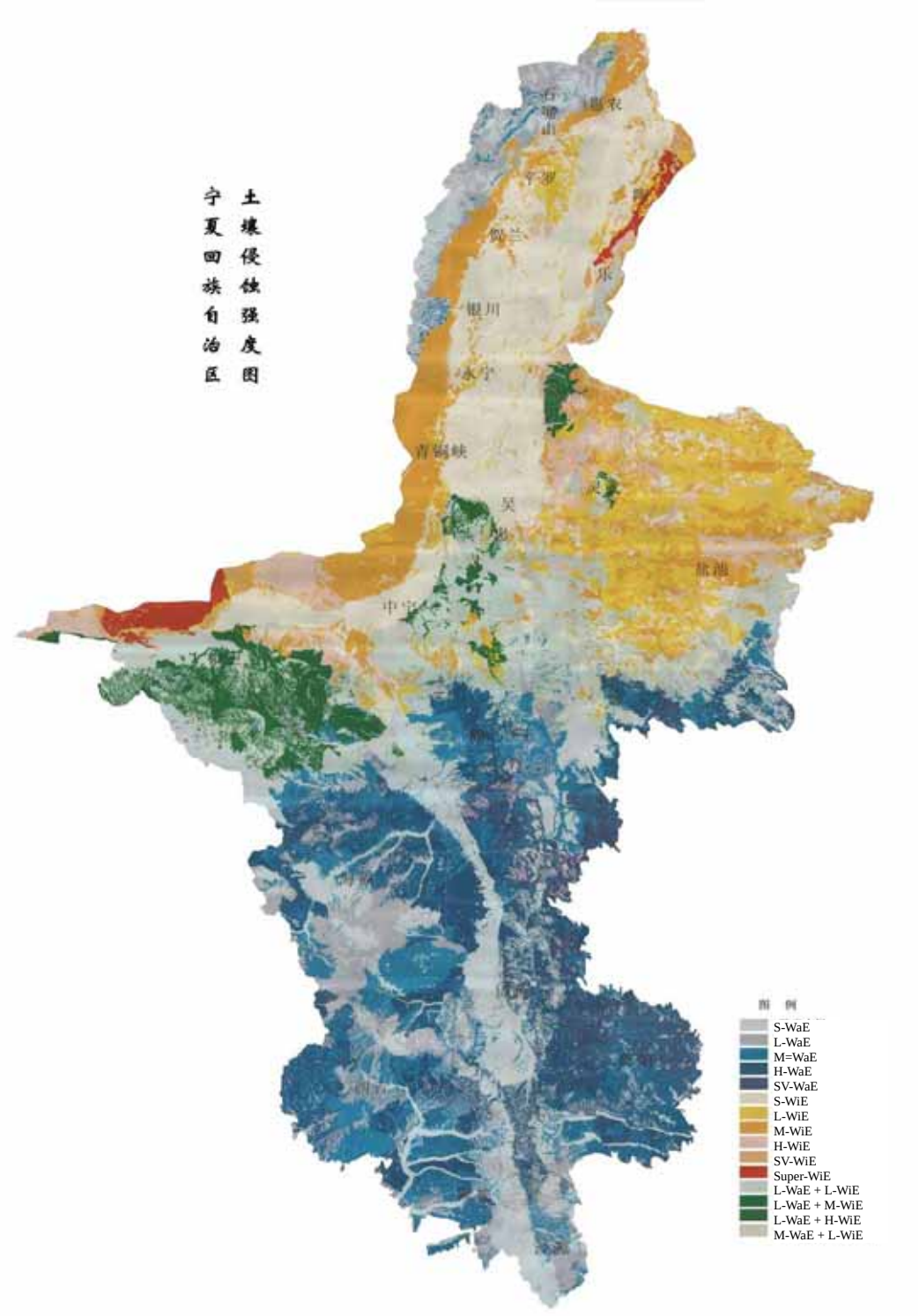
1.3. Relation between Poverty and Ecological Environment

1.3. Relation between Poverty and Ecological Environment

1.3.1. Poverty-stricken places normally overlap places of poor ecological environment. In Ningxia, around 80% of the places suffering from water erosion and soil loss at and above moderate degrees are distributed at the eroded loess hills at the southern part with poor natural conditions, while the around 83.4% of the sandified and desertified lands – at the dry and dust-windy places at the central part. The water conservation function impacted by water

erosion at the loess hilly areas is degrading, and the eco-system capacity of wind prevention and sand fixation impacted by wind erosion at the dry central part is weakening. Due to the weakened supports of natural conditions, the local economic-social development is slowed down, the local people are cornered in poverty, and the poverty-stricken people are forced to over-depend on natural environment. As a result, a vicious circle is built between poverty and environment-worsening.

Map of Poverty-stricken Counties in Ningxia



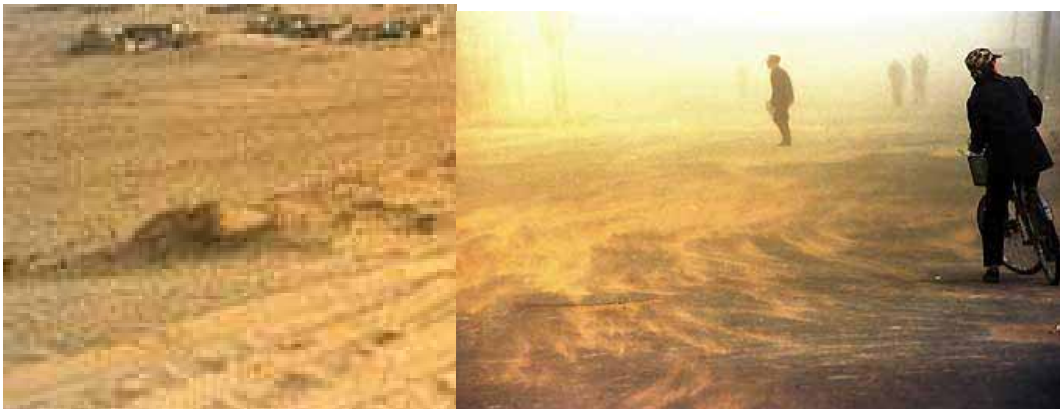
Map of Erosions in Ningxia

Notes: WaE=water erosion, WiE=wind erosion; S=slight, L-light, M=medium, H=heavy, SV=severe

1.3.1. Poverty pushes forward worsening ecological environment.

Due to the accumulated artificial impacts for hundreds of years such as wars and misuse of

natural resources, the self-regulating and self-rehabilitation capacity of the ecological systems is degrading. By early 1800s, Ningxia lost all the indigenous forests. As a result, the land resources, bio-diversity and the functions of eco-system became degraded. Stressed by the increasing demands for food, fodder and fuel, unsustainable and even plundering practices were employed such as farmland over-reclamation, over-grazing and over-use of natural resources of any value. As a result, the ecological environment suffered a great loss. Of the current farmland in Ningxia, 50% is slope farmland, gradually reclaimed since 1960s. In 1949, the total population and farmland in Ningxia was 535,000 people and 501,330 ha, which was increased to 2,455,000 people (4.6 times) and 945,330 ha (twice) in 1999, respectively. The per capita grain availability increase from 308 kg in 1949 to 320 kg in 1999 was at a bitter sacrifice of ecological environment. For instance, at Mt. Liupan and Mt. Luoshan, water source conservation forests reduced by 220,530 ha, the forested areas shrank by 142,130 ha (The erosion modulus on slope farmland is 12,400 t/km^2.a, while that on untouched slope is 6,550 t/km^2.a.), and the area suffering from water erosion and soil loss covered 75% of the territory. From the viewpoint of tendency, the area of water erosion and soil loss in 1950s, 1980s, 1990s and 1999 was 35,449 km^2, 39,175 km^2, 38,873 km^2 and 37,086 km^2 in Ningxia, respectively. From 1950s to 1983, Ningxia regulated 3,622 km^2 of eroded land; till 1990, the regulated land was accumulated to 5,540 km^2; and till 1999, the regulated land was accumulated to 10,243 km^2. At the same time, over-grazing was not effectively controlled, which pushed forward the degradation of grassland eco-system. In 2000, around 95% of Ningxia's grassland was degraded at different degrees, including 77.5% mediumly or heavily degraded. The vegetation coverage over the natural grassland was lowered to less than 10%. In accordance with National Environmental Protection Administration, Ningxia was one of 4 sources of sandstorms in China. Ningxia is also a passage and frontier of dusty winds towards the central parts (including Beijing).

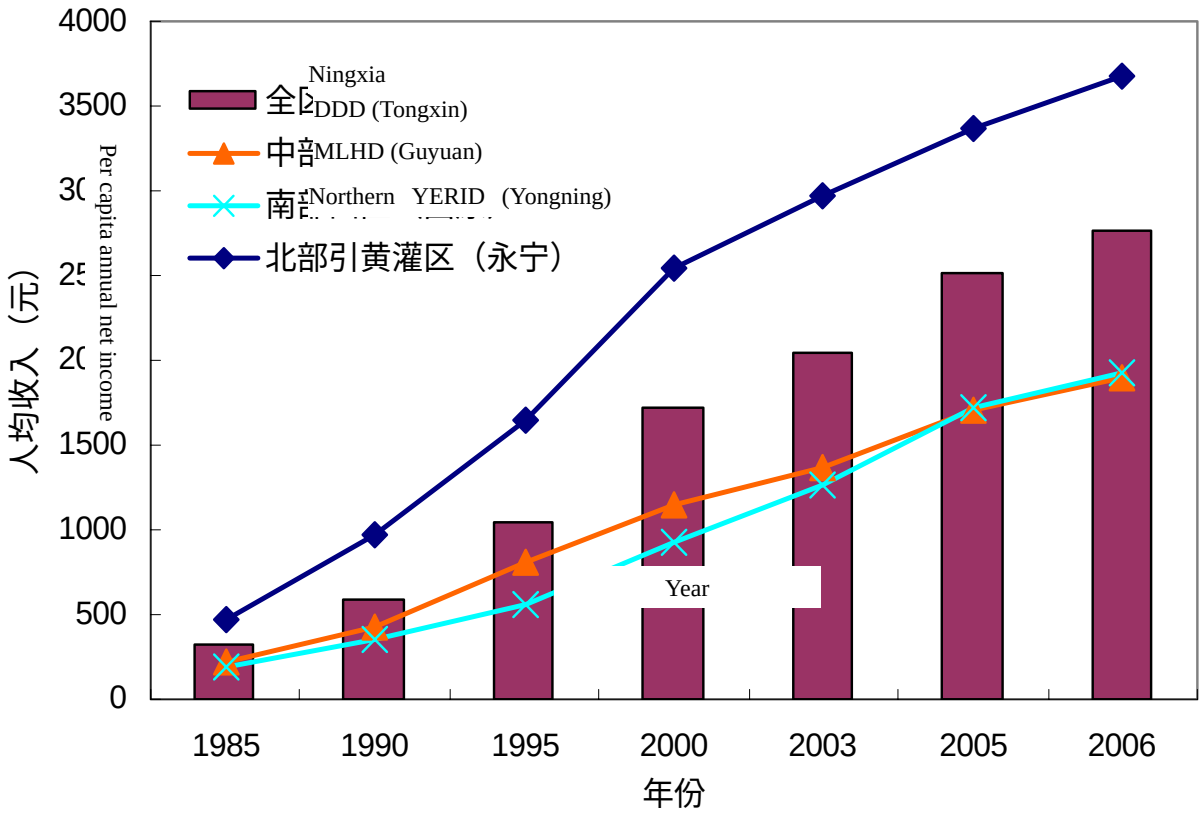


1.3.2. Poverty Intensifying Eco-environment Worsening

Stressed by the basic needs for survival, people are forced to ask the nature for food, fodder and fuel by plundering means of illegal farmland reclamation, extensive farming with limited

harvesting, overgrazing and over-exploitation of natural resources of any value, which is only to damage ecological environment. By early Qing Dynasty in 1800s, Ningxia lost all the indigenous forests, the land resources, bio-diversity and the functions of eco-system became degraded, and the capacity of economic service sharply dropped. The total population and farmland in 1949 in Ningxia was 4.6 times and twice of that in 1999, respectively. The per capita grain availability increase from 308 kg in 1949 to 320 kg in 1999 was at a bitter sacrifice of ecological environment. For instance, at Mt. Liupan and Mt. Luoshan, water source conservation forests reduced by 220,500 ha, the forested areas shrank by 142,100 ha (The erosion modulus on slope farmland was 12,400 t/km^2.a, which doubled that on untouched slope), and the problems of water erosion and soil loss became more and more serious. From 1950s to early 1980s, the eroded area enlarged from 35,449 km^2 to 39,175 km^2. Due to overgrazing, around 95% of Ningxia's grassland was degraded at different degrees (including 77.5% of the grassland moderately or heavily degraded). The vegetation coverage over the natural grassland was lowered to less than 10%. In accordance with National Environmental Protection Administration, Ningxia was one of 4 sources of sandstorms in China. Ningxia is also a passage and frontier of dusty winds towards the central parts (including Beijing).

Comparison of per Capita Rural Annual Net Income in Ningxia



1.3.3. Ecological Worsening Intensifying Poverty

Due to the degraded functions of eco-system, Ningxia's agricultural production was low and unstable. In 1982, the per rural capita annual net income in the poverty-stricken areas was RMB 44 and the grain production was 459 kg/ha. More than 70% of the farmers were short of food and cloths, livestock fodder was limited, and both human beings and livestock were short of drinking water. In 2000, Ningxia was hit by serious drought. In accordance with the national poverty line by then, 1,286,000 people were classified as low income population, including 527,000 people living below the absolute poverty line.

Although the number of poverty-stricken population had reduced remarkably by the year 2006, their food and cloths still greatly relied on natural conditions. Since the agricultural output is prone to fluctuation, the capacity against natural calamities and of self-development is still weak. Many farmers return to poverty in a year of natural calamity.

Chapter 2. Challenges of Poverty Reduction through Ecological Construction (PREC) in Ningxia

2.1. Frequent Droughts and Water Resource Deficiency

Since 1970s, the annual mean temperature has been fluctuating and rising, and it rose remarkably in 1980s and 1990s. With temperature rising, precipitation became remarkably declining. From 1960 to 2005, Ningxia's annual precipitation reduced by 63mm. From 1951 to 2000, the annual precipitation in YERID was in a tendency of declining with a decrease of 3.1 mm every 10 years, the annual precipitation in terms of quantity and effectiveness at MLHD and DDD reduced by 100~500mm, Ningxia's isoline of 400mm rainfall and the desertification line moved 80~100km southwards, the water replenishment was far less than the evaporation, and extreme weathers such as droughts became more and more frequent. In the said period, there were 48 dry years with drought probability around 72%. In 57 years

from 1949 to 2005, droughts happened in 41 years. Since the autumn of 2004, there have been successive drought years, even with a severe drought of 50 years' return, due to which, most of the rivers in the poverty-stricken areas dried up and more than 2.2 million people suffered from difficulties of drinking water shortage. Serious droughts resulted in a great and even a total loss of agricultural crops, and many farmers returned to poverty. Droughts not only intensify poverty but also bring lots of difficulties in ecological construction and rehabilitation. Due to the severe droughts, the survival rate of trees, shrubs and grasses planted was only 20~40% in spite of careful management.

2.2. Insufficient Integration of Environmental Factors and Low Function of Eco-system Service

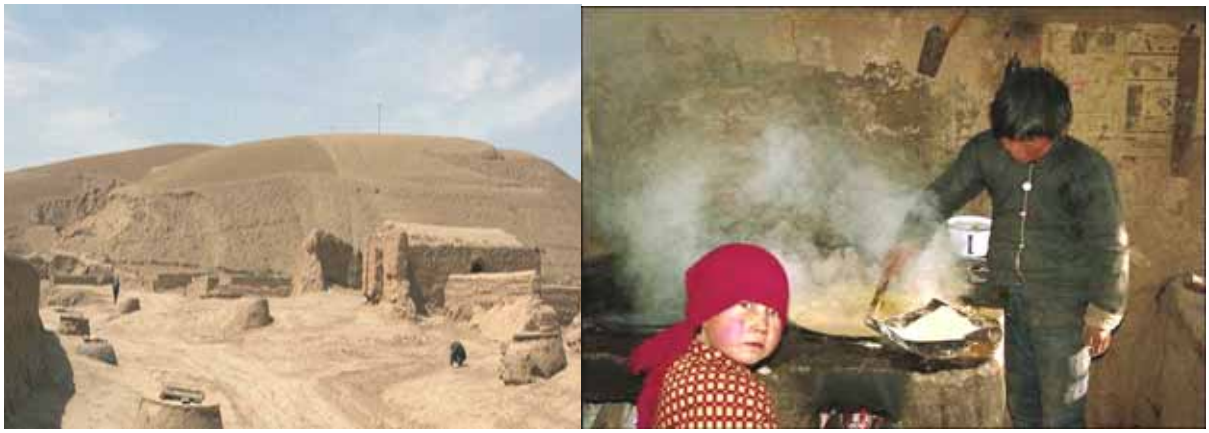
2.2.1. Improper integration among water, sunshine/heat and land resources: The improper integration of Ningxia's environmental factors is clearly reflected by the fact that the sunshine and heat resources in the northern and central parts are plentiful but precipitation is limited. The annual precipitation is only 200 mm, and the places with plentiful sunshine/heat resources at these parts amounts to over 90% of Ningxia's territory. Restrained by water deficiency, soil microorganisms are not active and the content of organic matter is low, which lowers the cycling speed and intensity of materials and energy. Most of the natural eco-systems are very simple in structure with limited input from the outside, which results in the low function of the overall eco-system. The bio-mass growth in the grassland, forest, wetland and rain-fed farmland eco-systems in Ningxia is lowered than the national average. For instance, the growth of natural forests in Ningxia is 1.5 m^3/ha (1.84 m^3/ha national average), aquicultural production in natural water bodies is 195 kg/ha (540 kg/ha national average), and the grain production in rain-fed farmland is 585 kg/ha (1860 kg/ha national average). Besides, the grassland vegetation communities are short of diversity, the vegetation coverage is mostly 20~70%, and the grass layer is 4~30cm thick. The fresh grass production at deserty grassland and steppe is 795 kg/ha and 1185 kg/ha, respectively (national average

1005~2010 kg/ha and 1500~4500 kg/ha). MLHD has higher precipitation but it is short of sunshine and heat resources. The annual precipitation amounts to 600mm, but the places with satisfactory sunshine and heat resources cover less than 10% of the territory. In addition to thin layers of soils and low fertility, the integration of water and land resources is seriously unbalanced.

2.2.2. Insufficient harmonization between man and natural resources: The investigations at Ningxia's poverty-stricken areas indicated that the poverty originated from the unreasonable arrangement of population and natural resources. Around 40% of the poverty-stricken people live at the places with harsh natural conditions. The conditions of production and livelihood are severe, and the potential for economic development is very limited.

2.3. Increasing Conflicts between Eco-system Bearing Capacity and Economic-social Development

Ningxia is located at the transitional zone between the Loess Plateau and Tenggri Desert & Mu Us Desert, between arid areas and semi-arid areas and between deserty areas and grassland. At this transitional zone, the ecological environment is fragile and sensitive to climate fluctuation. It is a place with high frequency and broad range of environmental changes as well as a place of frequent natural calamities. Most of Ningxia's territory is located at this transitional zone. Due to water resource shortage, dryness and frequent winds (winds with velocity $\geq$17m/s blow 24~30 days/year at DDD), the vegetation coverage is limited, water/wind erosion are active, the natural environment is poor and the bearing capacity of land resources is low. In accordance with UN's ideal value of population bearing capacity at dry mountainous areas, the suitable population density is no more than 7 people/km^2. Nowadays, the population density at MLHD and DDD is 67 people/km^2, which is close to 10 times the critical indicator. At MLHD, the ratio of ecological supply and demand is 1:1.5, the per capita ecological deficit is 0.63 and the ecological over-load is 630,000 people. At DDD, the per capita ecological deficit is as much as 0.82 and the ecological over-load is more than 800,000 people. These figures are far above the averages in western China.



2.4. Difficulties in Poverty Reduction through Ecological Construction

Ningxia's remaining poverty-stricken people, 2.02 million ha of water-erosion land and 1.183 million ha of sandified/desertified lands are all distributed in mountains and at remote areas with deficiency of natural resources, frequent calamities and backward infrastructures (such as for drinking water supply). At these places, the capacity against natural calamity is very weak, the farmers are deficiency in the capacity for self-development, the grade of poverty reduction is at low level, and the farmers who have basically got rid of poverty are very easy to return to poverty with unfavorable natural changes. Therefore, eco-system reconstruction and poverty reduction are challenged with lots of problems and difficulties.

Chapter 3. Important Measures Poverty Reduction through Ecological Construction and the Achievements in Ningxia

The regional economic development is playing a critical role in poverty reduction. For the sustainability of poverty reduction, the "blood injection" pattern of simple economic rescue is being replaced by the "blood self-production" pattern of economic development.

3.1. Optimizing Water Resource Arrangements and Upgrading Water Efficiency

The deficiency of water resources is the major course of poverty-stricken people increasing and eco-system unbalancing in Ningxia. To solve the problem of water deficiency and improve the resource integration among sunshine, heat, water and soil, focusing on upgrading water efficiency, Ningxia furthered the reasonable arrangement of water resources. At the agricultural ecological zone in YERID, the focus is water-saving. DDD focuses on water diversion. Water and soil conservation is the focus at MLHD. With the completion of groups of key-point hydraulic projects, the capacity of flood prevention and water resource arrangement and the water efficiency have been remarkably upgraded.

In YERID, safe irrigations have been achieved for successive years, the water diversion from the Yellow River and the irrigation quantity have been reduced from 7.97 billion m^3/year to 6.75 billion m^3/year and from 18,375 m^3/ha to 13,905 m^3/ha, respectively, and the irrigation efficiency has been upgraded from 0.37 to 0.40. At the same time, active efforts were made to

probe the conversion of water use right, and Ningxia became the first provincial unit striving for building water-saving society.

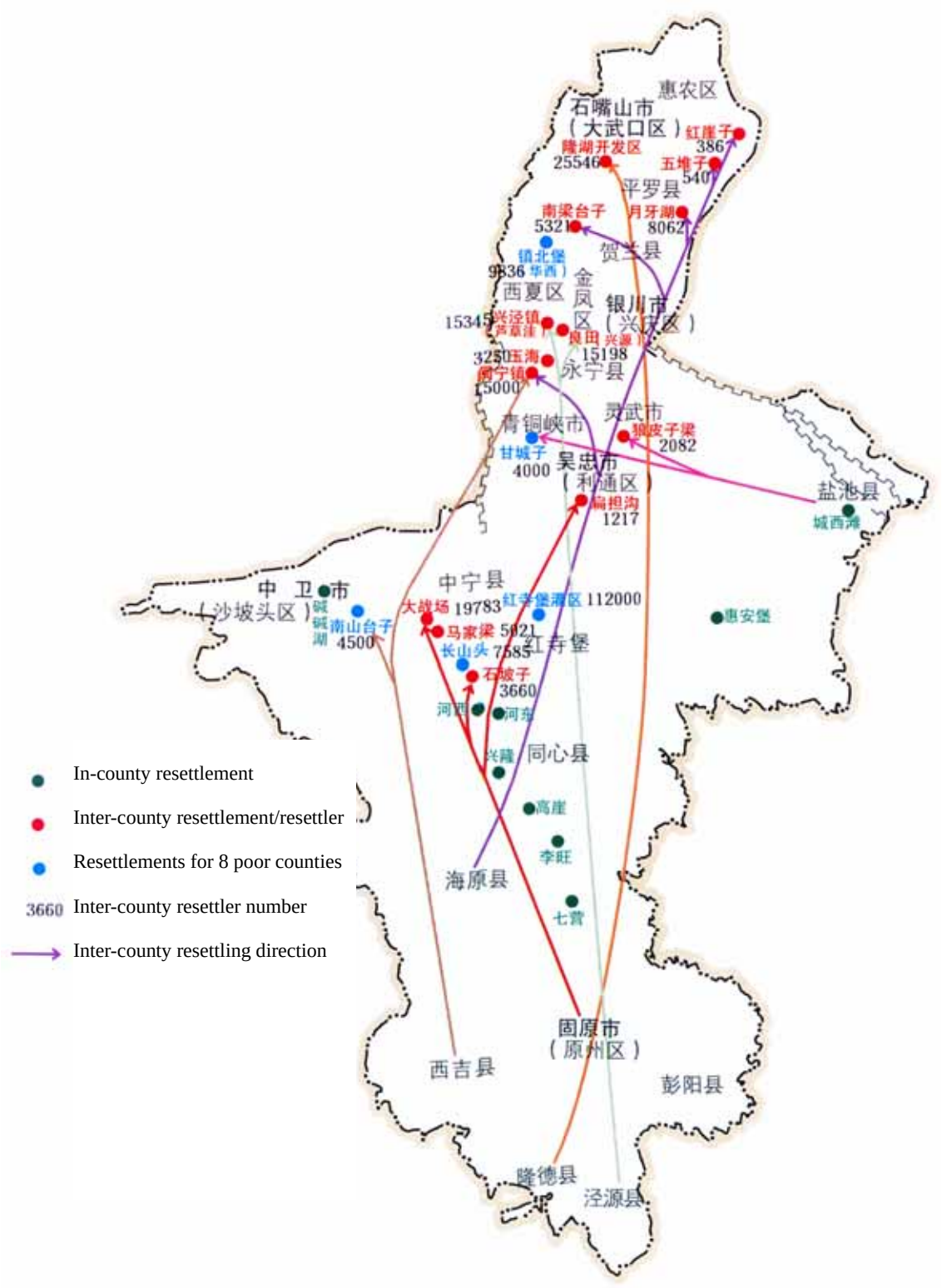
In DDD, the construction of lift irrigation from the Yellow River was accelerated. Upon the completion and extension of the key-point projects such as Guhai and Yanhuanding lift irrigation schemes, medium and small projects of water supply and water-saving supplementary irrigation have been constructed to form hydraulic and irrigation networks in favor of integrated management. At the same time, groups of rainwater harvest facilities have been constructed to help solve the problem of water deficiency in rain-fed farming. By 2006, around 2.35 million rural people (55% of the total) had completely or basically got rid of the problems in water security.

In MLHD, lots of efforts have been made in watershed management. On the basis of water resource availability, groups of reservoirs, water ponds, tube wells and water tanks have been constructed to intercept and use surface run-offs. In addition, lots of efforts have been made in the comprehensive use of brackish water, water diversion and water efficiency upgrading. By 2006, around 2.36 million people (55% of Ningxia's total rural people) had basically solved the problem of drinking water security. In water and soil conservation, 120 small watersheds have been regulated, covering 5864 km^2.

3.2. Optimizing the Arrangement of Man-power and Natural Resources

To optimize the arrangement of man-power and natural resources and reduce the artificial impacts on ecological environment, policies of poverty reduction through ecological construction have been employed such as "productive areas helping resource-deficient areas for mutual benefits and common development". Thank to the national supports for large- and medium-sized hydraulic construction and on the basis of the plentiful land resources on the state farms and at the margins of the irrigation schemes, resettlement construction was accelerated. On the basis of voluntary willingness, poverty-stricken rural people at the most resource-deficient places in MLHD were encouraged to resettle at irrigated areas with better production and livelihood conditions for higher potential of development. By 2007, Ningxia had built 24 resettlements and 45,330 ha of farmland at YERID and lift irrigation schemes in favor of 353,000 resettlers. The resettlements are of various features. For instance, Longhu and Lucaowa resettlements are featured with suburb type, Changshantou, Dazhanchang and

Majialiang resettlements are characterized with agricultural production, the resettlements in Hongsipu County are for comprehensive development, Huaxi and Minning resettlement villages are the examples of the cooperation between coastal well-developed province and inland under-developed areas. These are good achievements to re-arrange the relation between man and natural resources.



Map of Resettlements in Ningxia

3.2.1. Building oasis at desertified land: DDD was known in old days as “dry ocean” for the dryness, intensive evaporation and frequent dusty winds. However, the topography is gentle and flat, and the sunshine and heat resources are plentiful. What’s more, it is not far from the Yellow River, the lift height is less than 100m, and water source is basically assured. As a result, groups of new man-made oasis were built such as Hongsipu Development Zone, Tongxin Lift Irrigation Scheme and Yanchi Chengxitan Lift Irrigation Scheme. Taking the advantages of the Yellow River, the environmental factors and internal structures in the eco-systems can be improved through human efforts, and the systematic functions and environmental quality of the man-made eco-systems can be better than the original natural eco-systems. For instance, the wheat yield at the Yellow River irrigated resettlements has been stabilized at 5,250~6,000 kg/ha (far above the national average). This shows that fragile ecological environment can be meliorated with reasonable production activities for stable, harmonious and efficiency operation and development.

3.2.2. Lowering human’s dependence on environment: In accordance with the outlook of “nearing water, road and town”, the poverty-stricken farmers scattered at remote villages of ecological unbalance and water deficiency within the planned watershed are encouraged to resettle at the places better access to water, road and town. Each of the resettlers is provided with 0.167 ha of irrigated farmland for cropping and livestock raising. In addition, the farmers are encouraged to do off-farm work for income generating. By means of multi-management, farmers will live in better life. The investigations on 2,433 resettlers from Longde County showed that: In the place of origin, the per capita rain-fed farmland availability was 0.187 ha with yield of 1800 kg/ha and the per capita annual income was RMB 570; in the resettlement, each of the resettlers was allocated with 0.167 ha of irrigated farmland with grain yield of 6000 kg/ha and the per capita annual income was increased by RMB 500. In addition to

agriculture, a household could do off-farm work more than 150 days/year, and the per capita annual income could be increased by RMB 1200. Thus, the additional annual income per capita amounted to RMB 1700. Deducting the added expenditures such as for irrigation, electricity, water tariff and schooling fee, the per capita annual net income could be as much as RMB 1500. With the continuous improvement of resettlement infrastructures, the resettlers' income is close or up to the level of the traditional residents. In particular, the resettlers have improved their concept. Some of the resettlers with skills or smart thinking have achieved good life, and most of resettlers are living in better-off life. Besides, groups of income generating sources have been cultivated. Another case investigation was made of the resettlers from Mt Liupan. Before resettling, only 5.3% of them were access to water, electricity and road; 72.4% access to only electricity or road; 22.3% access to none of the three; and 65.1% were difficult in access to medical care and schooling. After resettling, in addition to access to water, electricity and road, medical care and schooling of higher level are conveniently access, and the basic conditions of production and livelihood have been significantly improved. For example, before resettling, Mr. Jia Bingzhang lived in Mt Liupan in Yuanzhou County. The old place was not access to road or electricity, and school and clinic was 12km and 25km away, respectively. There was no motor vehicle in the whole village. Even wheat flour and oil mills were 10~20km away, and everything was carried on back. It was an almost isolated life. The 5 family members shared 2 shabby rooms, and the per capita farmland availability was 0.267 ha of rain-fed slope above 25 degrees. The life was really difficult. One year after resettling in Changshantou Farm, he emotionally said, "kids go to school near, water convenient, transportation convenient, see doctor convenient. Compared with the old place, I live in dreaming paradise". Practices have proven: By means of optimizing the arrangement of man-power and natural resources, an improved relation among man, resources and environment can be built. As a result, human's dependence on environment can be greatly lowered.

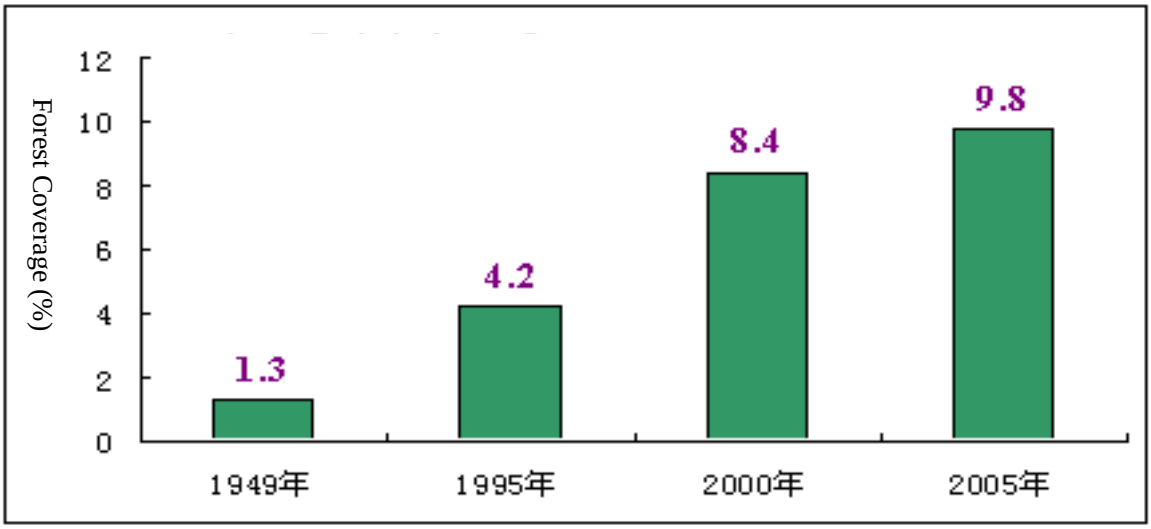
3.2.3. Decreasing costs of poverty reduction: Most of the poverty-stricken people in Ningxia live in the mountainous areas with poor conditions of production and livelihood and difficult

access to social infrastructures. To help them get rid of poverty is difficult and costly. According to the investigations in Longde County in the mountainous area, altogether 20,030 RMB/person was required to help the poor get rid of poverty, including 17,580 RMB/person input for the improvement of production and livelihood conditions and 2,450 RMB/person input for the improvement of social services. Due to the deficiency in the economic, environmental and social conditions necessary in the mountainous area, the sustainability of poverty reduction cannot be assured even with such huge inputs, let along the inputs are too huge for a poverty-stricken county. All kinds of conditions at the resettlements are much better than at the place of origin. After resettling, 12,000 RMB/person input is required for the improvement of production and livelihood conditions and 1,550 RMB/person input is required for the improvement of social services. What's more, the problems of food and cloths shortage can be sustainable solved with resettling, the resettlers will build up much higher potential of future development, and the costs for poverty reduction can be remarkably lowered.

3.3. Powerfully Pushing forward the Rehabilitation and Construction of the Beneficial Cycling System of Ecological Environment

3.3.1. Intensifying the rehabilitation of ecological service functions: With the national strategy of West China Development since 1998, groups of important projects have been implemented such as Natural Forest Protection Program, Three-Norths Shelter-Belt System Construction, Land Conversion Program, Decertification Prevention and Control Program, Plain Greening Program, Protective Forest Construction along the Yellow River and Green Channel Program. In the efforts of ecological rehabilitation and improvement, MLHD focuses on the construction of water source conservation ecological system at Mt Liupan and soil conservation ecological system at the loess hills. DDD focuses on the construction of windbreak and sand fixation ecological system. YERID focuses on the construction of farmland protection windbreak networks and urban scenic vegetation system.

Since 2000, Ningxia has planted 1,288,660 ha of artificial forests and built 547,130 ha of nature reserves, and Ningxia's forest coverage has increased from 8.4% before to 9.8% nowadays.



3.3.2. Intensifying the rehabilitation of natural grassland vegetation: In order to upgrade and rehabilitate the grassland vegetation coverage and its ecological functions, Ningxia has been carrying out a policy of free-grazing ban and encouraging confined livestock raising throughout Ningxia territory since 2003. Following the policy of grassland contractual responsibility system "One who contracts the responsibility will be the one who will be responsible to construct and manage and the one who will get benefit from it. This property is heritable, and this policy will keep the same unchanged", free-grazing ban has covered 2,443,330 ha of natural grassland, around 1,306,670 ha of natural grassland has been closed for natural rehabilitation, and around 210,000 ha of heavily degraded grassland have been meliorated through enrichment. As a result, the vegetation coverage on the major types of steppe and deserty grassland has been added by 50% and 20%, respectively; the grass production of the natural grassland has increased by 30%,

the artificial perennial grassland has enlarged by 122%, and the ratio of artificial grassland against natural grassland has reached 1:6 (among the national tops). In addition, there has been a great development of confined livestock raising. In accordance with the investigations in Yanchi County, the grass production increased from 26.7 kg/ha before the free-grazing ban to 106.7 kg/ha nowadays, and the vegetation coverage enlarged from 35% before to 65% nowadays. The vegetation coverage on steppe, deserty grassland and severely degraded grassland has increased by 50%, 20% and 25%, respectively. In addition, the tendency of grassland desertification has been held back to certain extent, and moving sandland has shrunk by 30.2%. In 2005, dusty weather and sandstorm reduced by 10 times and 5 times, respectively, with half of the previous intensity. Yanchi County is located at the southern margin of the Mu Us Desert. It had 80,000 ha of pure sand dunes and moving sand dunes could be seen anywhere before 2002. Nowadays, it has only around 13,330 ha of scattered sand dunes, and 90% of the grassland is covered with green.

3.3.3. Reforming the traditional pattern of animal husbandry: In order to solve the problems of grassland over-use and land desertification, Ningxia has employed policies of free-grazing

ban and confined livestock raising. This has powerfully pushed forward the development from the traditional rain-fed animal husbandry to modern pattern of intensive confined livestock raising. Ningxia's total number of sheep has increased from 8.21 million heads before free-grazing ban to 10.55 million nowadays (an increase of 29%), the profit from each sheep is RMB 20 higher, and per herdsman net income has increased by 26%. At the same time, 21 set of livestock markets and 70 sets of livestock processing plants have been built. A modern system of livestock development with reasonable structure has been preliminarily set up.

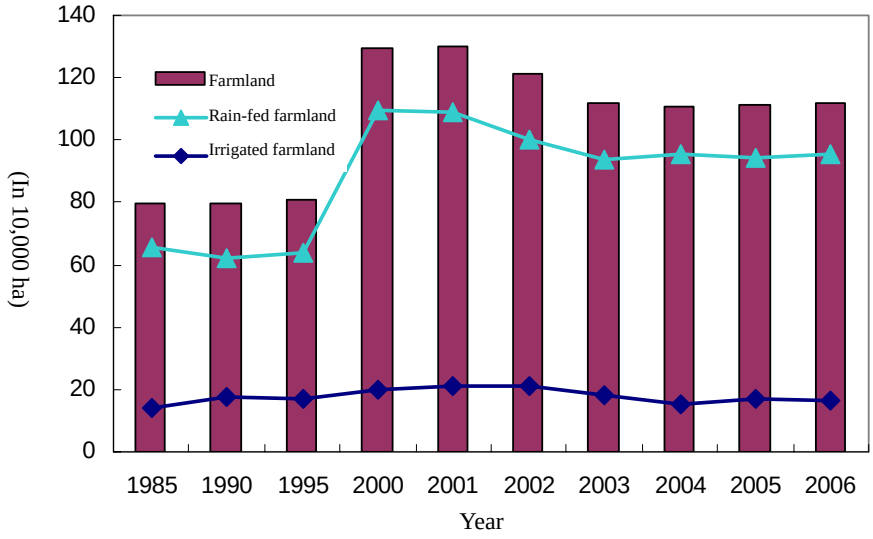
3.3.4. Rehabilitating wetland ecological functions: Through the construction of 30 projects of converting marginal farmland to wetland, de-silting and dredging up watercourses, rehabilitating vegetation and biologic protection and management, wild animals have increased remarkably both in species and quantity.

3.4. Upgrading the Comprehensive Capacity of Agricultural Production

3.4.1. Farmland protection: In order to properly manage the relation between ecological construction and food security/income increase and consolidate the achievements of ecological construction, Ningxia has strengthened the construction and protection of capital farmland and irrigation infrastructures such as lift irrigation facilities, tube-wells, water tanks and drinking water supply system. It is seriously forbidden to convert capital farmland into forest land or grassland. It is stipulated: capital farmland for food shall be kept at least 0.27 ha/person at arid and semi-arid areas and 0.2 ha/person at overcast/humid areas. The

construction of capital farmland is subsidized by 1500~1800 RMB/ha, and around 23,330 ha of capital farmland is built or improved annually. At the places with annual precipitation above 400mm, it is encouraged to construct high standard (i.e. large, wide and flat) terrace farmland. At the places with annual precipitation of 350~400mm, plentiful land resources and gentle topography, it is encouraged to construct interlaced terraced farmland. At the places with annual precipitation of less than 350mm, it is encouraged to construct warp farmland, silt farmland and pebbled farmland. The capital farmland conservation for food security is decided unchanged even for the farmers participating in the land conversion program. In 2007, the poverty-stricken areas in Ningxia achieved 320,000 ha of high-standard rain-fed capital farmland (40% of the rain-fed farmland), 104,000 ha of irrigated farmland with lifted water from the Yellow River, 39,870 ha of irrigated farmland by reservoirs or tube-wells and 17,930 ha of irrigated farmland with harvested rainwater. At the capital farmland in the northern part of YERID, it is forbidden to plant tree blocks, grow perennial grasses, dig fishponds or carry out other activities harmful to cultivation layer. Whenever possible, the land for urban construction should be barren or waste land. The farmland occupied but not yet used should be returned to agriculture. The abandoned house sites in village should be re-cultivated with crops. Around 36,000 ha of land at the margins of the traditional irrigation areas has been cropped by low-lift irrigation. More than 84% of the capital farmland has been effectively protected, and the farmland consumption is basically equivalent to the used farmland.

Ningxia's Farmland Resources from 1985 to 2006



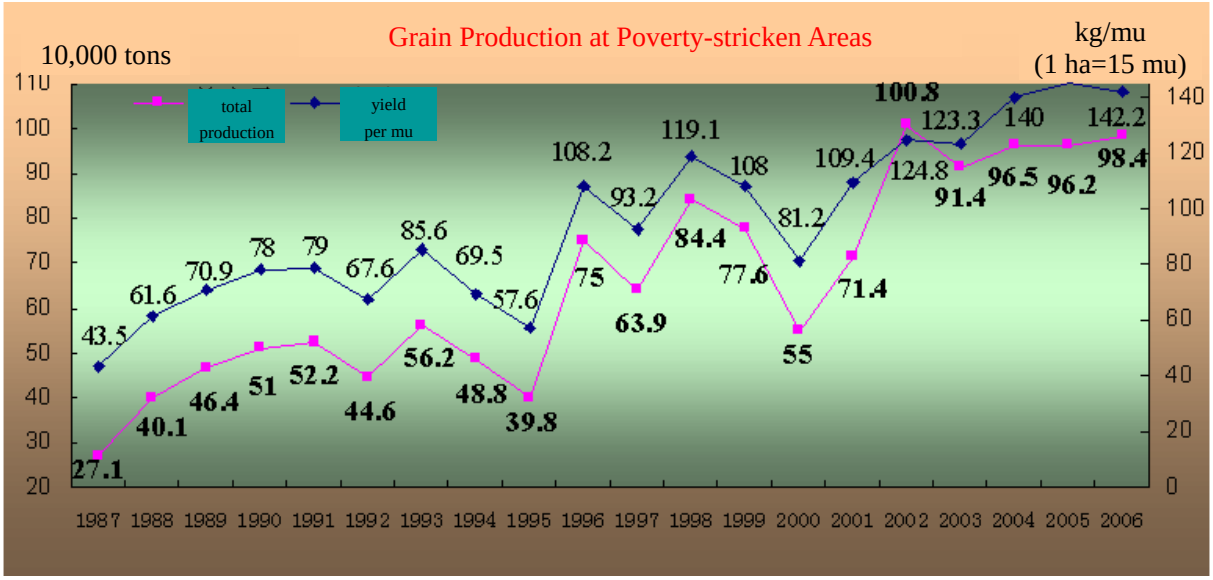
3.4.2. Upgrading grain production capacity and lowering the rate of farmland reclamation: At the same time when farmland protection is strengthened, lots of efforts have been made in

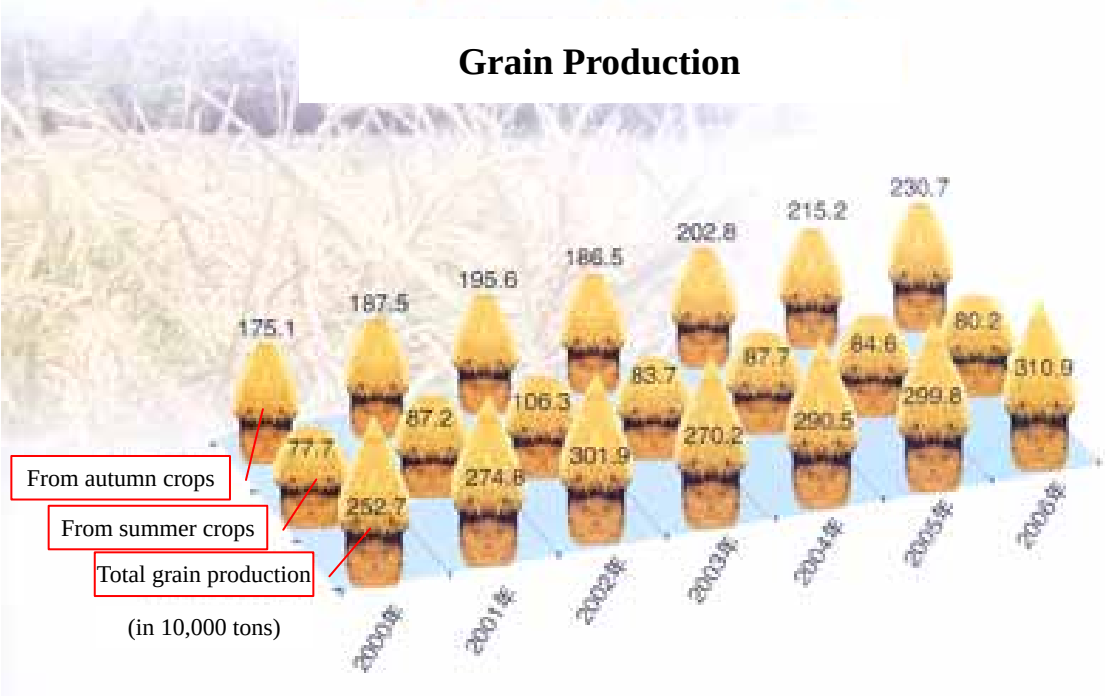
upgrading farmland quality, reducing slope farmland, enlarging the acreage of contour terrace farmland, warp farmland and silt farmland and promoting the level of farmland output. For example, even in dry years, the wheat production from terrace farmland and silt farmland averages 1.8 and 3.8 times as much as that from normal slope farmland. The yield from improved farmlands is 1500 kg/ha more than that from normal slope farmland with direct additional income of RMB 3000. The per hectare yield from irrigated farmland is 4.8 times as much as that from slope farmland. This originates from upgrading farmland quality.

Production of Capital Farmland (kg/ha)

Capital Farmland	Production	
	Year of deficient rain	Year of rich rain
Irrigated farmland	2617.7	2944.1
Terrace farmland	994.5	1392.1
Silt farmland	2100.1	2394.7
Slope farmland	541.4	897.5

In 1984, Ningxia became the first provincial unit in northwest China for food sufficiency and some surplus, and food importation from other provinces became history. In 1990, the grain production totaled to 2 million tons. Since 1995, the grain production has been stabilized above 2.5 million tons/year. In 1999, the grain production was upgraded to 2.94 million tons. In 2002, the grain production broke the record of 3 million tons. Since 2003, the cropping acreage each year has been kept around 800,000 ha (including 333,330 ha at YERID and 466,670 at MLHD) and the total production has been stabilized above 3 million tons/year (including 2.05 million tons from YERID and 0.95 million tons from MLHD). In particular, with the significant improvement of farmland quality at the poverty-stricken areas in recent years, Ningxia's capacity of food self-sufficiency keeps upgrading. In spite of the fact that the cropping acreage in 2006 was 42,000 ha less than in 1999, the total production of grains increased by 177,000 tons. The cropping acreage in 2007 was similar to that in 1999, the total production of grains was added by 230,000 tons. Ningxia's grain availability keeps the level above 550 kg/person, which is above the national average and is at the first place among the provincial units in northwest China. From 1999 to 2006, the grain consumption in Ningxia amounted to 2.3 million tons/year, including 1.2 million tons for food. Ningxia has become food self-sufficient with some surplus. The upgrading of grain production capacity has laid a solid foundation for ecological construction and poverty reduction.





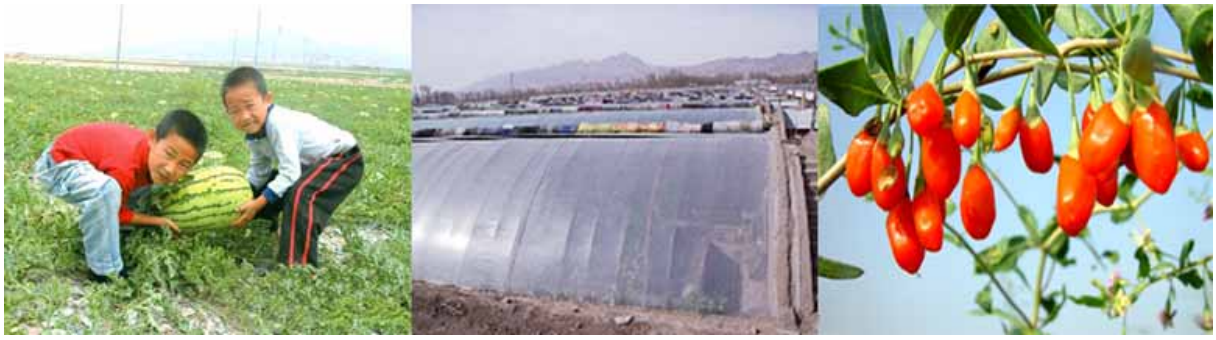
3.5. Improving the Management of Resource

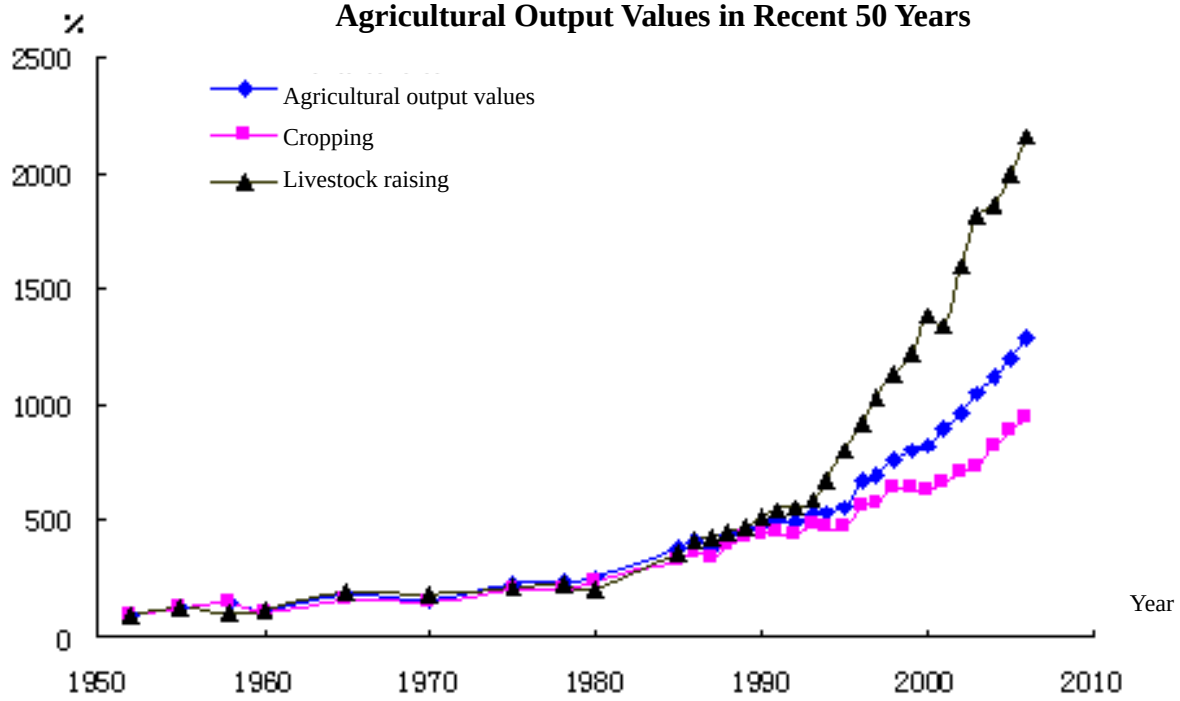
3.5.1. Replacing excessive farmland reclamation and extensive cropping by careful and intensive cropping for better harvest: Following the requirements for the beneficial cycling in eco-system, the structure of agricultural production is adjusted according to the specified natural conditions and regularities at the specified areas, so as to build and develop characterized industry of local advantage.


At YERID, on the basis of stabilizing grain production, the rich resources of sunshine and heat are sufficiently exploited, and there is a powerful development of protected agriculture with high efficiency and water saving. At rain-fed areas, precipitation regularities are respected. By means of infrastructural construction such as tube-wells and rainwater harvesting facilities, all the water resources possibly available from the underground and sky are collected. With water saving technologies such as point watering, dripping irrigation and ground mulching, dryness endurance crops are powerfully developed such as potatoes, fruit trees, miscellaneous grain crops and herbal medicines. In addition, grass growing and livestock raising are developed, and off-farm activities for income generating are encouraged.


Besides, groups of technologies are extended such as water saving technology for higher efficiency, fertilizer application on the basis of soil diagnose, the chemical application with high effect but low toxin, returning crop residues to farmland, fodder silaging and straw ammoniation. Production bases of agricultural and livestock products are built with environment-friendly features.

Through the strategy of agricultural industrialization, the production scale is enlarged and the construction of production bases is strengthened. As a result, the overall capacity of agricultural industrialization has been upgraded, and a framework of regionalized production with local advantages has been basically built. In 2007, wolfberry plantations at/around its primary production centers Zhongning County and Qingshui River Drainage Basin (QRDB) amounted to 33,930 ha; potatoes of 223,800 ha and fodder grasses of 533,330 ha was cultivated at/around MLHD and DDD; milk cows at/around Wuzhong and Yinchuan cities amounted to 320,000 heads; watermelons were cultivated over 48,000 ha at/around dry areas of Mt Xiangshan; jujube of 30,000 ha was growing at/around Lingwu and Zhongning counties; vineyards of 14,670 ha had been built at/around eastern piedmont of Mt Helan; fishponds of 23,330 ha had been constructed along the Yellow River; 8.3 million heads of sheep were raised at/around YERID and DDD; 1.6 million heads of beef cattle were fed at/around the mountainous areas of Mt Liupan; and 27,800 ha of protected agriculture were developed and 66,670 ha of open-ground vegetables were cultivated at/around YERID. Ningxia has built the largest market of wolfberry and the largest market of halal beef and mutton in China. Ningxia's products with trademark of Xiajin and Ningxia Red have become world-known. The output value of the agricultural strategic leading industries and regional characterized industries has amounted for 75% of the total output value of Ningxia's agricultural production. With the development of regional characterized production and the improvement of agricultural production structure, the output value of livestock raising and aquiculture has reached 36% of the total output value of agricultural production (3% higher than that in 2000). A modern framework of agriculture for common development of farming, forestry, livestock raising and aquiculture has been preliminarily built. In 2007, the activities of grass growing/livestock raising, potato cultivation and off-farm work helped the farmers in Guyuan Municipality achieve per capita annual net income of RMB 1360 (63% of the total income).





3.5.2. Optimizing land use structure: The actual cropped acreage at the poverty-stricken areas in 1999 covered 945,330 ha, while that in 2006 was 676,670 ha (a reduction of 268,670 ha). However, the area of forests and artificial grassland in 2006 was 314,000 ha and 400,000 ha larger than those in 1999, respectively. This is an indicator that lots of marginal farmland was converted for tree planting and grass growing in favor of water and soil conservation. For instance, the soil erosion modulus at Guyuan Municipality has been lowered by 18 m^3/ha.a, compared with that before the land conversion program.

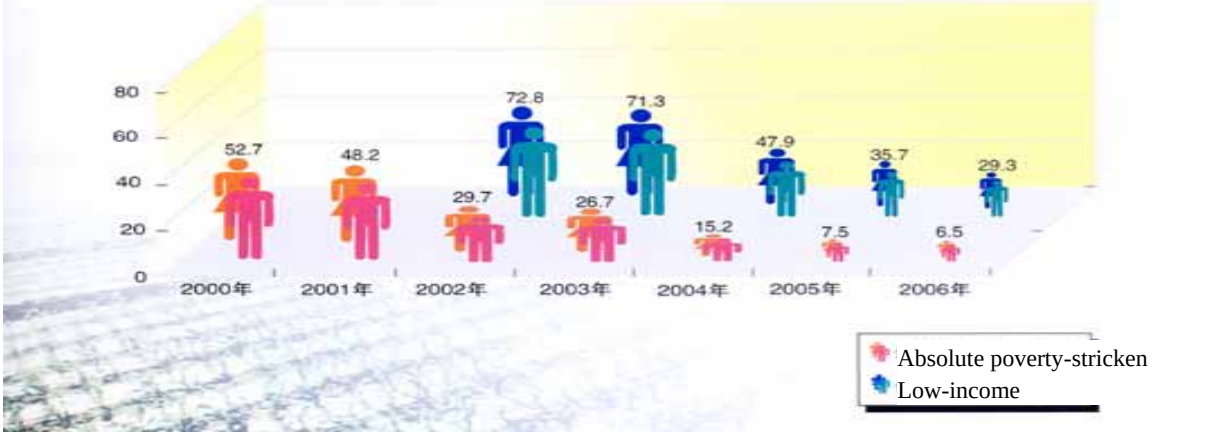
3.5.3. Extending rural clean energy in favor of environment: Following the policies of "suitable measures for specified places, complementation among multiple energies, comprehensive energy use, energy saving at the same importance of energy development" since 2003, and aiming at changing the traditional laggard patterns of production and livelihood, the campaign of rural energy development was conducted with each household as one unit, all the possible resources such as crop residues, solar energy and wind energy were utilized, and varieties of energy development technologies were combined with efficiency garden agricultural technologies, so that packets of practical models and technical

specifications have been generated to accelerate beneficial cycling between production and livelihood and between farmland and garden in favor of warm and clean environment, efficiency garden economy and environment-friendly agricultural production. By the end of 2006, bio-gas tanks had been extended to 560 villages of 173 townships throughout 22 counties; 106,000 households (12.3% of the total rural households) had been equipped with bio-gas tanks; and the expenditure for energy was reduced by 800 RMB/household. Three projects for large-scaled and 50 projects for small-scaled bio-gas tanks were conducted. Solar stoves, solar water heaters, energy-saving stoves (beds), solar greenhouses were extended by 100,000 sets, 120,000 sets, 550,000 sets, 70,000 m^2 (50 sets), respectively. In addition, 2114 sets of wind mill generators were installed and 4 sets of straw gasification stations were constructed. The beneficiary rural households increased from 10,000 in 2001 to 200,000 nowadays. In the recent 5 years, the number of bio-gas use households has increased by 10 times. The development of rural energy is marching forward from household-by-household bio-gas use to comprehensive clean energy use such as large-scaled bio-gas production, solar stoves, solar water heaters, energy saving stoves (beds) and straw gasification. As a result, the sanitary situation in villages has been remarkably improved, the use of straw and fuel-wood is reduced by 100,000 tons, and around 15,000 ha of forests avoided cutting.

3.5.4. Encouraging off-farm works for income generating: With more and more marginal farmland being converted for vegetation construction, lots of laborers are set free from farming practices. To make the best use of surplus rural labor, Ningxia Government has actively adjusted the structure of rural employment, off-farm economy has been recognized as one of the leading industries for income generating and poverty reduction, series of policies and measures have been formulated and taken to support the development of off-farm economy, and farmers are organized on planned basis to do off-farm work for additional income. In 2007, Ningxia exported 780,000 person-times of off-farm workers, the income from which amounted to 45% of the per rural capita annual net income. Off-farm economy has become one of the brilliant points of economic development.

3.5.5. Strengthening infrastructural construction and improving the livelihood conditions in the poverty-stricken areas: In order to thoroughly change the laggard situation and upgrade the livelihood of the poverty-stricken people, Ningxia has intensified infrastructural construction at resource-deficient areas. By the end of 2007, the per capita availability of high-standard rain-fed capital farmland and effectively irrigated farmland in the poverty-stricken areas amounted to 0.187 ha and 0.043 ha, respectively; 100% of the administrative villages became access to highways and electricity; 90% of the administrative villages became access to public buses and telephone; and 80% of the rural households became access to TV (8 channels). Nine-years compulsory education has been extended on overall basis. Schooling children have become free from tuition fee and supported with living subsidy, and the schooling expenditures and textbook costs have been exempted. Rural system of medical care cooperatives, rescue mechanism for serious illness and life security policy for low-income rural people have been practiced. Around 780,000 person-times of laborers have been trained with skills and technologies, and 31,000 households (including 155,000 absolute poverty-stricken rural people) have removed from loess caves and resettled in new houses. 29,453 households that respect the policy of “less children and better life” have been rewarded with RMB 89,419,000 of subsidy.

Absolute Poverty-stricken and Low-income Population in the Mountainous Areas (in million)



To sum up, with years’ efforts of construction and development, Ningxia has made significant achievements in poverty reduction through ecological construction, and the number of

poverty-stricken people has been remarkably reduced. From 2000 to 2006, the number of absolute poverty-stricken and low-income population reduced by 462,000 and 435,000 people, respectively. The ecological environment has opened a new chapter of “environment worsening being generally held back, environment being improved partially, ecological quality and economic benefit keeping the same pace”.

At MLHD, an ecological-economic forestry supporting system with water source conservation forests and soil conservation forests as the major features has been preliminarily built at Mt Liupan; and a framework of production bases for ecological-economic harmonious development has been preliminarily built, characterized with the production of potatoes, fodder grasses, livestock products, miscellaneous grains, wolfberry, herbal medicines, apricots and seedlings. Each year, the silt export to the Yellow River is decreased by 40 million tons, and grain production is added by more than 100,000 tons. For instance, Pengyang County has put 83 sets of small watersheds and 152,330 ha of eroded land under regulation, the managed acreage has increased from 11.1% of the eroded area to 69%, and the forest coverage has enlarged from 3% in 1983 to 20.3% nowadays. Pengyang County has been rewarded with many national honors for its achievements in ecological construction, water resources management, soil conservation, afforestation and marginal land conversion for vegetation construction. In 2003, Pengyang was listed as one of the national demonstration zones of ecological construction by State Environmental Protection Administration, and National People’s Congress recommended that Pengyang’s experiences of soil conservation should be extended at the similar places on the Loess Plateau. The land preparation belts in Yangwa watershed management in Pengyang were as long as that running around the Earth 3 cycles, which was describe as “China Ecological Great Wall” by the visitors of World Vision. Nowadays, around 80% of the eroded areas have been regulated. The grain production increased from 1020 kg/ha before the management to 2060 kg/ha in 2006, the silt interception amounts to 15,000 tons/year, and the vegetation coverage has enlarged to 22.7%. In 2006, per capita net income and grain production was RMB 2460.6 and 500 kg, respectively. In Longde County, 36,800 ha of high-standard capital farmland (amounting for 85.9% of the total farmland) has been built, 93.1% of the slope farmland has been constructed into terraced farmland, and per rural capita availability of capital farmland has reached 0.213 ha. All the slope farmland above 25 degrees has been converted for ecological construction. Around 16,990 ha of marginal farmland have been converted for vegetation construction. The forest coverage and vegetation coverage has reached 25.9% and 42.8%, respectively. Trees and/or shrubs are planted on 66% of the farmland ridges, more than 95% of the terraced farmland are well-maintained, and 72% of the eroded areas has been regulated. In spite of the fact that the sowing acreage is 20.1% less than that in 1990, the grain production increases by 35.9%. The

per capita grain availability has reached 454kg. The total output value, financial income and per rural capita net income of Longde County has increased by 3.4 times, 1.5 times and 2.9 times, respectively. Around 30,000 households are actively participating in cash generating activities such as greenhouse cultivation and livestock raising in stables as well as the production of melons, fruits, vegetables and herbal medicines, which adds 358 RMB/capita to the annual income. Longde County was rewarded an honor of model county of terraced farmland construction by Ministry of Water Resources. Upto now, 40 small watersheds in 7 counties of Ningxia have been recognized as demonstration projects by Ministry of Water Resources and Ministry of Finance.

At DDD, around 31,130 ha of desertified land have been regulated, and moving sand dunes have decreased by 30.2%. A historic achievement has been made that the speed of desertification management is higher than that of desertification expansion in Ningxia. The desertified land has decreased from 110,000 ha in 1970s to 78,870 ha nowadays. The tragedy situation of “desertification marching forward and human being withdrawing” has been preliminarily reversed. Ningxia has become one of the national tops in desertification prevention and control.

At YERID, high-standard farmland protection windbreak networks, tree belts along roads and embankment protection belts along the Yellow River have been built by 400,000 ha, 3600km and 389km, respectively. The regional micro-climate has been remarkably improved.

Through the construction of 30 projects of converting marginal farmland to wetland, de-silting and dredging up watercourses, rehabilitating vegetation and biologic protection and management, wild animals have increased remarkably both in species and quantity. Nowadays, there are 285 species of birds in Ningxia's plains, including 7 species of Grade 1 and 30 species of Grade 2 in the national protection list.

At urban districts and their suburbs, groups of urban greening projects of ecological, ornamental and social benefits have been done such as vegetation belts along Yin-Gu highway, protection forests at the west of Yinchuan City, vegetation construction over the eastern piedmont of Mt Helan, ornamental belts along the scenic watercourse and protection forests at the west of Shizuishan City. In the project of building Yinchuan a city of lakes, the scenic watercourse has linked 7 lakes such as Yuehai Lake, Xihu Lake and Huayanhu Lake. The ecological situation is marching forward from simple greening to ecological beautification. An environment of beautiful, natural and comfortable livelihood has been preliminarily built. In particular, Yinchuan City has become the most suitable place of livelihood among the provincial capitals in northwest China in the terms of sanitation, cleanness and air quality.


Yinchuan – City of Lakes

Chapter 4. Requirements for Studying Poverty Reduction through Ecological Construction

Through years' painstaking efforts, Ningxia has made some achievements in poverty reduction through ecological construction. Due to the long-term accumulation of ecological debts, the functions of eco-system service and the benefits of poverty reduction are still at relatively a low level. The forest coverage in Ningxia (only half of the national average) is rather weak in climate regulating, water/soil conservation and desertification control. Therefore, it is of urgent necessity to probe how to harmonize the relation among population, resources, environment, poverty reduction and economic development so as to (i) find beneficial and effective approaches to the rehabilitation of eco-system service as well as poverty reduction and development through detailed research, (ii) reasonably arrange resources and productivity, (iii) harmonize the relation between the economic development at poverty-stricken areas and population, resources and environment, (iv) set up PREC system

with locally characterized features, and (v) provide the decision-makers with scientific evidences in favor of eco-system beneficial cycling and the economic-social sustainable development at the poverty-stricken areas.

4.1. Dynamic Evaluation and Research on the Rehabilitation of Eco-system Functions

In recent years, Ningxia has implemented a series of important and large-scaled PREC projects such as the Land Conversion Program, Ecological Resettlements, free-grazing ban for grassland rehabilitation, soil/water conservation and basic farmland construction. On the basis of dynamic monitoring and evaluation of the above projects, the research will focus on the stability, service functions and efficiency of the eco-systems upon the integration of the original eco-system factors and the importation of the new factors.

4.2. Research on Upgrading Eco-system Bearing Capacity

Under the guidance of the theories of ecological economy, sustainable development and eco-system service function rehabilitation, the systematic research will focus on the bearing capacity of natural resources (such as water and soil), so as to propose scientific approaches to solving the typical problems in the eco-system function rehabilitation, poverty reduction and development at the poverty-stricken areas in Ningxia.

4.2.1. Research on upgrading the bearing capacity of water resources. Water resources are the most important factors restraining Ningxia's economic-social development. Upon the integrated evaluation of the region-by-region precipitation, evaporation, surface water, ground water, Yellow River water supply and other water resources, the water requirements for population development, industrial development, agricultural development, livestock development, tertiary industry development and ecological construction will be analyzed and predicted. The systematic research will focus on upgrading (i) the eco-system capacity of water conservation through vegetation rehabilitation, (ii) the water supply capacity through infrastructure construction, (iii) water source protection and sewage treatment/reuse, the construction of water-saving management. Proposals will be contributed to upgrading the bearing capacity of water resources.

4.2.2. Research on upgrading the bearing capacity of land resources. Upon analyzing the potential and reasonable development of land resources and by means of basic farmland construction at the poverty-stricken areas, the research will focus on (i) upgrading the capacity of farmland soil moisture retaining, (ii) improving soil fertility, and (iii) importing new technology and drought-endurance crops/varieties. Aiming at alleviating the problems of

successive droughts, proposals will be made for upgrading the bearing capacity of soil resources.

4.2.3. Research on rehabilitating eco-system service functions. The research will focus on (i) the sustainable use of natural grassland under the condition of free-grazing ban, (ii) man-made grassland construction, (iii) terraced-farmland construction, (iv) hydraulic infrastructure construction in favor of ecological improvement, (v) upgrading the productivity of land resources and the assimilation capacity of ecological environment on CO^2 and other wastes, and upgrading the bearing capacity of eco-system units.

4.2.4. Research on the integrated use of resources with technological improvement. The research will focus on the integration and improvement of resource management and technical upgrading. New technologies and new methodologies will be probed in favor of poverty reduction and resource efficiency.

4.3. Research on the Reasonable Arrangement between Population and Resources

In Ningxia, around 300,000 poverty-stricken people are living at remote places in deep mountains with deficient natural resources and frequent calamities, where the basic condition for survival is a serious problem. In order to keep the demands for ecological resources within the scope of ecological bearing capacity at Ningxia's poverty-stricken areas, one of the possible options is to lower the population pressure on the eco-system and upgrade the ecological bearing capacity in favor of sustainability of regional development. On the basis of eco-system and the bearing capacity of water and land resources, the research will propose approaches to ecological resettlement schemes, follow-up management and the direction of economic-social development.

4.4. Research on Ecological Agriculture

Ningxia has more than 20 advantages for the development of local-characterized ecological agriculture such as wolfberry production, grass growing and livestock raising. The research will focus on the technology to support the development of local-characterized production with eco-system beneficial cycle in Ningxia. The 4 research packages are:

- Model of ecological agricultural development for food security and people's health under the guidance of modern food concept;

- Model of ecological agricultural development by means of scientific upgrading and technical extension as well as the integration of traditional agricultural technology and

modern science;

- Model of ecological agricultural development by means of clean production, resource protection and the improvement of rural ecological environment; and

- Model of ecological agricultural development by means of multiple management, multiple production, multi-layer structure of agricultural economy, intensive production and industrialized management.

4.5. Research on PREC Policy and the Supporting Schemes

The research will focus on the policy study and formulation on development and environmental protection within the scope of resource bearing capacity.

Chapter 5. Ningxia's Strategy of Poverty Reduction through Ecological Construction

5.1. Strategy for Water Efficiency

Through reasonable arrangements of the local water resources such as the Yellow River, precipitation and ground water, the mechanisms of irrigation management and water tariff formation will be improved for high water efficiency to better satisfy the water requirements for livelihood, agricultural/industrial production and ecological construction.

YERID will focus on water-saving and accelerate the construction of modern water-saving irrigation. For the healthy development at this "land of honey and milk", the ground water will be reasonably used, the ground water table will be scientifically regulated, the management of flood water resources and wetland resources will be strengthened, and the water-saving capacity in industrial production and urban development will be upgraded.

DDD will focus on the reasonable use of the diverged water from the Yellow River. Within the scope of water availability, the water distribution structure for livelihood, agriculture and industrial development will be improved. The development of protected agriculture with higher water efficiency will be pushed forward, rainwater harvesting facilities will be constructed, possible measures will be taken to use flood water resources, and medium-sized and small hydraulic structures will be built. The large-sized projects of Yellow River water diversion will link medium-sized and small hydraulic structures to form an integrated network for water supply security.

MLHD will focus on water/soil conservation. With a watershed as a management unit and in accordance with the water resource bearing capacity of the watershed, reservoirs, water ponds

and water storages will be constructed to collect and use surface run-off, and possible measures will be taken to use flood water resources and blackish water resources. Water diversion structures will be constructed, and efforts will be made to upgrade water efficiency.

5.2. Strategy of Ecological Resettlement

Under the precondition of self-willingness, the poverty-stricken villages suffering from the serious deficiency of the basic conditions for survival will be encouraged to resettle at the places access to irrigation facilities, roads and social infrastructures (such as schools and medical services). To help these poverty-stricken resettlers with better livelihood and production potential, varieties of income generating activities such as industrial development and off-farm jobs will be pushed forward, so that the ecological and poverty-stricken problems will be thoroughly solved. By the year 2011, it is planned to resettle around 300,000 poverty-stricken people within the 9 counties, so that people will follow the availability of water and other resources and the pressure of population on environment will be alleviated to generate a harmonious relation between man and resources.

5.3. Strategy of Land Efficiency

5.3.1. Basic farmland construction: YERID will focus on water-saving by means of drainage improvement, small-plot irrigation and salinization prevention. In addition, farmland of mid- and low-yielding will be meliorated. MLHD and DDD will further the improvement of rain-fed basic farmland for upgrading production and lowering the rate farmland reclamation.

5.3.2. Lowering the rate of farmland reclamation: The effort for upgrade production and lower the rate of farmland reclamation will focus on the construction of water source conservation forest, soil conservation forest, sand fixation forest and windbreak network as well as natural forest protection, grassland vegetation rehabilitation and grass growing.

5.3.3. Developing PREC industries:

- Grass growing and livestock development: DDD will focus on sheep feeding, MLHD -- beef cattle raising, and YERID -- the intensive production of mutton, beef, milk and pork;

- Efficiency farming: With the construction/improvement of basic farmland and on the principle of food security, efficiency farming will be pushed forward by means of the development of protected agriculture and the extension of water-saving technology. The target is to help each household with one mu of protected agriculture (1 ha = 15 mu) for green-food production. Water-saving crops such as potato, watermelon, wolfberry, jujube, common fennel,

miscellaneous grain crops, liquorices and fodder grasses will be developed for stabilized production with the technical supports of rainwater harvesting, supplementary watering, soil moisture conservation and mulching; and

- Development of agricultural industrialization: Enterprises are encouraged to invest in agro-product processing in Ningxia. With the advantages of their resources such as finance, famous brands, trademarks and reputation, the strategy of famous product production will be conducted to push forward the processing and marketing agro-products with locally characterized features. Medium and small enterprises (MSE) are encouraged in technical improvement, product research & development, brand upgrading, quality control and technical training to upgrade MSE's capacity of self-development and market competition. It is encouraged to set up agricultural industrialization associations and farmers' cooperative groups to establish a cooperative mechanism between enterprises and farmers.

5.4. Strategy of Farmers' Wellbeing with Science and Technology

5.4.1. Demonstration will be strengthened to extend improved varieties with new, peculiar, excellent and rare features to pushed forward poverty reduction through and agricultural development and ecological construction.

5.4.2. Farmers' training will be strengthened through varieties of activities and projects such as "Training one million farmers", "Vocational training for off-farm jobs" and "Technical training for poverty reduction". Vocational courses will be added into the normal educational program in rural middle schools. With the establishment of labor mechanism, groups of modern farmers enriched with cultural, technical and management skills will be brought up.

5.4.3. Technical extension will be strengthened focusing on varieties of new and advanced technologies in clean production, improved varieties, resource efficiency, intensive crop cultivation and livestock raising, pest control, agro-product processing.