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Agricultural sustainability in a sensitive environment——a case analysis of Loess Plateau in China

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Abstract: Loess Plateau, an arid and semi-arid region in Northwest China, is well-known for its most serious soil erosion in terms of sediment yield each year. Soil erosion, which is intensified by agricultural activities, is the major factor influencing sustainable agriculture development in this region. It reduces productivity by removing nutrients and especially reducing water availability that is essential for crop production in the area. It also brings about off-site costs by demanding more efforts for maintenance of banks and dams along Yellow River through raising the riverbed with sediment. Climate is capricious and extreme weather conditions occur frequently, which impairs normal agricultural production with erosion and also decrease of water availability. Extensive way of farming still dominates on the Loess Plateau, which cannot produce satisfying economic results and needs to be improved or altered. Conventional agricultural production pattern needs to be reconsidered for husbandry has not been granted its due position. Agriculture is the backbone of economy. Poor agricultural production impedes economic development and vice versa, backward economy also influences the advancement of agriculture. Besides a large population, education status of farmers is another threshold that requires being resolved for a sustainable agriculture.

Although conventional agriculture has been practiced there for more than 5000 years, now it cannot meet the demand for food and fiber by the increasing population and some of its farming practices are contributing to environmental degradation directly or indirectly and can sustain no longer. Agriculture on Loess Plateau needs to find its own way of sustainability. To work toward a sustainable agriculture, chances and challenges both indwell on Loess Plateau.

Keywords: Loess Plateau; sustainable agriculture; soil erosion; water erosion; conservation practice

Introduction

The term "sustainable agriculture" was coined by Lady Eve Balfour in late 1970s(Rodale, 1990) to substitute the high input and output featured industrial agriculture when it has achieved what it was expected and began to produce more problems than it can solve(Olson, 1992; Ikerd, 1996). Although the concept of "sustainable agriculture" has been widely acknowledged, accepted and quoted, it means different thing with different people, just as myriads of answers to its definition(Olson, 1992; Neher, 1992; Lowrance, 1992). However, three common themes: ecological soundness, economic viability and social justice are exceptionally included in each definition(Altieri, 1987; Stenholm, 1990; Ikerd, 1996). All are important and none is sufficient to contribute to a sustainable agriculture. Sustainable agriculture involves the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resources base (FAO, 1989). The goal of agricultural sustainability expects to be obtained through tradeoffs among the three common themes. The proportion and connotation of them differs with specific sites and will change with time(Ikerd, 1996).

Loess Plateau is a vast and continuous body of wind-drifting loess with an area of 0.62 million km^2. For most part of it, annual precipitation ranges 300 – 500 mm. With a monsoon climate, precipitation concentrates in July, August and September, which accounts for 50% – 70% of the total rainfall and also varies among years, sometimes dramatically. Loess Plateau is the cradle of Chinese agricultural civilization. Conventional agriculture or Chinese organic agriculture has been practiced for more than 5000 years. Contrary to western industrial agriculture, most of agricultural systems there are so nature-dependent that they cannot manage nature disasters efficiently and may easily collapse under drought, flood, frost and

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other drastic climate changes (Wang, 1991; Chen, 1997). The greatest pressure they constantly feel is from the shrinking arable land and insisting demand for food and fiber due to rapid growth of population as well as its own low productivity. Conventional agriculture can no longer meet present generation's requirements for agricultural production and begin to jeopardize natural resource base that future generations depend on. It needs to be replaced by a new and better paradigm——sustainable agriculture, which is urgent and pressing and would be beneficial to regional progress as well as the country as a whole.

1 Factors influencing agricultural sustainability

1.1 Erosion

Loess Plateau is the most severely eroded area in the world in terms of sediment production each year. According to national standard for soil erosion tolerance (SET) on the Loess Plateau (NSWCB, 1997), more than half of the erosion area surpasses that level (Table 1). Erosion on the Loess Plateau can attribute to natural conditions as well as human being activities.

Loess that covered the Loess Plateau is medium to fine texture, deep and loose, with well-developed pore system (Liu, 1965). Soil developed from it succeeds these features, which makes it prone to water and wind erosion. As the loess just blankets the original geomorphology that consists of hills and basins and is complicated in itself, the Loess Plateau resembles the fragmented appearance with liang, mao, yuan landforms (Liu, 1964; Shi, 1981). When storms come down, which is the major form of precipitation in this area (Qian, 1991), erosion can easily develop, causing soil and water loss and deepening its fragmentation extent. Erosion is already there even before human settlement (Liu, 1964; Tang, 1990).

Table 1 Water erosion intensity on Loess Plateau*

Water erosion intensity, $t/(km^2 \cdot a)$	< 500	500 – 1000	1000 – 2500	2500 – 5000	5000 – 7000	7000 – 10000	10000 – 12500	12500 – 15500	15500 – 18500	> 18500	Sum
Percentage of the total area, %[1]	36.86	9.04	9.86	12.55	7.18	9.58	3.68	3.32	4.24	3.12	100

* Data source (permitted): CAS-NRIC (Natural Resources Investigation Committee) of NPC (National Planning Committee) in 1991; [1] The total area refers to the total water erosion area. Wind erosion area is not included. National level for SET on the Loess Plateau is 10 $t/(hm^2 \cdot a)$

Human activities, agricultural activities in particular, intensify and exacerbate the erosion situation (Shi, 1981; Wang, 1991; Zhu, 1991; Zheng, 1995). With the expanding of human activities, more forests or grasslands were converted to arable use or sites for cities, roads and other components of human infrastructure. It is recorded that during Ming Dynasty (from 14th century to 17th century), there still existed large patch of virgin forests on Loess Plateau (Shi, 1981), but now they cannot be traced even in mountainous areas, such as Ziwuling and Wutai Mt. To meet the increasing demand for food and fiber with a growing population, people are pressed to convert more land into arable use (Shi, 1981; Wang, 1991). Cropland even found its way onto steep slope with 250 or greater. Till 1996, total farmland area on Loess Plateau is 14.50 million hectares, among which 56.3% is slope fields with gradient more than 80, and that of gradient between 80 – 250 and more than 250 are 46.4% and 9.95%, respectively (Chen, 1996). Each year, 1.6 billion tons of sediment from the land will be removed to the riverbed of Yellow River and 70% of it is from slope farmland (Bai, 1991). Particularly, for slope fields with 250 or greater, it is estimated that 1 – 1.5 cm or even 5 – 6 cm deep of topsoil is striped off annually, amounting to 105 – 150t per hectare and containing nitrogen 80 – 225 kg, phosphorous 160 – 230 kg (Chen, 1996).

Sparsely covered with vegetation during wet and windy season is another trigger for erosion. Temperature accumulation of more than 0℃ on Loess Plateau varies between 1000 and 5000℃. In its southern part, the farming pattern is winter wheat-millet or winter wheat-corn in succession in one year; in the north, it is spring wheat, or corn, or millet. Windy days mainly occur in winter and spring, which

causes serious wind erosion, especially in early spring in the north when the surface land is dry, most vegetation including wheat is only in emergence stage and other cropping land is in fallow. From the south to the north and northwest, days with wind velocity more than 5 m/s can increase from 10 to 40(Hou, 1990). Winter wheat will be harvested in June and spring wheat in August and the crop fields will be tilled for corn or millet or potato, or just in fallow, which makes the soil more vulnerable to water erosion during the rainy season.

Soil erosion reduces the productivity of the land by loss of water, soil organic matter, nutrients, and depth of soil. It is estimated that the annual 1.6 billion tons of sediment contains 6.4 million tons of organic matter, 0.42 million tons of nitrogen, 2.10 million tons of phosphorus, 33.76 million tons of potassium and 0.96 million tons of micronutrient(Yu, 1991). Study carried in hilly loess area of northern Shaanxi Province shows that annual soil nutrient loss per hectare equals to 2250 kg of chemical fertilizer; annual nutrient loss in slope fields is 17.9 times of its total fertilizer input of that year(Zhang, 1996). With the loss of soil nutrient, land productivity declines and crop yield decreases. A simulation experiment carried in Shaanxi shows that with loss of 1 cm topsoil, there will be a wheat yield reduction of 22.5 – 43.5 kg/hm^2 (Liu, 1992) Guo *et al*. (Guo, 1981) have studied that when sediment loss reduces 23% and runoff 21%, the millet yield will increase 58%.

With the desperate loss of large amount of nutrient, precious water resource run off with it. Liu(Liu, 1999) estimates that water loss in slope fields is 450 – 900 m^3/(hm^2·a); for wasteland, it is 300 – 600, accounting for 15% – 18% and 10% – 12% of the total annual rainfall, respectively. As about 90% of its cropland is rainfed, precipitation effectiveness and soil water availability is essential for crop yield. Provided with irrigation system, maximum productivity of winter wheat on Loess Plateau can easily reach 7500 – 9000 kg/hm^2, compared with 3000 – 4500 kg/hm^2 under natural conditions(Hou, 1990). Due to insufficient supply of nutrient and water, crop yield is low and unstable, which presses people keeping to open up more wasteland for production and makes the restoration movement initiated by the central government harder to be pushed on (Fig. 1).

Soil erosion not only impair local agricultural production system and economic development, but endanger the security of people living by the lower reach of Yellow River with potential floods as considerable amount of eroded sediments settle on the riverbed and makes it rises gradually each year. Large sum of fund will be allocated for the study and supervision of the hydrological changes of Yellow River. Equally large scale of work force will be dedicated to the maintenance. Till 2000, the workload alone for maintenance of banks and dams along the lower reach equals to that of the buildup of 4 Great Wall (from YRCCIC web page 2001). Labor costs have never been calculated, as the majority of the labor force is compulsory, especially before 70s of the twentieth century.

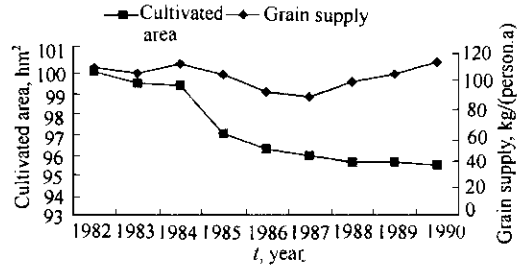

Fig.1 Variation of cultivated areas[1] and grain supply[2] of Shanxi Province[3] during 1982 – 1990*

[1]Take cultivated area of 1982 as 100; [2]take grain supply of 300 kg/(person·a) as 100; [3]area of Shanxi Province accounts for about 40% of that of Loess Plateau; * data source: download from www.sedac.ciesin.org/china

1.2 Capricious climate

We have to get along with a capricious climate. Except for concentration within a year, precipitation also fluctuates between and among years dramatically (Wang, 1991; Qian, 1991). Extreme weather phenomenon such as storms and droughts occurs frequently, which is detrimental for agricultural production (Table 2). The precipitation of one storm with intensity of 200 – 300 mm within 24 hours usually accounts

for 70% of its annual total amount. Storms reduce water use efficiency and increase chances of erosion. Compared with storms, droughts bring about no less damage to agricultural production. On the contrary, extreme droughts can cause complete production failure, which happens every 8 to 10 years according to meteorological statistics(Qian, 1991).

1.3 Extensive management

Conventional agriculture on Loess Plateau includes a capital-extensive multicultural system, with households as basic production units, a substantial reliance on natural inputs such as man-labor and organic fertilizer. Restoration of soil fertility was generally achieved through crop rotating, leguminous vegetation planting and fallowing. It was once applauded and envied by western researchers for the ability of sustaining the fertility of its soil after thousands of years' farming practice (Reganold, 1990). Although it can fully use internal recyclable energy and stay to be self-maintaining and regulating, which make it possible to last for several thousand years, the scale of energy flow is small and its conversion ratio remains low(Yu, 1990). Till 1990, only more than 40% of the cultivated area is mechanically tilled, 20% is mechanically sown and less than 7% is mechanically harvested, the rest depended on cattle and man labor(www.sedac.ciesin.org/China, 2000).

Table 2 Frequency of various intensity of storms on Loess Plateau during 1953 – 1975*

Intensity, mm	100	100 – 200	200 – 300	300 – 400	400 – 600	600 – 800	> 800	Sum
Shanxi Province		15	9	2	1			27
Shaanxi Province		16	7	2	1			26

* Take maximum precipitation within 24 hours as standard; data source: download from www.sedac.ciesin.org/china

It is known that fertility of soil is on decline on the Loess Plateau. Except for erosion, poor management cannot be spared. After each harvest, little fertilizer including organic and chemical, has been applied to the soil, especially slope fields(Yu, 1990; Chen, 1996). People cannot apply organic fertilizer as they have less room for green manure planting and crop stalks are removed from field as daily fuel. Most of them also cannot afford adequate chemical fertilizer. Chen *et al*.(Chen, 1996) showed that only 30% have been fertilized and there was no any form of fertilization for slope fields. According to sampling statistics of 1990 conducted by NRIC (Natural Resources Investigation Committee) of Loess Plateau, among 3332 samples, organic matter content of 59.7% samples is less than 1%; among 1326 samples, alkaline nitrogen content of 60.1% samples is less than 50 ppm. Phosphorous content is higher, but potent P is in deficiency. Soil integrity of physical, chemical and biological is essential for agricultural production. It requires recruit of nutrient to maintain its productivity. Studies have shown that appropriate fertilization can not only dramatically increase crop yield, but also improve water use efficiency(Hou, 1990; Wang, 1995; Dang, 1999).

Researches concerning wheat, corn and potato upgrading have been extensively unfolded, but the results only enjoy a limited popularity as they focus more on production quality rather than adaptability. There are diversified microhabitats on Loess Plateau due to its fragmented geomorphology, which requires diverse species to suit them. When only one or two crop types who boast higher yield are preferred, rather than an array of different varieties, it would reduce the complexity of agricultural systems and make them open to pests and diseases and subject to production failure (Hou, 2000). Millet species, which can better adapt to local adverse environment, have never been paid with adequate attention for improvement. As most of the indigenous varieties cannot come up with satisfying yield, they are threatened with abandonment.

Moreover, most farmers there are still tuning in the ancient timetable: to rise and go for tillage with the sunrise and to rest and come back home with the sunsets. They just accept what is offered passively and never expect to probe ways for efficient use of agricultural resources. The conventional agriculture systems are so nature-dependent that they are vulnerable to naturally and socially dramatic changes, such as

storms, floods, droughts and wars (Shi, 1981; Yu, 1990; Wang, 1991; Chen, 1997). Low input results in low output. Hunger, like a mob of wolves, was always at the corner, seeking to attack and could not be frightened away easily (Yu, 1990; Wang, 1991; Chen, 1997).

1.4 Agriculture production pattern

Agriculture production pattern also needs to be reconsidered. Due to overemphasis on grain production, livestock breeding has not been granted its due position on Loess Plateau, which not only impedes economic development, but also aggrandizes soil erosion for its extensive way of management. The scale of breeding is confined within individual households and there are generally 3 – 4 goats or sheep, 1 – 2 cattle or 1 – 2 pigs in a family, but they cannot be raised at the same time for lack of money and forage (sample investigation). Most breeds are indigenous and need upgrading in management or traits. Goats are examples. They are small, thin, agile and capable of climbing trees and steep slopes that are even inaccessible for human being for leaves and grass. They often cause serious damage to trees and expand soil erosion on steep slopes through overgrazing and stirring the essentially loose soil structure during scrambling. As they are active and usually in a state of wild grazing, a goat has to be kept for at least one and an half year before going to market and is worthy of 200 RMB Yuan(25 $) at most. But as they can feed themselves and need little attention, goats are still popular among farmers. Before better varieties come up, this phenomenon will continue, although many people are aware of its adverse impact on environment and the unbalanced value compared with its breeding period (household investigation). Absence of efficiently managed pastures is another bug in current livestock breeding. According to Husbandry Bureau of Shanxi Province (HBSXP), 4.55 million hectares of forage land, 80% of the total area is degrading and only 0.45 million hectares has been managed. The product of natural forage is low and usually with a poor quality and cannot satisfy the livestock. In Shanxi Province, productivity of a well-managed pasture is 12 times of the wasteland (HBSXP). Overgrazing is universal and becomes another source of soil erosion(figures concerning forage production is provided by HBSXP at a conference in 2000, Taiyuan).

1.5 Population and farmers' education status

Although people there acquire more arable land than the mean level of the nation, more than half of it is slope fields with serious erosion and low fertility and require additional management practices to attain normal yield. In 1996, average wheat yield for slope field was only 1350 kg/hm^2 or even less (Chen, 1996), compared with 3700 kg/hm^2 of the national level(www.sedac.ciesin.org/China, 2000). In 1997, each person has less than 300 kg of grain at his disposure in Shanxi Province, among which includes his own food, seed and feedstuff for livestock he raises(www.sedac.ciesin.org/China, 2000). With a poor quality of environment, the holding capacity of population of the land is relatively low. It is estimated that 2.0 mu(1 hm^2 = 15mu, Chinese unit) or 0.13 hectare of well-managed cropland can adequately feed one farmer on Loess Plateau, which is far from satisfying when the population, with a large base, is growing rapidly in recent years which will increase pressure on the land and threatens its ability of food production.

Moreover, education status of the general population, especially farmers, is discouraging. Its general illiterate ratio is two points higher than the national level and more than half of farmers are illiterate (Su, 1990). The knowledge of growing crops and raising livestock is passed on to new generations just through the repetitions of practices and procedures without any formal type of instruction. Improvement of quality of people should become another priority for a sustainable agriculture as human being is the receiver, disseminator and executor of practices concerning sustainable agriculture and successful future agriculture is dependent on "high thinking", not muscles nor "high tech".

1.6 Backward economic development

Agriculture is the backbone of economy. Environmental degradation leads to a poor agricultural

production and also impedes its economic development (Fig. 2 and Fig. 3). Both net income of farmers and GDP per person from Shanxi and Shaanxi provinces is lower than those of the national average and gaps seem to expand as time goes.

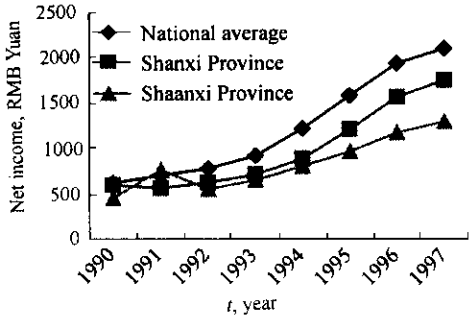

Fig. 2 Net income of farmers on Loess Plateau in 1990 – 1997 (Data source: download from www. sedac. ciesin. org/china; Shanxi and Shaanxi account for about 70% of the total area of Loess Plateau)

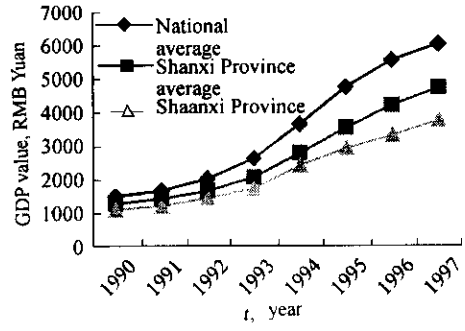

Fig. 3 GDP per capita on Loess Plateau in 1990 – 1997 (Data source is the same as Fig. 2)

Economic status vice versa influences agriculture production patterns. Green manure area has been dwindled dramatically (www. sedac. ciesin. org/China, 2000). Crop stalks are removed as fuel instead of being made into mulch and added to soil. Even livestock manure is baked to serve as fuel rather than put into fields. Fallow periods have been shortened considerably in order to obtain more harvest in a year. Local farmers cannot afford necessary amount of chemical fertilizer as well as seeds of improved varieties, which make the effort of putting the agricultural production back into its right cycle even more difficult (household investigation).

2 Challenges and chances for agricultural sustainability on Loess Plateau

2.1 Challenges

The major challenge is that the goal of sustainability of agriculture has to be achieved in a fragile and declining environment, which requires extra prudence in planning human activities comparing with other regions, and before finding an effective solution to its equally miserable economy, any measure solely focused on environment protection is impractical and infeasible. Economic viability must be priority for sustainable agriculture on Loess Plateau, as about 80% of the population are still farmers and more than half of their income are spent on daily food and clothes. In U.S., it is less than 2% and only a small portion of the income, respectively (Ikerd, 1996). It is impractical to require people to cherish the land that cannot feed them. In Youyu, a national-standard impoverished county from Shanxi Province, vegetation cover reaches more than 40% and the main component is conservation forests with poor quality, although cash forests and pastures can also be developed. It is not reasonable to expect a sustainable outcome.

However, it is unadvisable to realize economic purpose at the expense of environment as we have too much lessons in this aspect to learn from. Sustainable agriculture on the Loess Plateau needs to keep balance of ensuring a satisfying productivity and restoring and improving environmental quality. Both are virtually important and far from easy to be achieved on the Loess Plateau, especially when economic purpose and environmental results are incompatible with each other.

We also have to deal with a large and still growing population. Till 1997, population of Shanxi Province is 31.41 million with a natural growth rate of 10.12%, for Shaanxi Province, it is 35.7 and 7.6, respectively and for Ningxia Autonomous Region, it is 5.29 million and 13.49%, while the national

level is 12.36 billion and 10.06% (www.fjtu.edu.cn). Both predictions from Population Information Research Center of China(PIRCC, 1998) and National Population Planning Committee (NPPC) shows that general population growth of the country will slow down gradually and expects to see its negative growth in 2050 due to adoption of population control policy. But for Shanxi Province alone, 5 million more people will come to the world in 50 years(Fig.4), which will tense the indigent situation of local natural resources and make conservation work even tougher to carry on. Precipitation is the major way for water resource recruitment in the province. At present, its water resource per capita is only 20% of the national level and 3.8% of the world. Water availability per hectare of cropping land is only 2430m^3, 9.3% of the national level. For land area per capita, it is 35.6% lower of the national average(www.shanxi.gov.cn).

Finally, sustainable agriculture on the Loess Plateau requires preferential policies as it is still a fragile and backward region and needs special care before a well-balanced cycle being established between its environment and economy. Taxes and subsidiaries concerning agriculture production in particular should be regulated to cater to the farmers' interests and make their activities more reasonable. At the same time, it also urge people there to take concerted efforts against adverse situation and try to be self-sufficient, as we are still a developing country and there are many sections needs the help of the nation. Preferential policies should stay consistent.

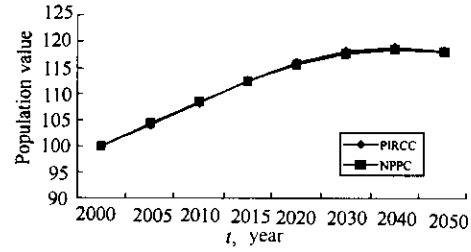

Fig.4 Prediction of population growth of Shanxi Province
(to take population of 2000 as 100)

2.2 Chances

Chances have been already there for sustainable agriculture on Loess Plateau. Many original farming practices in conventional agriculture can contribute to sustainability, such as rotation, intercropping, fallow, green manure planting, controlling pests with their natural enemies and low input of fuel energy and so on. Smartly and tactful designed water conservation establishments, such as terrace and fish-scale pitch have been constructed on the slope to block and store rainfall and reduce runoff, and thus alleviate erosion, which are believed to be the major reasons for the survival of agricultural civilization of the region (Liu, personal exchange; Sandor, 1991). Terrace is a great invention of this arid and semiarid region to make maximum efficient use of rainwater, which is essential for local agricultural production. A new built patch of terrace can block and store all the rainfall with intensity of less than 50 mm and can double crop yield(Zhao, 2000). They are the essence of conventional agriculture and will be an indispensable part of sustainable agriculture.

Unfortunately, extensive farming management has offset the effects of these practices and some of them even have been altered to satisfy changing human needs, such as the decline of green manure area. Measures that include variety selection and upgrading, efficient use of water with rainfall collection establishments, livestock breeding and other intensive management practices, are expected to be adopted to improve agricultural production and alleviate pressures on crop land. Collection establishments can take advantage of the concentration of precipitation and make full use of limited water resource. It has showed that such establishments can effectively relieve drought pressure on daily life as well as crop growth in dry years and ensure a stable and continuous yield(Cao, 1999).

Especially, livestock breeding proved to be successful in economic development as well as in erosion control in history on the Loess Plateau. When husbandry dominated agricultural system, erosion would be subdued economy would develop and the society would prosper somewhat(Shi, 1981). With an arid and semi-arid climate and no efficient irrigation system, livestock can buffer the negative impacts of low rainfall

periods by consuming crop residue that in "plant only" systems would have been considered crop failures. Livestock breeding can not only improve people's financial status as meat production and its market is more stable, but ensure the quality of life by the increment of high protein consumption, and generally enhance the soil fertility with manure. In conjunction with cropping operations, livestock can also make more efficient use of farm labor. Confinement livestock production is highly desirable for this region due to its complex topography and fragmented landform. Livestock should be accepted as the pillar industry of sustainable agriculture on Loess Plateau.

Chance also lies in people's consciousness. More people, besides researchers, from policymakers to farmers working in the field, become more aware of the ponderance environmental quality shares in the development of society and they begin to understand and accept the concept of sustainability, which will benefit the formulation and execution of relevant policy. Two important events in recent years contribute to an unprecedented scale of conservation activities in the country as well as on Loess Plateau. In 1998, the country's largest river——Yangtze River suffered the severest flood in 100 years in its history and cost several thousand of lives and tremendous loss of properties. In April and May 2000, the majority of the country experienced several severe "yellow storms" for the first time in its history of 50 years. After that, a number of programs and large scale of restoration activities initiated by NSTD(the National Science and Technology Department), CAS (Chinese Academy of Sciences) and NNSFC (National Natural Science Foundation of China) have been carried out in Northwest China, including Loess Plateau. Several key assessment projects have been approved and expects to provide an all-round perspective of Loess Plateau. The theme of sustainability will be surely considered and carefully explored.

Delightfully, sustainable agriculture can also rely on rich information that has already accumulated in previous studies. Extensive researches with different perspectives have already been carried out on Loess Plateau and a wealth of data concerning physical, chemical, biological and social aspects of the land, has been gathered(Liu, 1964; Chen, 1989; Tang, 1990; Qian, 1991), which makes further studies easier. Soil and water conservation studies have been conducted since the foundation of the country. Although it experienced ups and downs with the political climate of that period (Tang, 1990), great progresses have been made. Typical watersheds have been singled out as pilots where conservation measures of engineering, biology and tillage have been applied and studied for maximum ecological and economic marginal benefits both. Experience in this field abounds and is especially helpful for sustainable agriculture when it deals with environmental degradation on Loess Plateau. Moreover, CAS has organized two highly professional teams since 1955 to give comprehensive investigations of Loess Plateau. Their work ended up with a series publications containing prolific information of the Plateau and is a valued reference for succeeding study.

Actually, Loess Plateau is not "poor" in itself. It boasts lavish supply of light and adequate temperature accumulation for agricultural production. There is also a rich collection of indigenous species and varieties for crop and forage planting due to its diversified microhabitat. It has been studied that native varieties can better suit its surroundings, consume less water during its growth, have a high resistance to adverse weather phenomenon, and thus can ensure a more stable yield(Hou, 2000). Loess Plateau can also produce quality sorghum, millet and buckwheat that are cushion for farmers against poor weather and trade and price fluctuations. Moreover, rich mineral deposit, such as coal, gas, iron, wulfenite and other rare metals have been detected in this region(Feng, 1991), which lays a solid foundation for agriculture development.

3 Conclusions

As conventional agriculture on the Loess Plateau cannot meet the demand of current generations and

still contribute to environmental degradation, it needs to be replaced by a new and better paradigm-sustainable agriculture. For an ecologically and economically sensitive region in China, it takes time and effort to develop sustainable agriculture here. Keep aware of the challenges and try to take advantage of chances to work toward the goal of agricultural sustainability.

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