GIAHS Proposal

Zhagana Agriculture-Forest-Animal Husbandry Composite System

Location: Diebu County, Gansu Province, P.R.China

The People's Government of Diebu County, Gansu Province

August, 2016

SUMMARY INFORMATION

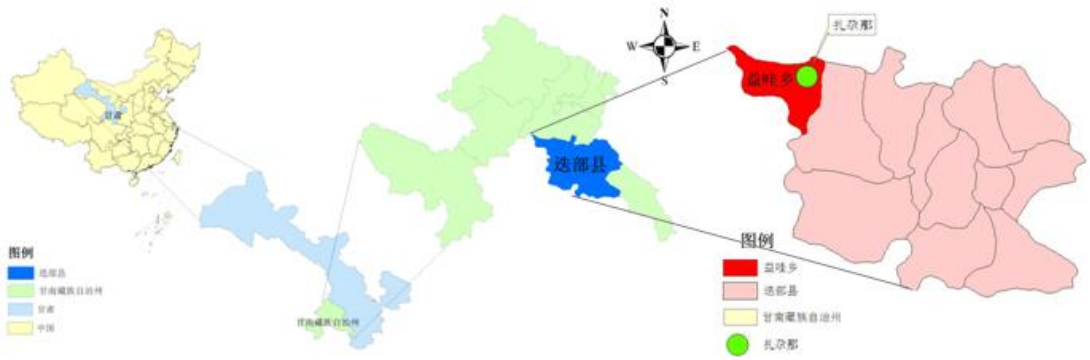
Title of the Agricultural Heritage System:

Zhagana Agriculture -Forest-Animal Husbandry Composite System

Requesting Agency/Organization:

The People's Government of Diebu County ,Gansu Province, P.R.China.

Country/Location/Site: Yiwa Village of Diebu County in Gannan Tibetan Autonomous Prefecture in Gansu Province of People’s Repulic of China locates between the 102°57'03"-103°15'07" E and 34°11'37"-34°98'06" N.



Accessibility of the site to capital city or major cities: 278 kilometers away from the Lanzhou Zhongchuan Airport, 132 kilometers away from the Jiuzhai Huanglong Airport, 139 kilometers away from the Xiahe Airport respectively. The place is connected with Lianhuo High-Speed,QingLan High-Speed and inter-provincial roads.

Approximate Surface Area: 49.44km^2

Agro-ecological Zone/s: Ecological transition zone of plateau farming and animal husbandry.

Topographic Features: The converage zone of Tibetan Plateau, the Loess Plateau and the Chengdu basin; surrounded by glacier-eroded landforms; the Central Valley of farmland, grassland and woodland distribute alternatively.

Climate Type: The convergence zone of the sub-tropical, temperate monsoon climate and the plateau alpine climate.

Approximate Population: 1546

Main Sources of Livelihoods: The animal husbandry, planting and forest

economy give the priority of the agricultural production and rural tourism.

Ethnicity/Indigenous Population: Tibetan

Summary Information of the Agricultural Heritage System

Zhagana Agriculture-Forest-Animal Husbandry Composite System is located in the three major landforms of the Tibetan Plateau, the Loess Plateau and the Chengdu basin and also lies in the convergence zone of the three climatic zone: tropical humid zone of Central and South China, the warm temperate zone of North China and the humid zone at the edge of the plateau, the type of vegetation is among the convergence of the Alphine steppe zone, the grassland of the northern temperate zone and the Quercus of the southern warm temperate zone and it is a transitional zone of Tibetan-Chinese culture as well as agriculture and animal husbandry. Local residents, the unique geographical and ecological location as well as the alpine and barren natural conditions co-evolve and evolve continuously, which forms a unique agricultural production which is relatively closed, complete, compact and self-sufficient. The macro landscape is the composition of agriculture, forestry, animal husbandry in the vertical zone and horizontal space. The recycling and rational utilization of the resources of land, forest, grassland and species are shown on the micro level and produces a variety of products to meet the needs of people's daily life and production.

Zhagana Agriculture-Forest-Animal Husbandry Composite System lies in the fragile ecological zone which is alpine and barren. It also locates in the priority area of biodiversity conservation. At the same time, it is located in the upper reaches of the Yangtze River and the Yellow River, which is an important water conservation area. Therefore, the system not only provides diversified and comprehensive material products in terms of ensuring the livelihood security of local residents but also has an important ecological function-biodiversity conservation, water conservation as well as water and soil conservation, which play an important role in

maintaining regional ecological balance and ecological security.

Meanwhile, Zhagana Agriculture-Forest-Animal Husbandry Composite System breaks through a single narrow industrial limit and meets the needs of consumers by providing a variety of material products. By means of the adjustment of ecological relationship, the integration of system structure function and other aspects of the delicate treatment, the method gives full play to the function of ecological environment and maintains the ecological balance and living environment. Through the reasonable collocation of different season planting, animal husbandry and forestry picking and other production activities, the labor force is fully utilized. The system has a strong regional characteristics of natural and social economy. It not only displays the diversity of nature, but also lays the natural foundation for the cultural diversity and uniqueness, which endows the agriculture broader and richer connotation and promotes the function of agriculture in the modern society to the diversification of direction.

In conclusion, Zhagana Agriculture-Forest-Animal Husbandry Composite System locates in the border of Gansu, Qinghai and Sichuan Province and it has been the bridge and link for economic and cultural exchanges between the mainland and Tibet since ancient times. The special location has created the blend of unique natural and cultural landscape, nomadic culture, Tibetan Buddhist culture and folk culture. Various forms of folk customs, songs and dances, folk crafts and other traditional culture pass from generation to generation. This unique combination of agricultural and cultural heritage constitute the basis of local traditional culture.

Contents

Zhagana Agriculture-Forest-Animal Husbandry Composite System lies in the Yiwa Village of Diebu County in Gannan Tibetan Autonomous Prefecture in Gansu Province of People's Repulic of China and locates between the 102°50'50''-103°10'20'' E and 34°09'40'-34°10'80'' N.

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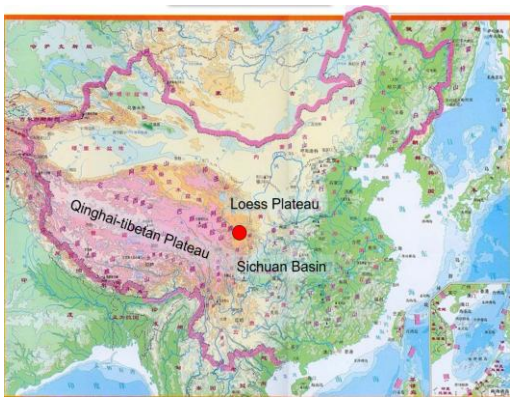
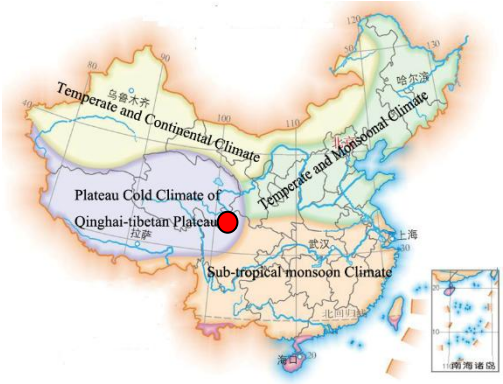
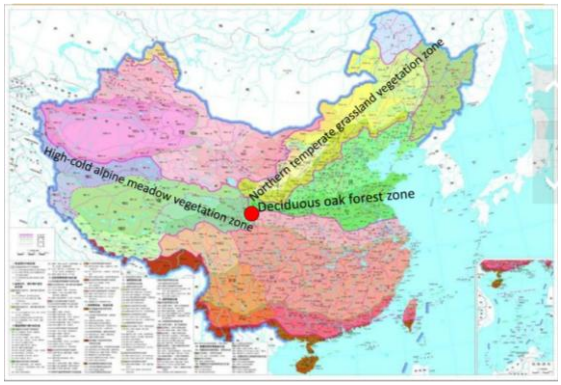


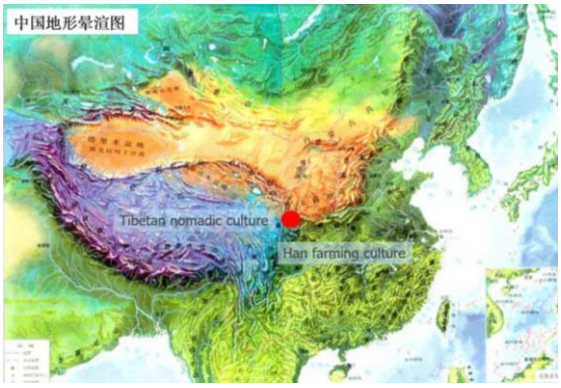
Topography



Climate



Vegetation



Culture

Figure1 Location

For thousands of years, local residents are co-evolved continuously with unique geographical location and alpine barren natural conditions. The nomadic culture, farming culture, forest culture and Tibetan Buddhism culture are long-term complementary, which forms the irrigated farming, in river, the interphase of mountain and woodland as well as grassland and cerebral mountain grazing, such a relatively closed, complete, close and self-sufficient unique mode of agricultural production and the unique and rich cultural heritage (Figure 2), showing the agricultural ecology and agricultural economic characteristics of the compound of agriculture, forestry and animal husbandry.

Zhagana Agriculture-Forest-Animal Husbandry Composite System shows a three-dimensional layout in accordance with the ecological environment. Farmlands, river, houses, temples as well as the surrounding mountain and forest and grassland matched appropriately, forming distinctive charm of the space of pastoral life. Both sides of the river are between 500-2500 meters above sea level, whose terrace is wide, soil is fertile, water is adequate, forming a contiguous land and staggered agricultural landscape. The poplars and willows are planted in the field, small forests and grasslands are on the banks of the river. Both sides of the valley of the low mountain zone are hillies and gullies, which are 2000-2600 meters above sea level, forming the alternate distribution of forest and grassland where Juema pig and cattle are fostered. At an altitude of 2600-2800 meters, where the plateau, meadow, scrub, known as the brain mountain area (Generally as grassland) are distributed.

Figure2 The panorama

The compound production of agriculture, forestry and animal husbandry is also the need of the local people's lives, each family unit can be provided a variety of production materials and necessities of life in a relatively closed geographical environment through the compound production of agriculture. The residents here are religious believers, they change their occupation constantly with the change of season, they engage in different occupation, such as: Nomadic farming, hunting and cutting woods and so on. They are also farmers, hunters and woodcutters, each holding of multiple occupation.

Meanwhile, Zhagana Agriculture-Forest-Animal Husbandry Composite System breaks through a single narrow industrial limit and meets the needs of consumers by providing a variety of material products. By means of the adjustment of ecological relationship, the integration of system structure function and other aspects of the delicate treatment, the method gives full play to the function of ecological environment and maintains the ecological balance and living environment. Through the reasonable collocation of different season planting, animal husbandry and forestry picking and other production activities, the labor force is fully utilized.

Zhagana Agriculture-Forest-Animal Husbandry Composite System lies in the fragile ecological zone which is alpine and barren, it also locates in the priority area of biodiversity conservation. At the same time, it is located in the upper reaches of the Yangtze River and the Yellow River, which is an important water conservation area, which plays an important role in maintaining regional ecological balance and ecological security.

1 Characteristics of the agriculture heritage system

1.1 Food and Livelihood Security

Zhagana Agriculture-Forest-Animal Husbandry Composite System is a suitable strategy for local residents to adapt to the natural environment, which forms the irrigated farming, in river, the interphase of mountain and woodland as well as grassland and cerebral mountain grazing, such a Vertical and three-dimensional multiple type of economy. This is the best layout of the geographical environment, showing the mutual dependence of agriculture, animal husbandry and forestry as well as the complementary advantages of the compound ecosystem. (Figure 3)

Figure 3 Zhagana Agriculture-Forest-Animal Husbandry Composite System

Zhagana Agriculture-Forest-Animal Husbandry Composite System forms a relatively closed, complete, compact and self-sufficient economic unit, which can ensure local people's food supply and livelihood security in the area where the communication is inconvenient (Figure 4).

First of all, Agriculture-Forest-Animal Husbandry Composite System can meet the needs of the normal life of farmers. The planting industry provides flour, vegetables and other food. Animal husbandry provides milk, meat and other food as well as fur. The forest provides housing construction, non-staple food and medicine, so as to ensure the minimum living needs in cold plateau region.

Secondly, Agriculture-Forest-Animal Husbandry Composite System can also meet the needs of the normal production of farmers. Livestock can provide fertilizer and animal labor for farming. Planting industry provides forage and winter venues for livestock. The forest not only provides raw materials such as wood for agricultural production, but also the unique local stocking site of Juema pig.

Finally, Agriculture-Forest-Animal Husbandry Composite System also provides a material basis for the maintenance of traditional Tibetan traditional lifestyle and traditional culture. Tsampa (and Stir-Fried Noodles with Vegetables), tea and mutton (eat by hand) constitute the main diet structure of the Tibetan. Whether civilians or nobles, whether laity or nobles whether, farmers or herdsmen, the diet structure is common and without change for thousands of years. At the same time, the Tibetan traditional culture-economic activity, lifestyle, customs, manners, literature, art, religious activities is also inseparable from the Tsampa, tea and mutton (eat by hand).

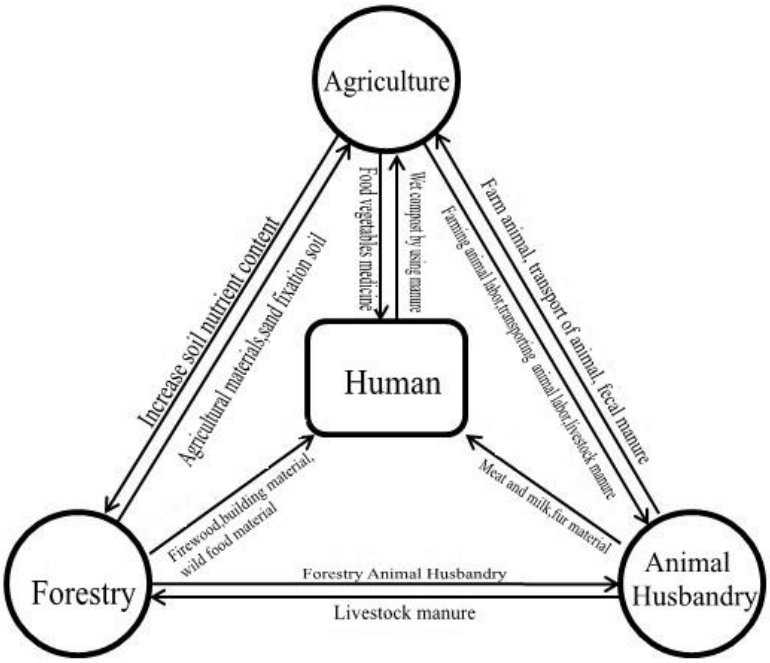


Figure 4 The cyclic structure of Zhagana Agriculture -Forest-Animal Husbandry Composite System

1.1.1 Animal husbandry products

Animal husbandry is the main part of the Zhagana Agriculture -Forest-Animal Husbandry Composite System, the main mode of production is the nomadic, which provides a lot of meat, milk and eggs for local residents. The main animal species include cattle, yaks, goats, horses, mules, donkeys, pigs, chickens and bees (Figure 5).

Looking from the structure, the yak, cattle, goat breed are the advantages of livestock and from the characteristic, Juema pig which is domesticated from wild boar in Gannan region is a specific, small, old and lean type of pig; Secondly, dzo is the hybrid offspring of yak and cattle,male dzo is strong and flexible, the milk production of female cattlethan yak is 50%-100% higher than yak, but the milk fat rate of female is lower than that of yak.

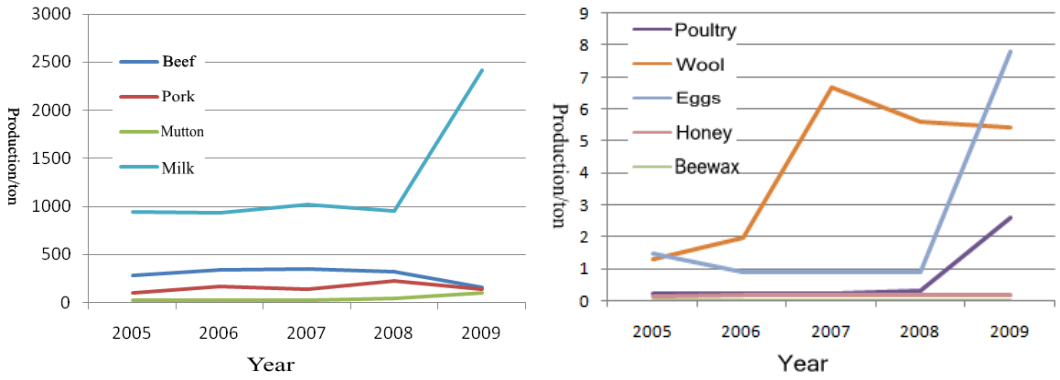


Figure 5 The animal husbandry products of Zhagana Agriculture -Forest-Animal Husbandry Composite System (2005-2009)

1.1.2 Planting products

As the limited local soil and climatic conditions, planting and development are regarded as a supplement to animal husbandry and wild products, which mainly provides vegetables, the necessary plant protein for local residents as well as provides forage for the livestock industry, its developed degree is relatively low (Figure 6).

In addition to barley, most crop varieties are imported from overseas and there are not many local varieties. At present, as for the variety of food crops used in the production, among which, 26 types are cereal (barley, winter wheat, spring wheat, corn, buckwheat, broom corn millet and grain). 5 types are beans (broad beans, peas), 5 types are tubers (potato). As for the variety of economic crops, among which, 7 types are oil crops (rapeseed, flax), 16 types are vegetables (cabbage, Chinese cabbage, green radish, radish, onions, leeks, garlic, cabbage, cauliflower, corm cabbage, celery, coriander, spinach, tomatoes, lettuce, horned pepper). 2 types are medicinal herbs (Radix Codonopsis, Angelica Sinensis). 7 types are forage crops (oats, alfalfa, clover roots, Wuhu, comfrey, vetch).

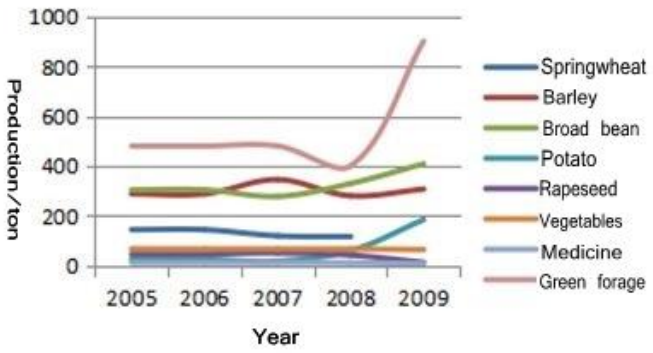


Figure 6 planting products of Zhagana Agriculture -Forest-Animal Husbandry Composite System

1.1.3 Forestry products

As a result of its location where is a transition region from the warm temperate coniferous forest to the cold and temperate coniferous forest of southeastern mountain of Tibetan Plateau, the types of forest vegetation types are more complex, the place not only has zonal vegetation components, but also the vertical distribution of vegetation is very significant. Therefore, a wealth of raw materials of forestry can be provided to the production and life of local residents (Figure 7).

Traditional Tibetan dwelling—the materials of pedal housing are drawn from the internal system, the row frame for drying barley and a series of agricultural production tools are also included. Secondly, various edible fungi are grown under the forest, including 2 classes, 8 catalogues, 23 families, 55 genera and 131 species. Among them, there are eighty-eight kinds of edible fungi, which are also used for medicine. Thirdly, firewood and other raw materials, including herbs, tree gum, paint, turpentine, spices etc are provided.

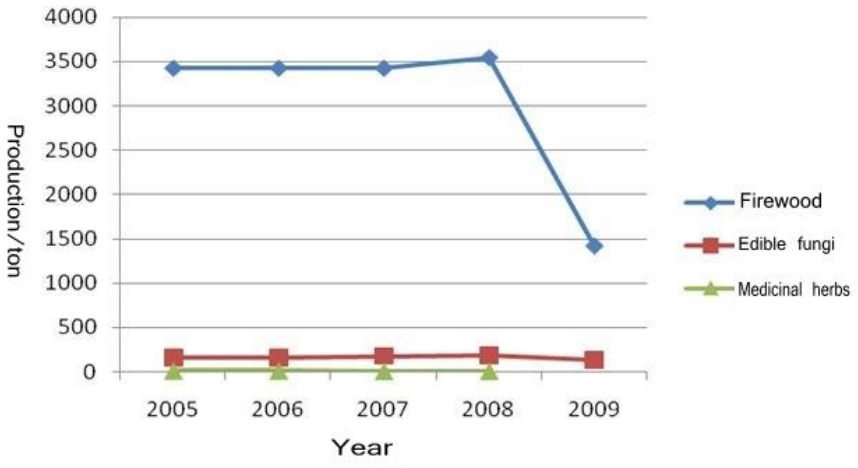


Figure 7 The forestry products of Zhagana Agriculture-Forest-Animal Husbandry Composite System (2005-2009)

1.2 Biodiversity and Ecosystem Function

Zhagana Agriculture-Forest-Animal Husbandry Composite System lies in the transition area of Min Die mountain of the west of Qinling Mountains and the eastern edge of Tibetan Plateau transition, which is a transition zone of climatic region of the Tibetan Plateau, the climatic region of Southeast monsoon, the vegetation area of Alpine grassland and the vegetation zone of temperate forest. It belongs to the biodiversity conservation priority areas which is put forward by conservation strategy and action plan of China biodiversity (2011-2030).

On top of the mountain, where is 4200 meters above sea level, exposed bedrock, steep slopes and its base formed the loose and messy Alpine flowstone beach. The famous Tibetan Saussurea Medusa and rhodiola are grown sparsely on the flowstone beach.

In the area of 3600-4200 meters above sea level, vast alpine shrub as well as alpine Meadow Steppe are developed. Here is a natural pasture, which is also a natural breeding base for digging Cordyceps sinensis.

In the area of 2400-3600 meters above sea level, Overlapping peaks,

ravines can be seen and the gradient of the slope changes between 30-36 degrees, the green and towering trees of the primeval forest are reared, the species are various. Precipitous mountains waterfall, lakes, flowers and birds all add radiance and beauty to each other and it also creates natural resources of hunting, cutting wild herbs, Tibetan medicine and wild mushrooms.

On the open terrain of the Bailong River and the hillside terrace of the banks of the rivers the soil is good and the soil layer is thick, which provide a good farmland for planting crops, fruit trees and vegetables.

Agriculture-Forest-Animal Husbandry Composite System not only provides a variety of material products for local residents, but also has important ecological functions in the protection of biodiversity, water and soil conservation and water conservation, Especially being as the watershed of the Yellow River and the Yangtze River and the upper reaches, the function of water and soil conservation as well as water conservation is particularly important.

1.2.1 Biodiversity

Zhagana Agriculture-Forest-Animal Husbandry Composite System where the climate is mild, forests are dense, meadows are broad, wildlife is abundant not only provides a wealth of raw materials for the production and living of local residents but also maintain the stability of the system and the function of ecology.

The vegetation coverage rate of Zhagana Agriculture-Forest-Animal Husbandry Composite System has reached 87%, with the change of topography and climate, the diversity of agricultural biodiversity is rich and various. Forest area is the largest, accounting for 58% of the total area. Pasture area is smaller, accounting for 30% of the total area. Arable

land is the smallest, accounting for nearly 20% of the total area.

(1) The site-specific Agricultural Biodiversity

The Type of farming land of Zhagana Agriculture-Forest-Animal Husbandry Composite System is mainly cinnamon and light clay of the soil texture, which is barley, conducive to the growth of barley, beans and rape. The hot and humid area of the valley grows high- quality wheat and High-yield intercropping corns and high-value vegetables. Humid area of the middle part of the mountain is dominated by wheat, barley, beans, potatoes and eggplant, fruits and vegetables. The main planting medicine are Radix Codonopsis, Angelica Sinensis.

The main crop varieties are shown in Table 1.

Table 1 The Agricultural Biodiversity of Zhagana Agriculture-Forest-Animal Husbandry Composite System

The name of species	Variety denomination
Triticum aestivum	Winter varieties: old red wheat, Mazhamai, Ganmai No. 23, Shannong 184, feimai, Wudu No. 5, Zhongyin No. 2, etc. Spring varieties: Shuwan 751, Shuwan 761Gaoyuan 338, Jin 2148, Lin Nong 14, Wei Chun No.1, Mianyang No.11, Mianyang No. 12, Family 13, Pingliang No. 36.
Hordeum vulgare var. **nudum**	Local varieties: long awn barley, yellow belly. Varieties are introduced: six- row barley, Tibetan-lan barley, peony barley (yellow barley), Aiganqi, purple barley.
Zea mays	Golden hou, small golden
Allium fistulosum	Unknown variety.
Allium sativum	General varieties.
Allium tuberosum	General varieties.
糜	Only one variety.
Fagopyrum esculentum	Sweet buckwheat, tartary buckwheat.

Vicia faba	White horse tooth broad bean, kenaf teeth buckwheat, sheep eye broad bean.
Solanum tuberosum	Yuejin, Anti disease No. 1, four- jin yellow, small white flower
Pisum sativum	Local varieties: white peas, spotted colored pea.
油菜	Rape, Oro rape, yellow mustard, 78J-1, 78J-2, 78J-3 (Gannan No.1).
Linum	Common varieties.
Raphanus sativus	Green-white radish, water radish.
Daucus carota var. **sativa**	Unknown variety.
Lycopersicon esculentum	Unknown variety.
Solanum melongena	Unknown variety.
Apium graveolens	Unknown variety.
Coriandrum sativum	Unknown variety.
Spinacia oleracea	Unknown variety.
Lactuca sativa	Unknown variety.
Capsicum annuum	Unknown variety.
Cucumis sativus	Unknown variety.
Phaseolus vulgaris	Unknown variety.

The type of poultry in Zhagana Agriculture-Forest-Animal Husbandry Composite System is mainly Yak, cattle, horses, mules, donkeys, sheep, goats, pigs, chickens, rabbits etc.

The forage is mainly oat, yuenkanin, alfalfa, alfalfa, clover, vetch, comfrey etc.

(2) The rich and colorful related biodiversity

According to survey statistics, the total species of wild plants of Zhagana Agriculture-Forest-Animal Husbandry Composite System are:more than 140 families, 480 genera, 1600 species. Among them, there are 24 genera, 17 families and 30 species of moss. There are 14 families, 22 genera, 50 species of fern. 5 families, 10 genera and 30 species of

gymnosperm and 114 families, 420 genera, 1500 species of angiosperm, which account for 30% of all the higher plants in Gansu Province.

There are about 34 families, 65 genera and 150 species of large fungi, including 112 kinds of edible fungi, 80 kinds of edible and medicine fungi, 38 kinds of medicine fungi, 5 kinds of toadstools. The precious edible or medicinal species are Cordyceps sinensis, Tricholoma matsutake, Morchella esculenta, Morchella Conica and Morchella etc.

Among them, there are 11 kinds of wild and rare plants which are national protected. The Chinese yew and Kingdonia uniflora are belong to the Class I protection of mild plants of China, Cercidiphyllum japonicum, Tetracentron sinense, brought the spring wood, Cupressus, Abies Chensiensis, wheat hanging spruce, Picea neoveitchii, Picea purpurea, Fraxinus mandshurica are belong to the Class II protection of mild plants of China.

Chenopodiaceae and lobular black Ryoko are only distributed in Zhagana Agriculture-Forest-Animal Husbandry Composite System, In addition, sandalwood, Tilia amurensis and Fraxinus Species will become the rare species in Diebu due to excessive use.

There are 545 kinds of medicine recorded in the “Tibetan medicine resources list of Gannan”, including 515 kinds of plants, 20 kinds of animals, 10 kinds of fungi and mineral.

According to survey statistics, there are 183 species of terrestrial vertebrates in Zhagana Agriculture-Forest-Animal Husbandry Composite System. Rare wild animals and animal species are especially rich in this area. There are 10 kinds of Class I national-protected animals, which are: Jinpeng, Chinese Grouse, Tetraophasis obscurus, lophophorus lhuysii, giant panda, snow leopard, forest musk deer, spotted deer, takin and golden eagle etc. There are 30 kinds of national protected animals, 22

kinds of endemic animals in China, including Alpine Stream Salamander, Amolops mantzorum, Bufo minshanicus, Chinese toad, North Scutiger, Rhabdophis, plateau viper, Tetraophasis obscurus,green-tailed pheasant, Chrysolophus pictus, Crossoptilon auritum, Garrulax davidi, Garrulax sukatschewi, Garrulax formosus, parrotbill, rock squirrels, Trogopterus xanthipes Milne-Edwards, aerates, Myospalax fontanieri, Chinese jumping mouse and Moschus berezovskii etc.

1.2.2 The function of Ecosystem

(1) Water and soil conservation

Soil erosion is a natural phenomenon on the surface of the earth and good vegetation conditions can play a very good role in soil and water conservation. The Forest ecosystem, grassland ecosystem and hillside farming system of Zhagana Agriculture-Forest-Animal Husbandry Composite System all have outstanding function of soil and water conservation.

- **The forest ecosystem**

Forest soil and water conservation function is mainly expressed in the following aspects: Canopy, shrub grass and litter layer has effect of interception, which can effectively reduce the intensity of precipitation and disperse the total amount, and reduce the impact of rain on the surface soil of the forest land, which can prevent the surface erosion and gully. The strong soil penetrability and thick litter layer flow can obviously reduce the flow, which can effectively inhibit the formation of surface runoff. Vegetation layer can effectively reduce wind speed and wind power and it can reduce wind erosion and weathering, so as to avoid the loss of the surface soil of forest land. Vegetation roots can effectively fix the soil, which can reduce the erosion caused by the drastic change in

temperature or gravity; small biological cycle can improve the physical properties as well as the ability of anti-wind and water erosion of soil.

The experiment of Pinus plantation shows that 16-40% of rainfall kinetic energy can be decreased by canopy, shrub herb layer can weaken the total kinetic energy of rainfall of 44.4%, litter layer not only can weaken 9% of the total kinetic energy because of the effect of interception but also can cut off all the kinetic energy of rainfall from canopy and shrub herb layer.

Forest ecosystem can not only effectively prevent soil loss and reduce the loss of sediment to achieve the purpose of maintaining soil fertility, but also provide rich nutrients for the different vegetation in the forest ecosystem. According to the content of the main nutrient elements in the soil and the soil fixed by the forest ecosystem, the situation of the fertility maintenance in the forest can be obtained.

- **Grassland ecosystem**

The effect of grassland vegetation on soil and water conservation is also obvious. On the one hand, herbaceous plants are more close to the surface than other plants, so that it can play a role in maintaining the surface soil; On the other hand, the root of herbaceous plants is mainly distributed in the soil surface layer, which can effectively prevent the erosion of the surface soil. The study showed that the ability to intercept surface runoff was 34% for the forest land grown of 3-8 years, as for the grassland grown for 2 years, the ability to intercept surface runoff is m54%, which is 20 percentage points higher than that of forest land.

The comparative study of soil erosion of wheat, sorghum, fallow and native grassland shows that the amount of soil erosion in native grassland is almost negligible, the amount of soil erosion in the land of wheat reached nearly 1200kg/hm^2, the amount of soil erosion in the land of

sorghum is greater than 2700kg/hm^2 and the amount of soil erosion in fallow also exceeds 1700kg/hm^2.

In addition, grassland ecological system also has a good effect in anti-wind erosion. The amount of wind erosion in farmland is 1.8-4.0 times of the amount of soil erosion in the uncultivated grassland. In addition, the research of the relationship between wind erosion and vegetation shows that the wind erosion rate increases exponentially with the decrease of vegetation coverage.

All of these show that the grassland vegetation plays a very important role in the prevention of soil erosion.

- **Hillside farming system**

The way of planting in the Zhagana Agriculture-Forest-Animal Husbandry Composite System is by utilizing dry farming terrace, which has good soil and water conservation function and it is embodied in two aspects.

The first aspect is the soil conservation. The terrace slope whose slope is changed and increases the infiltration time, and it slows down the flow rate of the surface runoff. At the same time, due to the cut-off slope runoff, the runoff collection area of the slope is reduced, and the runoff volume is reduced. The terrace ridge intercepts the surface runoff of natural precipitation and sediment carrying so that the runoff is reduced by 94.7% and the benefit of water and sediment reduction is 100%, to a certain extent, it controls the occurrence of geological hazards such as landslide and debris flow.

The second aspect is water conservation. The water cycle of the terrace ecosystem is a part of the hydrological cycle in nature. Under the influence of factors such as natural and human factors, the terrace stores rainfall runoff or irrigation water, excess water is discharged into the

lower reaches of the surface runoff through the surface return flow or the drainage of the deep seepage of groundwater to the surface runoff. And the water return to the atmosphere through the field surface soil, water layer evaporation, and crop transpiration, it is constantly changed with the conversion of time and space.

(2) Water conservation

Due to the shortage of fresh water resources, global climate change, the unreasonable distribution of water resources, the uneven distribution of precipitation space and other reasons, the function of water conservation of natural ecosystem is becoming more and more prominent. The forest ecosystem and grassland ecosystem of Zhagana Agriculture-Forest-Animal Husbandry Composite System have outstanding function of water conservation.

- **The forest ecosystem**

Forest changes the form of the distribution of precipitation, the forest canopy, shrub grass layer, litter layer, soil layer absorbs, accumulates the precipitation and conserves a large quantity of water resources by the function of interception. In the absence of the forest, the precipitation will be quickly flows through the river, with the existence of the forest, it will have sufficient function of accumulation and redistribution of precipitation, which will make most of the water become effective water which circulates in the original area. According to the results of the current forest ecological location monitoring, the precipitation capacity of the coniferous forest in the cold and temperate zone of mountainous region of Zhagana Agriculture-Forest-Animal Husbandry Composite System is about 100mm.

Secondly, depending on its runoff regulation and water conservation capacity, the forest can reduce the peak flow, delay peak arrival time,

increase the dry season flow, delay the time of arrival of the dry season, reduce the ratio of flood and dry and increase the effective utilization of water resources. In 2002, the sustainable development strategy research group of forestry of China showed that if the forest coverage rate in the small watershed of Zhagana Agriculture-Forest-Animal Husbandry Composite System increased 2%, the flood peak would decrease 1%. When the forest coverage rate reached a maximum value of 100%, which would reduce the limit peak value of 40-50%.

In addition, the role of forest water purification is also very obvious. Canopy layer and soil layer can absorb a variety of substances from atmospheric precipitation, which can absorb the pollutant. Studies on the absorption of pollutants in the precipitation of Chinese fir forest indicate that the accumulated amount of 18 organic pollutants in the atmospheric precipitation is 1.86kg $\cdot hm^{-2}$, and the accumulative contents in the water which penetrates the canopy, stem runoff, surface runoff and underground runoff are decreased to 0.363 and 0.193 and 0.021 and 0.004 kg kg $\cdot hm^{-2}$, The decline ranges are as high as 80.48%, 89.62%, 98.86% and 99.68%, respectively.

- **Grassland ecosystem**

Grassland vegetation, on the one hand, can increase organic matter content in the soil and improve soil structure through the decomposition of organic matter. On the other hand, the porosity of the soil can be improved by the insertion of the root system in the soil. The effect of these two aspects can significantly improve the water conservation capacity of grassland soil. The water conservation capacity of grassland ecosystem is very important in the area of mountain, hills and rivers, because it can play a very good role in regulating runoff and flood in these areas.

Study on the moisture content of soil in alpine meadow grassland (2003) indicates that the relationship between vegetation coverage and soil moisture is significant, while maintaining its original plant construction and high degree of coverage, the soil has a higher water holding capacity and the function of water conservation is obvious. After the degradation of the Alpine meadow and grassland, the Alpine meadow soil is becoming dry and the water holding capacity is weak, the soil water content and water holding capacity will not be improved significantly even it is ameliorated by the means of manual work.

The research on the improvement of herbaceous plants shows that soil bulk density decreases by 3.1-10.1% after planting herbaceous plants, the porosity increases by 2.34-6.72%, the water permeability increases by 73.14-55%, The water stable aggregates and the aggregation degree increase 16.72-67.1% and 24.24-193.06% respectively, The dispersion rate and erosion rate decrease by 0.45-12.9% and 11.97-21.4%, respectively, and the soil water conservation capacity is significantly increased.

1.3 Knowledge hierarchy and adaptation technology

1.3.1 Knowledge System

(1) The rotation fallow system

Due to the cold, humid climate and relatively barren soil of Zhagana Agriculture-Forest-Animal Husbandry Composite System. The rotation fallow system of farmland is implemented in order to maintain the soil fertility. Barley-potato-broad bean, spring wheat-rape-broad bean are the forms of the rotation system. This method not only makes the soil maintain the vitality due to the rotation of different crops, which will not

make the soil harden either, but also makes the crops absorb and utilize the beneficial resources mutually.

In addition, the fallow system is also implanted in the Zhagana Agriculture-Forest-Animal Husbandry Composite System, which means the barley is planted in the first year, the potatoes are planted in the second year, broad beans are planted in the third year and the land is fallow in the fourth year. The main form of fallow is: Three years' tillage and one year's fallow, or two years' tillage and one year's fallow. In one year of fallow, the land should be deeply plowed for two times, which is to prevent weeds, make the soil loose and absorb moisture and sunshine.

(2) Pest control

The terrain of Zhagana Agriculture-Forest-Animal Husbandry Composite System is very complex, the relative relief differs significantly and vertical climate changes significantly too, the type of climate is various, forming a different ecological environment. It also provides crop diseases, insects, mice and weeds the conditions for the survival and reproduction, the various crop diseases, insects, mice and weeds distribute extensively and do serious harm to the land.

The dynamic system of the method of "focusing on the prevention and comprehensive integrated control" is utilized in the prevention of crop diseases, insects, mice and weeds. Such as the breeding of varieties of anti-disease and insects, reasonable crop rotation system, intensive cultivation, fallow and eradication of weeds as well as the protection and utilization of natural enemies of mice and insects.

(3) Compost and fertilization

The manure is accumulated for a whole year in the Zhagana Agriculture-Forest-Animal Husbandry Composite System, Soil and fertilizer retting and green manure are used in summer and autumn.

Forest litter, plant ash, the manure of human excrement and urine, livestock manure and gasket material, feed residue are mixed and accumulated, finally, the animal manure is made from the microbial action of the mixture (Figure 8).

Figure 8 Compost

(4) Taboo

There are many traditional customs of Zhagana Agriculture-Forest-Animal Husbandry Composite System is against the ecological environment protection, such as one cannot climb the mountain randomly and hunting, collecting materials, mining, logging, clamoring, and picking mountain flowers, grass, wood, stone, soil and other things are all prohibited. The random earth digging and free hacking are also forbidden. The digging of grass Mountain, grassland is prohibited in the pastoral areas. Praying for the God of the land is a must before digging in the crop growing areas. The random digging, casting and burning dirty and smelly things in the field as well as random deforestation are prohibited.

From an ecological point of view, the Tibetan residents have a wide range of taboos on the mountains, forests, grasslands, plains, rivers and lakes and the distribution of the natural species of animals and plants,

which contains certain environmental protection consciousness, showing a profound thought of sustainable development. These taboos avoid the loss of soil and loss of water caused by deforestation, grassland desertification and the phenomenon of ecological imbalance.

1.3.2 Adaptive technology

Zhagana Agriculture-Forest-Animal Husbandry Composite System is an ecological and production system which is formed in the long-term development of mutual coordination between the local residents and the natural environment，including the systems of adaptive technology of agriculture-forestry composite, agriculture-animal husbandry composite and forestry-animal husbandry composite.

(1) Agriculture-forestry composite

Affected by topography, climate, soil, irrigation. The farmland of Zhagana Agriculture-Forest-Animal Husbandry Composite System is mainly distributed in the middle and low part of shady slope and terraces along the river at an altitude of 2400-3000 meters above sea level. The forest land is mainly located in the higher altitude area, there are a small amount of distribution of forest land in the farmland (Figure 9).

The outer forest plays an ecological function of preventing soil erosion, water conservation, the relief of drought and flood disaster and it effectively regulates the microclimate. The trees in the field can provide firewood fuel, materials for building and making tools and stop the wind from blowing the earth away, which, to a certain extent, has reduced the human destruction of natural forest. And production technology of intercropping of crops, rotation, system, straw compost increase the nutrient content in soil and it plays a role in promoting the growth of forest trees.

Figure 9 Agriculture-forestry composite

(2) Agriculture-animal husbandry composite

Part of the reclaimed farmland is distributed alternately with natural grassland, the planting and animal husbandry are mixed together. Generally, the reclamation of farmland is implemented in the grassland and there is a grassland left between the farmlands, whose area is equal to the farmland or a little bit bigger than the farmland.

Keeping the same size of the grassland can be conducive to keeping water and soil, the moderate amount of livestock can be grazed, these are the main animal labor for cultivating, and it is also the main tool of transportation and provide the farmers meat and milk at the same time. And crop straw, artificial cultivation of forage is the main source of livestock forage in this region, which plays very important role in the growth of livestock and poultry fattening.

In addition, the drying rack of barley plays a role in the captive breeding of cattle and sheep and other livestock in winter. In the summer, the forage or vegetables are planted, and the function of the manure of livestock and poultry manure after the process of fermentation is fully utilized. Therefore, whether in the valley beach or in the shallow mountain area, retention of the farmland whose area are equal to the large

grassland has important economic significance and ecological significance for the local residents.

(3) Forestry-animal husbandry composite

The forestry and animal husbandry are regarded as a pillar industry in the Zhagana Agriculture-Forest-Animal Husbandry Composite System and it is the main economic source of the local residents. The mountains of Zhagana Agriculture-Forest-Animal Husbandry Composite System is so deep that the Shrub forest and is connected with grassland. In addition, the system memory contains a certain area of forest grassland, which is the foundation of the animal husbandry of forest.

The most representative variety of the animal husbandry of forest of Zhagana Agriculture -Forest-Animal Husbandry Composite System is Juema pig. It adapts to the plateau climate, reflects sensitively, runs fast, has a resistance to strong sun light and also has a strong foraging ability and it can maintain its growth without supernumerary forage. From the period of crops sown to the period of harvest, the pigs are grazed in the dense grass pasture and forests by the households alternately and the pigs eat the fresh and juicy stems, leaves and seeds of some wild plants. The pigs can find the food by themselves in winter and spring. The forage is supplied after the pigs return to their hogcotes. The faeces of the pigs can be used as a good fertilizer to provide nutrients for the growth of forest trees.

The implementation of forestry-animal husbandry composite has a strong practical significance in increasing the livestock and poultry production, maintaining ecological balance, improving land use efficiency, reducing costs of production and increasing farmers' incomes.

1.4 Agricultural Culture, Value System and Social Organization

Traditional Tibetan culture (aboriginal culture), Tibetan Buddhist culture and the Han's farming culture were introduced into and adapted to the special conditions of the composite ecosystem of agriculture, forestry and animal husbandry, which gradually formed the special cultural features and social organizations of Zhagana Agriculture-Forestry-Animal husbandry Composite System. In the meanwhile, Zhagana Agriculture-Forestry-Animal husbandry Composite System still retains primitive cultural conventions and the temples of the Ben religion and the Hua religion (the Sakya school of Tibetan Buddhism).

(1) The festival culture

It includes the Buddhist festival culture and the secular festival culture.

The festival culture and the sacrifice culture of Zhagana Agriculture-Forestry-Animal husbandry Composite System embody the cultural features of the agriculture-forestry-animal husbandry composite system, not only taking in the traditional nomadic culture of Tibetans, but also taking in the elements of the Han's farming culture, which at the same time show their forestry features (especially the hunting culture and the clothing culture). From various lyrics for festivals and the sacrifice chanting can it be concluded that the locals present highly esteem and love to nature, signifying ideas of distinct eco-ethic and emotions of eco-belief.

The Luosa Festival. It is the grandest festival the same as the Han's Spring Festival. Once entering the La Month (the last month in the Chinese lunar calendar), the public will do all preparations for celebrating the new year: cleaning up houses, sweeping yards, taking out rubbish,

repairing the cooking bench (for worshipping cooking gods), burning incense (for mountain gods by burning cypress mixed with fried barleys, spices and yak butter), hanging out the new clothes worn during the New Year celebration for farewell to the old and usher in the new. In addition, a cypress need to be hung around the main door and deep-fried dishes are also prepared (dishes are made into the animal shapes of oxen, sheep or river deer, whose colors determine the prospect of the coming year.) the shrine in the living room is decorated with colorful lights, Hadas (silk scarves for respect or congratulation) of colors, colorful ribbons, lucky knots and etc. Bowls of clear water are offered. Lights of yak butter are lit. Sacrifices are placed. Borrowed items are returned. On the Eve of the New Year (when night falls), all family members sit around warm beds or the fireplace and enjoy the New Year dinner and drink barley wine. On this night of the Eve, people stay up until cocks crow at dawn (similar to the staying-up in the Han's region).

The Arrow Putting-up Festival. From the 4th to 15th of May every year in the lunar calendar each village burns incense on its stand of putting up arrows in the holy mountain, spreads Longda (fly prayer flags) and puts up arrows. When incense is lit, the sacrifices of milk, cheese and yak butter (known as "the Three Whites") need to be placed. Once incense burns, villagers throw little water and wine, yak butter, barley pies and other sacrifices brought from home into the burning incense. After Lamas chant, the sacrifices of different shapes made of barley pies and yak butter are to be colored in red, yellow and green, and later all of them are put into the burning incense, flaming up and cracking into smoke. At that time Lamas begin to beat drums and cymbals, chant *the Incense Burning Ode* and praise virtues of mountain gods. This has a significance of eco-education.

The Buddha Cruise Festival. Lasan Temple, a Tibetan Buddhist temple and built in 1645, is located in the core area of Zhagana Agriculture-Forestry-Animal husbandry Composite System. On the 8th and 9th of January in the Tibetan calendar is the traditional dharma assembly in Lasan Temple and the Buddha Cruise Festival. The festival is hosted in turns by the four villages in Zhagana. People move the huge colored Thangka to the Buddha exhibition stand in Lasan Temple. Wherever the Thangka goes, people kneel down, worship devoutly and follow the Buddha. This Thangka is painted with natural minerals. Its color is brand new all year round and never fades away. When the Thangka unfolds, Buddhist drums and slogans echo with chanting of monks and the disciples in front of the Thangka kneeling down and kowtowing for devout prayers (Figure 10).

Figure 10 The Buddhist Cruise Festival

(2) The eating culture

Barley pies (fried noodle with barley), tea and mutton eaten with hands consist of the main eating structure of the local residence. Whoever he is a common or a noble, a secular or a monk, a peasant or a shepherd, the

eating structure is the same and has never changed in the past millenniums.

The barley wine is a typical product combining agriculture, forestry and animal husbandry. Barley is a major planting crop in highland husbandry areas. Brewing skills is introduced from the Han's farming areas. The bear gall used in distiller's yeast is from hunting in primitive forestry.

(3) The Tibetan Medicine Culture

The Tibetan medicine, taking in the advantages of the traditional Chinese medicine, the ancient Indian medicine and the ancient Arabic medicine, is gradually accumulated, improved and finally forms the distinctive traditional medicine system through rich production and living practices for a long time.

As early as 2,000 years ago, the Tibetan got to master the medical properties of some food step by step by searching food on the plateau and in snow areas. Such early medicines as vinasse and warm yak butter for staunch bleeding and injury are all gained gradually in living. According to figures, more than 2,000 species of plants, 159 kinds of animals and over 80 minerals can be medicine.

(4) The Architecture Culture

The old-type residence is mostly the board house (Figure 11). There is the line, "the board house of the Western Rongs" in The Mao's Poems (127 AD. to 200 AD.). The line, "the all in that region build a house with boards, which in poems is called the board house of the Western Rongs", is in Notes on Water Systems: the Wei River (472 AD. to around 527 AD.). The basin of the Bailong River is the central region of the ancient Western Rong. Because of influences of the Rong culture in a long term, the building style of the residence is full of the features of the Rong

people.

The type of the local residence is mainly the board house. Along the front and back eaves where water drains sets up a horizontal U-shape wood tank inclining to the outside of the yard in order for water diversion. The right front of the triangle space on the roof is open with one side. The other three sides are blocked with rattans and fences or roughly nailed with boards. The space is used to stack firewood and farming tools. A lumber made into a ladder leans to the edge of the bungalow up to the cleanly swept roof for the owner to sunbath grain, clothes or other little housework.

The residence in Zhagana Agriculture-Forestry-Animal husbandry Composite System is mostly on the skirts of forests where the climate is rainy and moist and there are many mountains and dense forests so it is convenient to pick up building materials nearby. In chilling winter the board house can take in heat and keep warm with stronger resistance to cold.

Figure 11 The board house

(5) Water Mills and Its Culture

The water mill (Figure 11) is commonly believed to be invented in the Jin Dynasty (226 AD. to 420 AD.). It is a machine for processing rice, grain and beans into powder and thick liquid, which greatly improves work efficiency of the agricultural production in the ancient times.

The water mill has two types: horizontal mills and vertical mills. Setting up horizontal gears or vertical ones depends on the factors as the local water resource, water potential, and matches of gears and the axle.

Horizontal water mills are set up where there is great water momentum, which are powered by a horizontal water gear. The wheel axle is installed with fan blades. Water flows drive gears passing movement to the mill.

Vertical water mills are set up where there is less water momentum but a large quantity, which are powered by a vertical gear. The wheel axle is installed with a gear connecting a gear horizontally set up on the lower part of the mill axle. The wheel is moved by the movement of gears.

A mill hut of Zhagana Agriculture-Forestry-Animal husbandry Composite System has 7.5 meters in length, round 5.6 meters in wide and approximately 6-7 meters in high with a V-shape roof. The half of a mill is right over the river made of wood; the other half is by the river whose outside cover is made of stones and the inside is wooden. Water is led to the triangle wood wheel on the bottom of the mill hut. Water momentum drives the stone mill inside of the hut in order to mill and grind yak butter, wheat and other farming crops by water energy (Figure 12).

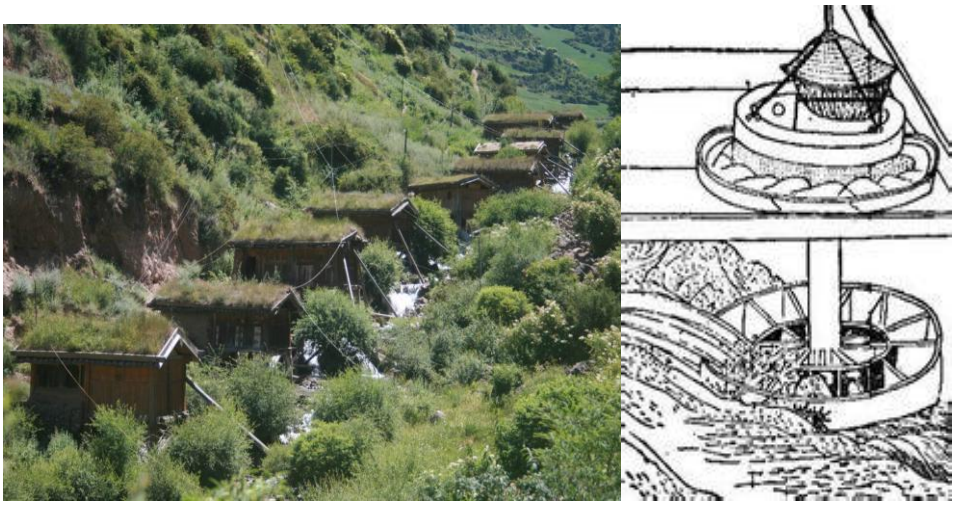


Figure 12 The water mill of Zhagana Agriculture-Forestry-Animal husbandry Composite System

(5) Value systems

Zhagana Agriculture-Forestry-Animal husbandry Composite System locates itself in the shared border region of Gansu, Qinghai and Sichuan and has been a bridge and connection for the inner land and the Tibetan region to exchange economy and culture. Special local advantages create distinct natural and cultural landscapes. Nomadic culture, the Tibetan Buddhist culture and folklore interweave one another and finally form distinct succession of composite agricultural culture. The distinct succession of composite agricultural culture is priceless treasure and consists of the base of local traditional culture. For example, Juema pigs, fur and leather as symbols of wealth and presents in weddings and funerals are characteristics for the locals' ethnic identity. Firewood accumulation is a demonstration of the locals' hard work. In addition, many of the local festivities are also closely relevant to production procedures and processes of agriculture, forestry and animal husbandry.

1.5 Landscape and Water and Soil Resources Management

1.5.1 Landscape feathers

Zhagana Agriculture-Forestry-Animal husbandry Composite System is in the cold highland region of poor resources. Limited resources and isolated space result in the approximate saturation condition of population within the settlement. The closed structure is good for developing agricultural eco-restraint behavior arriving at sustained utilization of resource and environment and in harmonious accordance with geographical landscapes and finally creates inward settlement space. It is a want in mentality for a closed culture course.

In a general view, the walkway starts from the household, runs along

the Yiwa River and enters the village. It then crosses four village communities in the S shape and finally connects the outside of the settlement in the northwest. As the walkway stretches further, oriented by the Yiwa River and interlaced but regularly scattered farmlands on the slope, residential node space scatters along the slope in groups, and fields, the river, residence and temples attach radiance to the surrounding mountains, forming rural living space of lingering charm. The whole space sequence progress linearly, which arranges as natural landscapes change and forms scenes in combinations of movement and dynamic, density, scattering and artistic imageries so that the Zhagana rural landscape get to be realized and showed fully (Figure 13).

Figure 13 The Landscape Mode of Zhagana Agriculture-Forestry-Animal husbandry Composite System and the Hand-drawing Landscape Mode

(Note: the satellite picture is from Google earth)

On horizontal landscapes (Figure 14), human activities are the core part among the factors of the inner settlement. The natural factors of buildings of farmlands and residence, fields, ponds, forests, meadows, and mountains spread inside-out concentrically. The outmost part, mountains, poses encircling; the crooks flowing from mountains surround or cross through the village. The concentric structure ensures that every factor has sufficiency in the cycle of matter and the flow of energy, and benefits the community’s ecology from sustaining.

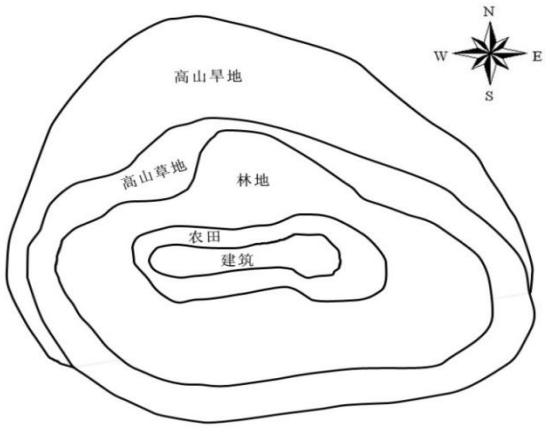


Figure 14 The Horizontal Landscapes of Agriculture-Forestry-Animal husbandry Composite System

On vertical landscapes (Figure 15), the settlement constituents from top to bottom are mountains, meadows, forests, residence, fields and rivers. The natural constituents are on the top in space. Rainwater from the slope on the top of the mountain guarantees moisture of the climate within the settlement and sufficiency of farming irrigation. The valley between the two mountains in the north is a natural flood prevention zone. Human activities mainly gather on the bottom. These constituents in vertical space maintain a good region circle of settlement ecosystem, and they are necessity for farmland management as well as a mental want for people's agriculture production in mountains. Above the connate natural level of the landscape aesthetic conscious system, aesthetic experiences caused by landscape subunits with various features greatly echo with the Chinese enclosure and shelter modes.

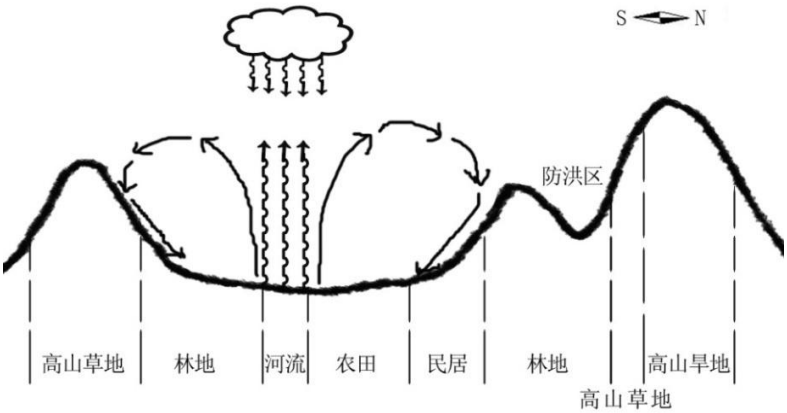


Figure 15 Vertically special landscapes of Agriculture-Forestry-Animal husbandry Composite System

1.5.2 Land and Water Resources Management

Zhagana Agriculture-Forestry-Animal husbandry Composite System is a distinct land and water resources management mode used by the local people for adapting to natural conditions of barren soil on the cold highland and developing agricultural production in a special geographical eco location.

This special land and water resources management mode is a composition of agriculture, forestry and animal husbandry at the macro level. Zhagana Agriculture-Forestry-Animal husbandry Composite System is in the juncture of the Tibetan Plateau oriented by nomadic production and the Loess Plateau oriented by farming production, where the Tibetan and the Han cultures collide and mingle with each other. It forms a Han-Tibetan compact community occupied majorly by Tibetans and a farming-and-husbanding production pattern. At the same time, Zhagana Agriculture-Forestry-Animal husbandry Composite System is in the transitional area where coniferous forests of warm temperate zone transit to coniferous forests of cold temperate zone in the southeastern mountains on the Tibetan Plateau. Vegetable types there are complex.

There are not only zonal vegetable types but also distinctive vertical distribution of vegetable, all of which provide an abundance of forestry raw materials for the local people to produce and live. In the background, the agriculture-forestry-animal husbandry management mode in the lower-altitude areas has taken shape in the Tubo times since the 6th century.

Furthermore, this distinct land and water management mode manifests recycling and reasonable using of lands, forests, meadows and species resources at the micro level for producing varieties of products to make up the relative isolation caused by daily life and production and to meet intact, compact but self-sufficient economic units. Domestic animals accommodate meat protein, fur and skin for people's lives and offer animal force and fertilizers for farming. Planting accommodates vegetable protein for lives and fodders for domestic animals. Forestry raises rich planting and breeding products in forests and the local specialty, Juema pigs, as well as maintain balance of ecosystems together with meadows.

2 Historic Evolution and Relevance

Zhagana agriculture-forestry-animal husbandry composite agricultural production form and lifestyles have a long history. This economy mode has been formed in the lower-altitude area in the Tubo times since the 6th century. It is an outcome through long time of complementation and mixing of the Tibetan nomadic culture and the Han farming culture. It sets a good example of harmonious living of man and nature and sustainable development of human kind.

2.1 Witness of Harmonious Co-existence of Nomadic Culture and Farming Civilization

Throughout the origin and development of Zhagana Agriculture-Forestry-Animal husbandry Composite System fully embodies mingling with each other and harmonious co-existing of nomadic culture and farming civilization:

The Neolithic Age- the bud of agro-culture: archaeological studies disclose that 3,000 years ago the bud of human civilization (husbandry civilization) appeared in the basin of the Bailong River in Diebu County, showing that there was the origin and influence of husbandry civilization in Diebu County in the ancient times.

The Shu-Han period- introducing the Han's farming civilization: in the 6th year of the Jianxing Year (in 227 AD.) Zhu Geliang, Prime minister of the Shu Kingdom, warred with the Wei Kingdom and Diebu then was in the charge of Yinping Prefecture (where is Jinwen County now), Yizhou, Shu-Han. The Shu-Han's outstanding general Jiangwei stationed in Tazhong (where is western Quzhou and Luoda of Diebu), the east boundary, and stored grain by planting crops. Inland advanced agriculture civilization of the Han was also brought into Diebu.

The Tuguhun period-forming of the agriculture-forestry-animal husbandry composite system: in the 6th year of the Yongjia Year (in 312 A.D.) reigned by the emperor of the Jin Dynasty, Huai, Tuguhun from the Xianbei people led an army to conquer Di and Qiang groups. In the Southern and Northern Dynasties when is the 15th year of the Yongjia Year (in 483 A.D.) Liusong conferred King of Longxi upon King of Tuguhunn, Wang Muli. In 663 A.D. Tuguhun was annihilated by Tubo. During the time span of 350 years reigned by Tuguhun is forming of early

composition of Zhagana's agriculture, forestry and animal husbandry. In the Tuguhun period positive practice of the Hanization policies was carried out with profound influences of spreading inland farming culture. Since Tuguhun disappeared, Tubo has reigned over Diebu, Gannnan, for 300 years when the Tibetan nomadic culture put great and lasting effect on development of Zhagana Agriculture-Forestry-Animal husbandry Composite System.

The Reign of "Chief Yang" in the Ming and Qing Dynasties-maturity of the agriculture-forestry-animal husbandry composite system: in the 4th year of the Zhengde Year (in 1509 A.D.) reigned by the emperor, Wu, of the Ming Dynasty, when Chief Wangxiu came to the capital to meet the emperor, Emperor Wu, Zhu Houzhao, conferred the name Yang Hong to him and granted his family to use the surname for generations and to build thousands of forces and residence subject to Taozhouwei. Chief Yang had reigned continuously over 500 years before People's Republic of China abolished the chief system. Chief Yangs in all ages positively pursued civilization, kept in good relationship with the central government, closely tied up with the inland economy, actively took in inland advanced agriculture civilization. The garden in the cental Diebu belonged to the orchard of Chief Yang; his grain barn (the Cuigu Barn) was in the lower part of Diebu. During Chief Yang's reign, political stability, peaceful society and unimpeded trade provided a guarantee for Zhagana Agriculture-Forestry-Animal husbandry Composite System to sustainably develop and promote itself on and on.

2.2 Witness of Integration Development of Tibetan Buddhism and the Han Belief

Zhagana Agriculture-Forestry-Animal husbandry Composite System is in the conjecture of the Tibetan and the Han. With the agriculture-forestry-animal husbandry composite system developing and maturing, its cultural base, Tibetan Buddhism and the Han belief, is also in the course of contrary and integrating development.

Because of long time of development of the Ben religion and Tibetan Buddhism, they have comprehensive social foundations, traditional and huge powers of political and social circles. In the early ages of the Ming Dynasty, the Han people as a foreign minority (who stayed there as soldiers in the Ming's army) realized that for living they must establish religion powers for their own to counter the Qiang's and Tibetan religions and had cognition of fighting against the Qiang and the Tibetan relying on folk strength of belief. Therefore, with strong military actions and the great support of local officials and country gentlemen, Han's folk belief confronted fiercely with the local Tibetan religions, which gradually poses the situation that the Han belief and Tibetan Buddhism each occupies a half of territory and other religions survive in between them.

As Zhagana Agriculture-Forestry-Animal husbandry Composite System matures and develops, economic foundation gradually influences and makes ideology change. The two big religions finally reach an agreement that together with the Ben religion they form a religious landscape like "the Inverted Triangle" in Quzhou. At last, the Han folk belief is shared by the Tibetan and the Han, and makes the local Tibetans become composite religious disciples who believe not only Tibetan Buddhism and the Ben religion but also the Han folk belief. Religious

culture has bidirectional effects. As the Tibetan and the Han keep in interacting, intermarriage among them appears widespread. Ethnic fusion makes the Han accept Tibetan Buddhism and the Ben religion and take them into the belief system. The Han also become composite religious disciples who believe not only their folk belief but also Tibetan Buddism and the Ben religion. Appearance of dual composite religious disciples lays a foundation in turn for social stability, ethnic harmony and religion sharing of Zhagana Agriculture-Forestry-Animal husbandry Composite System.

3 Contemporary Relevance

3.1 A Good Model for Agriculturally Sustainable Development of Plateau Arid Ecologically Fragile Zones

Zhagana Agriculture-Forestry-Animal husbandry Composite System is a special pattern for agriculture production and living created by the local resident for a long time of coevolution and mutual adaptation with the local ecology and environment. It is a system highly adapting to the environment.

Zhagana Agriculture-Forestry-Animal husbandry Composite System is in the eastern Tibetan Plateau with infertile soil and fragile ecology. In natural conditions, over time the local people pursue neither over-exploited material interests, comfort and unlimited consumption lifestyle basing on environmental destruction and killing the goose that lays the golden eggs nor living as an ascetic monk abandoning material life for spiritual life alone, but the peaceful, quiet, and mild life focusing on harmonious relationship of human and nature on condition that various

material products meet living necessity. They even protect forests, meadows and rivers regardless of using taboo means. They maintain biodiversity and rich primitive vegetables and establish plentiful spiritual culture. Therefore, even though geographical conditions restraint and social productive force has been lagging behind for a long time along with stagnant economy, the idea of pursuing harmony of human and nature functions positively for agriculturally sustainable development.

3.2 A Foundation Laid for the Multi-functional Development of Modern Agriculture

Zhagana Agriculture-Forestry-Animal husbandry Composite System breaks up the single and narrow industry limitation and meets consumers' needs by providing a variety of material products; fully plays an environmental role in ecosystem by subtly adjusting eco-relations and integrating systematically structural functions, and at the same time reduces some impacts of negative effects and maintains ecological balance and living surroundings; makes a full use of labor by properly arranging various production activities of plantation, animal husbandry and forestry picking in different seasons. The agriculture-forestry-animal husbandry composite system has strong naturally regional and socially economic characteristics which embodies diversity of nature, lays a natural foundation for cultural diversity and uniqueness, gives broader and richer connotations to agriculture, and drives agricultural functions to develop toward pluralism in the modern society.

The productive function. The agriculture-forestry-animal husbandry composite system focuses on adopting lateral coupling of different agriculturally technological processes to produce diverse products

including meat, eggs, milk, barley, fur and skin, herbs and other living products. On the other hand, it lowers possibility of polluted soil and water caused by fertilizers, farming chemicals, livestock and poultry at the source to solve product quality in agricultural production.

The ecological function. The agriculture-forestry-animal husbandry composite system fully plays roles of forest ecosystem, meadow ecosystem and on-slope farming ecosystem in maintaining biodiversity, preserving water and soil, and conserving water resources, creating fine ecological environment and laying an external foundation for developing products with highly eco added value. The composite system constitutes vertical gradient landscapes and horizontal gradient landscapes. A unified entity of mountains, forests, meadows, land, water and the board house offers environmental conditions to development of recreational agriculture.

The cultural function. Products from the agriculture-forestry-animal husbandry composite system have distinct backgrounds and connotations of culture, history, geography and humanity as well as regional features and ethnically cultural characteristics. Reasonably utilizing these resources can develop effectively local economy. Inheritance and transmission of cultural heritage is of great significance for carrying history forward and enhancing national dignity.

4 Threats and Challenges

(1) Temperature Rising and Rainfall Decreasing Caused by Global Climate Change

Climate data analyses reveal that the climate change tendency of Zhagana Agriculture-Forestry-Animal husbandry Composite System recently shows that temperature is ongoing rising and rainfall is overall

decreasing (Table 2).

On the one hand, because of decreasing rainfall and imbalanced distribution, there are more and more influences caused by droughts on agriculture, especially since the 21st century wide ranges of spring droughts and summer droughts have occurred frequently.

On the other hand, water is the major limiting factor to pasture's growth; rising temperature's positive effects to pasture are not obvious, but evaporation is intensified so pasture is forced to want more water; in addition to decreasing rainfall and human factors, deterioration and desertification of pasture pose a direct threat to sustainable development of animal husbandry.

Table 2 Temperature and Rainfall Changes of Diebu Country in nearly 4 Decades

Times	Annual temperature anomaly in each times (℃)	Different years' rainfall anomaly percentages (%)
1970s	-0.3	7
1980s	-0.2	2
1990s	0.4	-8
2000s	0.5	-10

(2) Intensified Eco-deterioration by Excessive Development

The Diebu Forest Zone is one of the key wild natural forest zones of Gansu Province. It has been supporting the country with high-quality timber of $2,300\times10^4$ m^3 worthy of over 10 billion RMB within the zone since Forestry Bureau of Diebu County established in the late 1950s. Excessively lumbering for a long time damages ecological conditions in Diebu County. The forest resource decreases lowering capacities of conserving water resource and preserving water and soil of forests. According to the current state's survey of land utilization in the whole

county, by the end of 2015 the whole county had lost erosion area of 1,732.14 km^2 in total, exceeding one third of the county's territory.

(3) High Work Intensity but short of family labor

Zhagana Agriculture-Forestry-Animal husbandry Composite System is fit for the traditional social-family organization structure where three generations live together. Some of labor manage agriculture, and others engage in animal husbandry. With implementation of the national family planning policy, most of the local people only give two births. People gradually realize the importance of education receiving and a large proportion of the children begins to go out for getting modernized education and working as the Chinese education system was formulated and promoted continuously as well as provinces and autonomous regions carried out supporting measures. Hence, local families face a sharp decrease in their family labor, and family labor intensity gets increased suddenly. Some families have to narrow the planting area or cut down the number of the raised livestock due to insufficient labor force.

The ideas and views of the local people are gradually changed as gaps between the city and the countryside are narrowed and towns grow larger. Zhagana Agriculture-Forestry-Animal husbandry Composite System will appear increasing limitations in terms of lack of labor and high labor intensity.

5 Protection and Development Measures

5.1 Launched Activities

(1) Systems and Mechanisms

The Diebu Committee of the Communist Party of China and the government of Diebu County attach great importance to dynamic

protection, adaptation management and sustainable development of Zhagana Agriculture-Forestry-Animal husbandry Composite System. Firstly, the Leadership Group of Agriculture Heritage Protection and Development in the charge of the county magistrate and co-worked by Agriculture and Husbandry Bureau, Forestry Bureau and other relevant departments was established, under which Administration Office for Agriculture Heritage is set up.

(2) Ecological Projects

During the periods of the 11th Five-year Plan and the 12th Five-year Plan, by carrying out eco-protection and construction policies, the Tianbao Project, biodiversity protection, the prairie protection project, the Degraded Farmland into Forests Project, water-eroding land management, disaster prevention and a series of eco-protection and construction projects essentially convert the degradation tendency of ecological conditions in the system. Ecological conditions tend to be better and biodiversity gets recovered.

(3) Scientific Researches

Gannan Tibetan Autonomous Prefecture of Gansu Province and Institute of Geographic Sciences and Natural Resources Research of Chinese Academy of Sciences signed a strategic cooperation framework agreement to collaborate comprehensive scientific researches in aspects of ecological civilization construction, eco-tourism development, agriculture heritage protection and glacier geological investigations in order to lay a scientific foundation for the sustainable development of Zhagana Agriculture-Forestry-Animal husbandry Composite System.

5.2 Potential and Opportunities

(1) Potential for Protection and Development Brought by

Agriculture Heritage Brands

Agriculture heritage is valuable treasure crystalizing diligence and wisdom of a great number of laboring people. In 2002, the Food and Agricultural Organization (FAO) initiated Globally Important Agricultural Heritage Systems (GIAHS). China was one of the first countries to respond to programs of GIAHS. Over a decade, brand value of agriculture heritage has been going up and gradually caught the public's attention. It provides a platform for protection and development of agriculture heritage in Zhagana Agriculture-Forestry-Animal husbandry Composite System.

(2) New Opportunities to Protection and Development Brought by Special Regional Advantages of the Tibetan area of Gannan and Diebu

In recent years, the country has strengthened supports to Tibetan regions especially to the regions apart from Tibet with preferential policies. It is pointed out in the 5th Tibet Work Conference of the Central Government and the State Council's Suggestions to Supporting the Tibetan Regions in Qinghai and Other Provinces for Economic and Social Developments that key attention should be paid to investments of infrastructure construction, enhanced construction and protection of ecological conditions and proactive supports to develop advantageous industries with characteristics. Sitting in the conjuncture of the Tibetan Plateau and the Loess Plateau, Diebu County is a major ecological shelter zone playing significant roles of conserving water resources, supplementing water, preserving water and soil, maintaining biodiversity, adjusting regional climate and others. It also has irreplaceable roles in maintaining water resource in the basin of the Yellow River and ecological security. Speeding up the social and economic developments

of Diebu and construction as a ecological shelter zone raises high demands for agriculture heritage protection.

5.3 Scheduled Activities

Regarding significance of Zhagana Agriculture-Forestry-Animal husbandry Composite System, the following work and activities should be strengthened in order to better protect and make sustainable use of it.

(1) The near-term work (from the year of 2016-2017)

First, Diebu County should improve and put into effect the Agriculture Heritage Protection and Development Plan of Zhagana Agriculture-Forestry-Animal husbandry Composite System as soon as possible.

The Plan points out clearly the specific objectives, activities and plans to be practiced, relevant guarantee approaches and etc.. It should be put into effect as soon as possible after the People's Congress of Diebu County examines and approves of.

Second, Diebu County should formulate as soon as possible Agriculture Heritage Protection and Development Regulations of Zhagana Agriculture-Forestry-Animal husbandry Composite System (which is abbreviated for Protection and Development Regulations in the following).

Protection and Development Regulations clearly states policies and measures for regulating protection and development, and formulates sound supervision and means to award and punish.

(2) The middle-term work (from the year of 2018-2020)

First, further enhancing publicity and education for raising up understandings.

On the one hand, by means of traditional ethnic festivals, the Gannan

Shambhala Tourism Festival and the Chinese Ecological Civilization Lazikou Forum, the agriculture heritage of Zhagana Agriculture-Forestry-Animal husbandry Composite System is advocated for strengthening its influences, raising up the whole society's understandings of the agriculture heritage of Zhagana Agriculture-Forestry-Animal husbandry Composite System, making a good atmosphere for protecting the agriculture heritage where all the public of ethnic groups in Diebu County devote to protecting the agriculture heritage.

On the other hand, teaching and learning of traditional culture are proceeding among young generations. Elder people with rich experience are hired to instruct by themselves and with personal examples. Specialized courses of agriculture heritage protection and traditional culture are offered in schools of all levels and types producing successors for agriculture heritage of farming, forestry and animal husbandry.

Second, formulating preferential policies for supporting protecting and developing agriculture heritage

In the first place, business organizations are encouraged to proactively take part in protecting and developing agriculture heritage, and given relevant preferential treatments and exemption policies. In the second place, farmers and herdsmen on heritage sites are encouraged to actively throw themselves into agriculture heritage protection and development, and awarded direct subsidy in capital according to certain standards. A number of households are selected and developed as model households in terms of remarkable contribution to agriculture heritage protection and development. In the third place, professional technicians and experts with comprehensive knowledge of agriculture, forestry and animal husbandry are introduced to conduct technological instructions on agriculture

heritage protection and development of the Diebu's agriculture-forestry-animal husbandry composite system, and to give technology trainings to farmers and herdsmen.

(3) The far-term work (from the year of 2021-2024)

First, expanding the relevant products' market of the agriculture-forestry-animal husbandry composite system.

On mature conditions, brand advantages of agriculture heritage are made full use of, and relevant products with local features are developed, produced and put into market.

Second, structuring multilateral participation mechanisms.

Structuring and improving multilateral participation mechanisms consisted of by "governments-enterprises-communities" step by step forms a joint force in areas of scientific researches, academic exchanges and popularization of sciences by guidance of international organizations and cooperation of governmental inter-departments, governments and scientific institutes, and governments and enterprises, enabling protection and use of culture heritage of Zhagana Agriculture-Forestry-Animal husbandry Composite System to be an example.

5.4 Anticipative Influences on Society and Ecology

(1) Promoting the rural cultural construction of Diebu County

Exploration, protection, utilization and inheritance of agriculture heritage of Zhagana Agriculture-Forestry-Animal husbandry Composite System are important conducts for "constructing an inheritance system of excellent traditional culture", "maintaining basic elements of ethnic cultures" and driving cultures of agriculture and rural areas of Diebu County to a greater development and prosperity. They are also the supporters of the implementation of the local government's development

strategies to construct a model county of ethnic-culture demonstration. All the public of ethnic groups in Diebu County must be encouraged to further highlight, protect and inherit agriculture heritage.

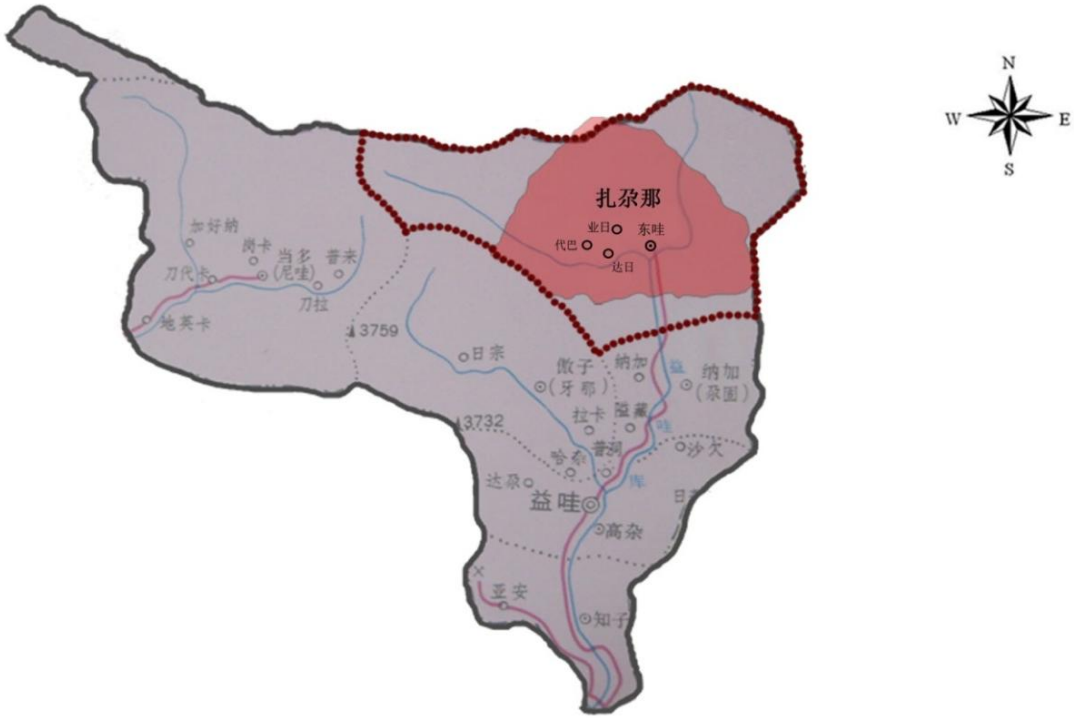
(2) Promoting development of modern agriculture of Diebu County

Zhagana Agriculture-Forestry-Animal husbandry Composite System bears an abundance of production experience, traditional technologies and ideas of harmonious development of human and nature, and lots of advanced ideas offering examples and references to development of modern agriculture. Exploration, protection, utilization and inheritance of agriculture heritage of Zhagana Agriculture-Forestry-Animal husbandry Composite System enable the local farmer and herdsmen as well as ethnic minorities to have better understandings of traditional knowledge and management experience and to apply these knowledge and experience to coping with faced challenges in modern development for realizing a combination of inheritance and innovation of traditional culture and enhancing comprehensiveness, coordination and sustainability of the development of modern agriculture of Diebu County.

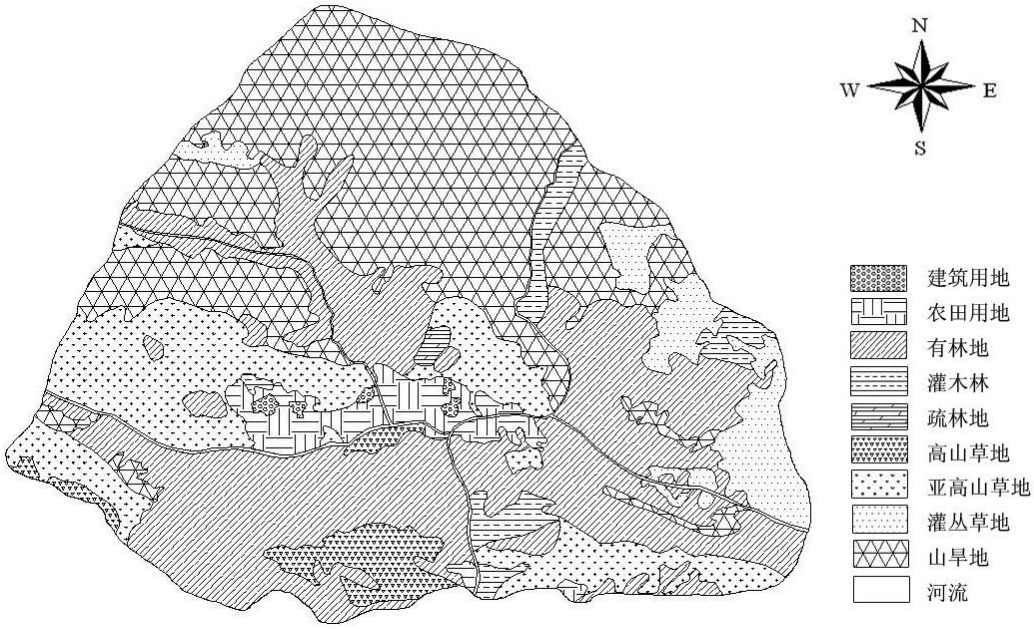
(3) Stimulating employment and income increasing of the farmers and herdsmen on heritage sites

Developing relevant products of agriculture, forestry and animal husbandry by making use of Zhagana Agriculture-Forestry-Animal husbandry Composite System and the agriculture heritage brand can not only raise up market competitiveness and popularity of products but only help increase income of farmers and herdsmen. In the meantime, as multifunctional agriculture ceaselessly develops, the relevant products of agriculture, forestry and animal husbandry integrating with tourism enrich tourist development, widen approaches to advocate and protect agriculture heritage, and then promote development of local economy.

Appendix 1 Maps and Photos



Location of Zhagana settlement in Yiwa village



Land use types of Zhagana settlement

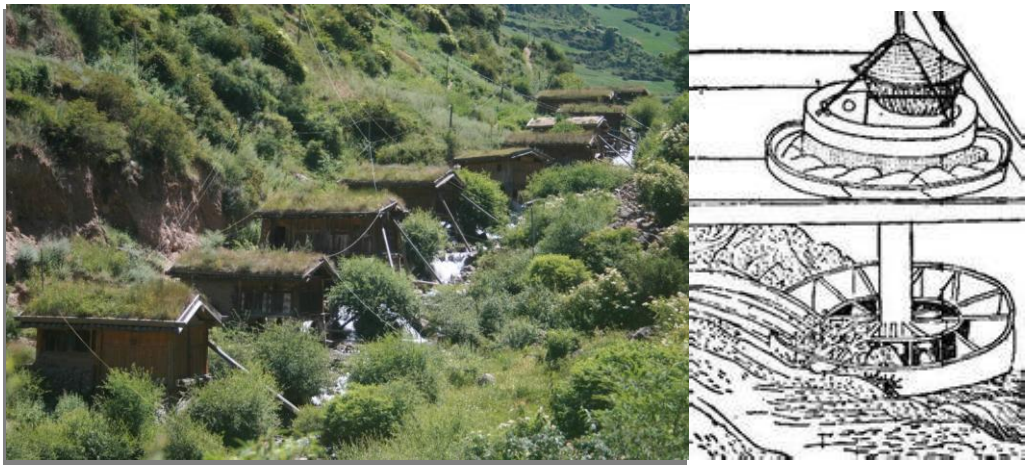
Zhagana Agriculture -Forest-Animal Husbandry Composite System

Highlands Ranch

Agriculture-forestry composite

Harvest

Compost



The water mill

The board house

Tibetan Buddhist culture

Clothing culture

Appendix 2 Regional Fern List (22 families, 14 genera, 50 species)

1. LYOOPODIACEAE

Lycopodium obscurum Linn. f. strictum (Milde) Nakai ex Hara

2. SELAGINELLACEAE

1. *Selaginella vardei H. LévI*
2. *Selaginella helvetica (Linn.)Spring*
3. *Selaginella kansuensis Ching et Hsu*
4. *Selaginella nipponica Franch. et Say*

3. EQUISETACEAE

1. *Equisetum palustre Linn.*
2. *Equisetum arvense Linn.*

4. BOTRYCHIACEAE

Botrychium lunaria (Linn.) Sw.

5. PTERIDIACEAE

Pteridium aquilinum (Linn.) Kuhn var. 1atiusculum (Desv.) Underw. ex Heller

6. SINOPTERIDACEAE

A1eudtopteris argentea（Gmél.) Fée

7. ADIANTACEAE

1. *Adiantum pedatum Linn.*
2. *Adiantum fimbriatum Christ*
3. *Adiantum davidii Franch.*
4. *Adiantum erythrochlamys Diels*

8. GYMNOGRAMMCEAE

1. *Paracymnopteris delavayi (Bak.) K. H. Shing*

2. *Paracymnopteris bipinnata (Christ) K. H. Shing var. auriculata (Franch.) Ching*

9. ATHEYRIACEAE

1.*Gymnocarpium jessoense (Koidz.) Koidz.*

2. *Lunathyrium giraldii (Christ) Ching*

3. *Cystopteris moupinensis Franch.*

4. *Cystopteris montana (Lam.) Bernh. ex Desv.*

5. *Pseudocystopteris atkinsonii(Bedd.) Ching*

6. *Pseudocystopteris diebuensis Y. Sh. Lian, sp. Nov.*

7. *Pseudocystopteris spinulosa (Maxim.) Ching*

8. *Dryoathyrium obtucipinnatiatum Y. Sh. Lian, sp. Nov.*

9. *Athyrium sinense Rupr.*

10. *Athyrium subsinense Ching*

10. ASPLENIACEAE

1. *Asplenium nesii Christ*

2. *Asplenium kansuense Ching*

3. *Asplenium adiantum-nigrum Linn. Var. yuanum (Ching) Ching*

11. ONOCLEACEAE

Matteuccia intermedia C. Chr.

12. WOODSIACEAE

1. *Woodsia andersonii (Bedd.) Christ*

2. *Woodsia macrospora C. Chr. et Maxon*

3. *Woodsia cycloloba Hand.-Mazz.*

13. DRYOPTERIDACEAE

1. *Dryopteris incisolobata Ching*

2. *Dryopteris rosthornii (Diels) C. Chr.*

3. *Dryopteris juxtaposita Christ*

4. *Dryopteris goeringiana (Kunze) Koidz.*

5. *Dryopteris komarovii Kosshinsky*
6. *Polystichum melanostipes Ching et H. S. Kung*
7. *Polystichum shensiense Christ*
8. *Polystichum moupinense (Franch.) Bedd.*
9. *Polystichmn lachenense (Hook.) Bedd.*
10. *Polystichum duthiei (Hope) C. Chr.*
11. *Sorolepidium glaciale Christ*

14. POLYPODIACEAE

1. *Lepisorus pseudonudus Ching*
2. *Lepisorus clathratus (C. B. Clarke) Ching*
3. *Lepisorus venosus Ching et S. K. Wu*
4. *Lepisoorus eilophyllus (Dids) Chlng*
5. *Lepisorus loriformis (Wall.) Ching*
6. *Pyrrosia drakeana (Franch.) Ching*

Appendix 3 List of Regional Gymnosperms (5 families, 10 genera and 31 species)

1. PINACEAE

1. Tsuga Carr

Tsuga chinensis (Franch.) Pritz.

2. Picea Dietr

1. *Picea asperata Mast.*
2. *Picea crassifolia Kom.*
3. *Picea wilsonii Mast.*
4. *Picea neoveitchii Mast.*
5. *Picea purpurea Mast.*
6. *Picea brachytyla (Franch.) Pritz.*

3. Abies Mill

1. *Abies chensiensis Van Tiegh.*
2. *Abies ernestii Rehd.*
3. *Abies recurvata Mast.*
4. *Abies fargesii Franch.*
5. *Abies faxoniana Rehd. et wils.*

4. Larix Mill

1. *Larix potaninii Batalin*
2. *Larix Principis-rupprechtii Mayr Fremdl.*

5. Pinus Linn.

1. *Pinus tabulaeformis Carr.*
2. *Pinus armandii Franch.*

2. CUPRESSACEAE

1. Sabina Mill.

1.*Sabina squamata (Buch.-Hami1t.) Ant.*

2. *Sabina pingii (Cheng ex Ferré) Cheng et W. T. Wang var. wilaonii (Rehd.) Cheng et L. K. Fu.*

3. *Sabina vulgaris Ant. var. erectopatens Cheng et L. K. Fu*
4. *Sabina chinensis (Linn.) Ant.*
5. *Sabina saltuaria (Rebd. et wi1s.) Cheng et W. T. Wang*
6. *Sabina przewalskii Kom.*
7. *Sabina convallium (Rehd. et Wils.)Cheng et W. T. Wang*
8. *Sabina tibetica Kom.*

2. Juniperus Linn.

Juniperus formosana Hayata

3. CEPHALOTAXACEAE

Cephalotaxus sinensis (Rehd. et Wils.) Li

4. TAXACEAE

Taxus Linn.

Taxus chinensis (Pilger) Rehd.

5. EPHEDRACEAE

Ephedra Tourn ex Linn.

1. *Ephedra intermedia Schrenk ex Mey.*
2. *Ephedra equisetina Bunge*
3. *Ephedre sinica Stapf*
4. *Ephedm monosperma Gmel. ex Mey.*