The impact assessment of “Grain for Green” program in Dingbian, China

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Preface

This work chose Dingbian County in Yulin City as the study point to evaluate the impact and the sustainability of "Grain for Green" program. Although China's economy developed very fast after the People's Republic of China was founded, the development of China in different region is very uneven. Chinese have built several international cities, such as Shanghai and Shenzhen, in the east; meanwhile farmers in the loess plateau are not yet completely out of poverty. One of my most important goals in WUR is to contribute what I have learned to Chinese farmers. "Grain for Green" program is the largest environment restoration program and also the largest poverty alleviation program in China. So I chose one of the counties in Loess Plateau to study the impact of "Grain for Green" program.

This study was not possible without the contribution of many persons. I am particularly grateful to my supervisors, Alexander Wezel at ISARA-Lyon and Kees van Veluw at WUR who closely supported me throughout the whole thesis process with much attention and professionalism. I would also like to thank Felix Bianchi and Cor Langeveld who gave me the kindest guide for writing and structuring in thesis ring. I would also particularly thank to Professor Xiaohong Tian at Northwest A&F University in China, for his enthusiastic help and guide in the laboratory and allowing me to use his laboratory for free.

Many important things happened during the period of my thesis, the most important of which is my marriage. I have temperately stopped my study in WUR and went back to China to get married in the end of 2017. I would like to thank my wife for keeping supporting me to finish my MSc study and have a further study for Ph-D, even though I have spent very little time with her at home in recent years. And I would like to express my gratitude to Rogier Schulte, my supervisor for Ph-D study, and again to Alexander Wezel and Kees van Veluw, who gave me time and allow me to finish the events in my life with great patience.

I lived on the Loess Plateau for two months in order to collect the data required for my thesis. I would like to thank Mr. Zhang and Mr. Wang, the local farmers in Loess Plateau, who allow me to live in their home for several days when I cannot find a restaurant locally, and Mr. Xu who drive me with a motorbike to transport between villages when the road is not available for car. I would also like to thank Dingbian Pufengda co. Ltd to provide me a car and a long-term resident in the town for free.

Abstract:

Grain for Green (GfG), also called Sloping Land Conversion Program is the largest reforestation program in the world. The GfG started in 1999 and ended in 2006, involved 124 million people, 32 million households in a total of 1,897 counties and 25 provinces. Many researchers reported the benefits in ecological and environmental aspect, farmers' income, labor retribution, and environmental consciousness of local farmers. But one of the remaining questions is whether the project can be sustainable after the program end. This thesis randomly chooses 10 villages, including 5 participating villages and 5 non-participating villages, in Dingbian County in Yulin City to collect data. Data of soil organic matter, Soil physical structure and biodiversity were collected as the indicator of environment. 50 families, 5 in each village, were interviewed to collect the information of household's income and opinion to GfG. Two linear regression models were used to detect the extent of the effects of different internal and external factors on households' income and evaluation of GfG program. The result shows that the GfG program significantly increased the biodiversity and improved physical soil structure. But the soil chemical characteristics didn't have a significant difference between participating and non-participating villages. In addition, participation in GfG has had a significant negative impact on farmers' income, happiness of life and satisfaction with GfG program was not high. There is no significant difference in environmental consciousness between two groups.

Key words: Grain for Green sustainability environmental restoration farmers' income farmers' attitude

1 Introduction

The Loess Plateau is located in the north central part of China, involving seven provinces: Mongolia, Qinghai, Shanxi, Shaanxi, Gansu, Ningxia and Henan. It is the largest loess accumulation area in the world with a total area of 6.42×10^5 km^2. Because of its unique geographical location and rich deposits of coal, oil, bauxite and other resources, the Loess Plateau has an important position in China's economic construction and development. (Baike.baidu.com, 2018)

However, the vegetation destruction in the Loess Plateau is serious and the surface erosion is increasing, which makes the soil erosion area expand sharply. 69.99% of the total area of the Loess Plateau, 4.54×105 km^2, has soil erosion exceeding 1000t / (km^2·year). An average of 1.6 billion tons of mud flows into the Yellow River annually. Until 2011, the area experiencing soil erosion in China due to human factors is expanding more than15, 000 km^2 per year, and the increase of soil erosion amount is more than 300 million tons. (Li Yonghong, 2011) Severe soil erosion and arid climate caused the Loess Plateau to suffer serious damage to environment. Its vegetation-covered area is only 1.2×10^7 km^2, which is far lower than the national 18.83%. The grassland vegetation area experiencing land degradation of Loess Plateau is increasing and the ecological environment is quite fragile. Yin et al. (2005) pointed out that 80-90% of the soil erosion can be prevented if there were proper forest coverage in Loess Plateau.

There are many reasons of the degradation and soil erosion of the extensive grassland, such as improper policies in history, excessive logging, overgrazing and poor maintenance of rangelands. To solve the problem of food and accelerate the process of industrialization, the Chinese government had carried out several unsustainable policies. In 1949, when the People's Republic of China was just founded, most of the Chinese were still suffering from hunger. The total grain production in China in 1949 was only 1,130 million tones, amounting to 209 kg per person (CSY 1991). After 1949, population in China saw a rapid growth, and more food was needed to feed increasing people. So the Chinese government began to turn large areas of forestland, steppes and wetland into farmland, which caused heavy vegetation coverage degradation. (Du 2002).

In 1958, the main leaders of China believed that the nation needed to have a comprehensive industrialization as soon as possible. Agriculture was treated as the main source to fund industrial growth in this period. The Chinese government chose grain and steel as the major indicators for country's development. Steel is the main material for developing heavy industry and grain was used as the food for workers and the funding for industry. In this period, the main leaders of China believed in utopian optimism and had poor awareness of sustainable development (Shen 2008). They believe that the nature has endless potential and advocate to largely use natural resources to increase production. '人有多大胆，地有多大产', in English 'Your determination determines your productivity' is one of the most famous slogan during this time. (Tao 1958) Chinese government had carried out many unrealistic goals in this period, such as the yield of rice should aim at 5000kg per mu (equivalent to 75000kg per ha), and the total output of steel in 1958 should be doubled over last year, which is 10,700,000t (Tao 1958). Such unrealistic goals had brought serious burden and stress for both industrial and agricultural sectors.

Hence, the government encouraged communes to become independent production units by building 'soil blast furnace' as small factories to produce steels by their own. Till 1959, over 700,000 commune enterprises with small factories were established, which brought 710 million Yuan's industrial output, taking up to 10% of the total in China (Yu 1991). However, using 'soil blast furnace' is a kind of simple, crude and inefficient processing method of iron and steels, and which also need large amount of wood to fuel. So large amounts of trees were cut as fuels and cause a serious deforestation (Tao 1994 ; Li 1985 ; Du 2002). Also, it is impossible to produce such amount of agricultural products to reach government's expectation on existing land. So farmers could only expand the area

of farmland at the sacrifice of forest and grassland. This period in Chinese history was called “The Great Leap Forward”(1958-1960).

Of course, Chinese government never wants to waste the forest and other natural resources in purpose. In 1949 when the People's Republic of China was just funded, Chinese government had instituted the Ministry of Forestry to manage the forest and try to use natural resources more rationally. However, instead of promoting sustainable development policies, the vision and mission of MOF from 1949 to 1978 were promoting the nation’s development. In such period, trees and timbers were regard as fuel and cheap raw material for industry. And the forestland, wetland and grassland were treated as unemployed land, which people only use them to provide more agricultural area by destroy. Although there were some people in MOF pointed out the importance of vegetation coverage and the sustainable development during “The Great Leap Forward”, but their voices were ignored. (Li 1988a ; Wang 2000)

From 1959 to 1961, several disasters happened in many parts of China, such as a widespread drought in West China, frost in the North and flood in the South etc., and lead to a significant famine and cause 1.04 million people died. (China Disaster Report 1949-1995) Hence, Chinese government stopped the “Great Leap Forward” and tried to focus more on agriculture. But the major policy was the same: expand more farmland and have more products.

During Cultural Revolution (1966-1976), many staffs in Chinese government, including MOF, were removed. Political purging made the MOF doesn’t have enough people to redress the deforestation in past several years or control forest fires. From 1966 to 1977, over 110,000 forest fires happened in China, and more than 670,000 ha of forests lost per year (Wang 2000). Without an efficient MOF, cut forests also became uncontrolled while there was a large need of expanding farmlands to feed the burgeoning population. Thus, more forests were transformed into farmland to product more grain. Furthermore, farmers in arid area have to largely seek new grazing and farming lands. More and more farmer started grazing and farming on ecologically sensitive area, such as steep slopes. This situation continues until 1979, Chinese government enacted The Forest Law which outlined the permitted and forbidden activities after Cultural Revolution. In 1998, a massive flood in midstream of the Yangtze River caused 4150 people died, 18 million people homeless and more than ¥116 billion（about€ 14.9 billion） in pecuniary loss. (Lu et al. 2002) Some environmentalist pointed out that the reasons of floods were deforestation and soil erosion in upper reaches (World Bank 2001). From 1949 to 1990, the Forest coverage in China had decreased form 30%-40% to only about 10%. In 2000, China’s population had reached 1.26 billion, accounted for 22% of the world’s population, but the forest coverage only reached 4.1% of world’s total. (Lei 2002). Hence, Chinese government implemented six Key Forestry Programs (KFP) cover more than 97% of counties in China to restore the forest, vegetation and ecology.

1.1 Grain for Green program

Grain for Green (GfG), also called Sloping Land Conversion Program, is the most important program of the six KFPS. The GfG involved 124 million people, 32 million households in a total of 1,897 counties and 25 provinces and is the largest reforestation program in the world. (Mao et al. 2013) The main purpose of the GfG is gradual stop farming in steep slope land that is liable to soil erosion, and then reconvert the land to their original vegetation (forest, grass and lake, as well as barren hill and wasteland afforestation). Farmers in GfG program can voluntarily convert sloping land into forest land in areas where suitable for returning farmland to forests, and the government provides food, cash, seeds and subsidies to farmers in accordance with uniform standards. The food subsidies for households in the Yangtze River Basin and the southern region are grain 2250 kg per hectare annually, while it in the Yellow River Basin and the northern region are grain 1500 kg per hectare per year. The cash subsidy for farmers is 300 yuan per hectare annually, and the allowance for seeds and afforestation costs is 750 yuan per

hectare, the duration of subsidy is from 5 years to 8 years. Returning farmers also have the ownership of trees, and the contract period of the afforestation can be extended to 50 years. (Hprc.org.cn, 2018)

1.1.1 Program timeline.

The GfG started in 1999 in three selected provinces, which are Sichuan, Gansu and Shaanxi as a trial project. During the pilot phase of GfG (1999-2001), more than 15 million farmers in the program village choose to return their land to original vegetation (Uchida et al. 2005). There were a total of 1.2 million ha (408,000ha per year) of farmland converted in pilot phase, for a total cost of 3.65 billion CNY (equals to about 0.5 billion EURO) (Xu and Cao 2002). In 2000 the GfG was extended to 13 provinces and started to be expanded nation-wide, including 24 provinces, among 1580 counties. The GfG was originally planned to end in 2006, but in 2007 the Chinese government adjusted its subsidy policy and started a new round, because it expand very quickly and widely adopted by local farmers. The GfG project was officially ended in 2016. Many researchers reported the great success of the project. China has returned farmland to forests in total of 26.9 million ha from 1999 to 2008, including 9.3 million ha of afforested land for reforestation, 15.8 million ha of afforestation in barren hills and wasteland, and 1.8 million ha of closed forest (Chen et al, 2015). During GfG program, the vegetation coverage of the Loess Plateau has been significantly increased. The vegetation coverage of the Loess Plateau changed from 31.6% in 1999 to 59.6% in 2013, with an increase of 88.6% (Chen et al, 2015).

1.4 Literature review

1.4.1 Farmers' compensation

According to State Council of China (2004,2007), farmers who participate the GfG can receive three kinds of subsidies: grain, living subsidies (cash) and seedlings. When the policy of GfG is adopted, first of all, local governments will count the number of households who are expected to participate and the area of farmland which need to conserve to economic trees, ecological trees or grass land, and report the results to the central government. The central government will distribute the funds to local governments according to the number of households attended and the area of land conversion. Local governments will count the area of retired land for each household and pay the subsidies in accordance with State Council of China. Table 1 illustrates the different subsidies in three periods in two regions.

Table 1 The subsidies in three periods in two regions.

Location of farmland	Living subsidy (Cash)	Grain or cash			Seedlings (Cash)
		1999-2003	2004-2006	2007-2015	
	Yuan/mu (ha)/year	Kg/mu (ha)/year	Yuan/mu (ha)/year	Yuan/mu (ha)/year	Yuan/mu (ha)
Yangtze River watershed	20 (300)	150 (2205)	210 (3150)	105 (1575)	50 (750)
Yellow River watershed	20 (300)	100 (1500)	140 (2100)	70 (1050)	50 (750)

*Source: State Council of China (2004, 2007)

*Mu is the common unit of measurement for land area in China, with 1ha=15mu

Farmers in Yangtze River basin can receive 150kg of grain per year for transferring 1 mu of cropland in the Yangtze River basin and farmers in the Yellow River basin could receive 100kg, because that the soil in the

Yangtze River basin is more fertile and the annual grain production is also higher. In 2004, the government changed the grain subsidies into cash subsidies, at Yuan 1.4 per kilo of grain, for three main reasons. Firstly, considerable order of food will lead to higher food prices and food shortages. The second reason is the high cost of transporting food in large quantities. The distribution of grain subsidies was charged by local governments, which means the local government had to buy grains form local state- owned companies and deliver grains to households. The cost of distribution brought a large financial pressure. (Cui 2009) Thirdly, change the grain subsidies into cash could prevent corruption, because some local officers brought cheap grain for households and wrote higher quality grain with more expensive price on the bill. (Cui 2009)

The farmers also receive cash payment of Yuan 20 per mu of retired land per year as living subsidies. In addition, the government also provides a one-time cash subsidy to farmers to buy seedlings at the beginning of the GfG, at 50 Yuan per mu. (State Council of China 2002).

The amount of subsidies which farmers would receive is based on the survival rate of seedlings. The Forest Bureau of China and the local GfG implementation office would send officers to intendance the survival rate to ensure farmers really planted and took care for the trees when they are still young and need attention. In the beginning, farmers only received 50% of the grain and cash subsidies and 100% of seedlings subsidies (Uchida et al. 2005). If local farmers want to receive the remaining 50% of the grain and cash subsidies, they must guarantee at least 70-85% survival rate and passed the first-year inspection (SFA 2001) (Uchida et al. 2005). Farmers who failed in the inspection could replant the seedlings in next year, and the government would pay the subsidies for this year and previous one. So the farmers could replant every dead tree and receive full amount of subsidies during GfG because the subsidies were paid retroactively. (State Council 2007)

1.4.2 Problems and deficiencies of compensation

Some literatures mentioned the corruptions have occurred during GfG. For example, Xu and Cao (2002) reported that the government's payment system was not adopted in some areas. Zuo et al. (2003) did a research about whether the payment were actually gave to participating farmers and found that farmers didn't receive the full compensation in several cases. Xu and Cao (2001) did a survey among 1,026 households, and found that only 50.5% had received fully subsidies and 31.9% had received partial and 17.6% had received nothing at the time of the survey. And some evidence shows that there was a significant shortfalls in compensations actually delivered to the farmers (Bennett, 2008). However many researchers argued that the shortfalls could have many reasons and not 100% blame to the corruptions. Bennett (2008) pointed out that the compensation of GfG is not end during the time of surveys, some retired farmland may have not been certified by the local GfG implementation office yet. In some cases, local government deducted some subsidies to hire laborers to help farmers to plant trees, or to pay for back-taxes owed by the farmer or other administrative cost (Xu and Cao 2001; Zuo et al. 2003).

In 2004, the central government of China recognized seriousness of the corruption problem, which some officers in local authorities were siphoning off the subsidies, and changed the method of paying (Delang and Wang 2013). From that point, the compensations were transferred directly into farmers' bank account through the Rural Credit Cooperative. In this case, farmers could easily check how much money they received because all the compensations were recorded in their passbook. And farmers have rights to sue the local government or the Forest Bureau if they didn't receive full amount of subsidies. In this way, the government could ensure farmers' benefits, decrease the risk of corruption, and increased the transparency of compensation system of GfG (FDOGX 2006).

In addition to the government's own corruption problem, the compensation method of GfG also has many deficiencies. For example, some researchers pointed out that making compensation conditional on the survival of the trees has some negative consequences. Yin et al (2005) pointed out that some farmers usually planted trees at a very high density to make sure that enough trees survived. In this case they can easily reach the government's

standard so as to claim 100% of subsidies. However, the trees would take longer time to grow if the density of the forests is too high. And the quality for such forests are unsatisfied because the canopies of trees are too close, which also lead to a lower ecosystem functionality and higher vulnerability (Yin et al. 2005). Trac et al. (2007) monitored several countries and reported that the average density for seedling is 148 seedlings per mu, equals to one seedling for every 4.5m2 or 2,220 seedlings per hectare.

1.4.3 Ecological and environmental impact of GfG

Till now there is no nationwide assessment of the ecological impact of the Grain for Green, so it can only be gauged from case studies in selected regions. Most studies mentioned that the biodiversity index of soil fauna was significantly higher in converted forestlands and significantly increases with the increase of vegetation species.

Liu et al, (2011) selected 4 different reforestation patterns (mixed forest of multiple tree species, fast grown forest, interplant forest with trees and medicinal plants, and mixed forest of bamboo and broad leaved trees) comparing with farmlands in Ruichang city, Jiangxi province to detect the diversity and the composition of insects. The result shows that the number of insects and insect species richness in reforestation land are significantly higher than farmland. Liu et al, (2011) conclude that the insects' diversity significantly increases with the increase of vegetation species.

Li et al, (2012) did a research on the variations of the community composition and individuals' number of soil fauna in limestone red soil region of Ruichang city, Jiangxi Province after six years of converting cultivated lands into forestlands． They selected three type of converted forestlands (mixed forest of multiple tree species, mixed forest of bamboo and broad leaved trees and tree-seedling integration land) comparing with cultivated lands. The result shows that the biodiversity index of soil fauna was significantly higher in converted forestlands than in cultivated lands, and was the highest in mixed multiple-species forestland and the least in tree-seedling integration land. (Li et al, 2012)

In addition, most studies concur that the physical properties of the soil, including soil fertility, porosity, and nutrients, have improved, and soil erosion and river sedimentation have slowed down.

Luo et al. (2003) examined changes in Boluo Village of Qingzhen Town (Guizhou Province) over 3 years. In total 50 soil samples were collected from land with 15°, 25° and 35° slope, with and without GfG reforestation. Not surprisingly, the researchers observed that runoff became more severe when the degree of land slope increased. Reforestation reduced the loss of soil nutrients due to runoff, and led to a recovery of soil fertility: organic matter, nitrogen (N), phosphorus (P) and potassium (K) all increased after the GfG was implemented, although there was no significant change in the pH value.

Table 2 Amount of Yellow Soil Nutrients with and without GfG.

Land Use	pH	Organic Matter (k/kg)	Total nitrogen (k/kg)	Total potassium (mg/kg)	Total phosphorus (mg/kg)
Without GfG	5.46	24.76	1.42	618.5	105
With GfG	5.38	26.46	1.62	725.8	110

*Source: Luo et al. (2003)

Yang et al. (2006) analyzed the effect of soil and water conservation on cropland that returned to forest in Wuqi county (northern Shaanxi Province, and not very far from Dingbian) through field observation and experimental studies. Both the physical and chemical characteristics of the soils greatly improved after implementation of the GfG, in particular the bulk density of the soil (Table 3) and its chemical characteristics

(Table 4). Yang et al. (2006) concluded that returning cropland to forest and prohibiting grazing in mountainous areas are the most effective approaches to control soil erosion and water loss in the Loessy Hills region.

Table 3 Bulk density of soil of different depth before and after the GfG (g/cm3).

Depth	Before the GfG				After the GfG			
	Trees	Shrubs	Grass	Average	Trees	Shrubs	Grass	Average
0-20cm	1.45	1.40	1.42	1.42	1.30	1.27	1.38	1.32
20-40cm	1.43	1.45	1.49	1.46	1.30	1.32	1.29	1.30
40-60cm	1.38	1.47	1.48	1.33	1.21	1.31	1.27	1.26
60-80cm	1.46	1.48	1.53	1.49	1.28	1.33	1.23	1.28

*Source: Yang et al. (2006)

Table 4 Chemical characteristics before and after the GfG.

Land Use	pH	Organic Matter (k/kg)	Total nitrogen (k/kg)	Total potassium (mg/kg)	Total phosphorus (mg/kg)
Before GfG	5.46	24.76	1.42	618.5	105
After GfG	5.38	26.46	1.62	725.8	110

*Source: Yang et al. (2006)

Feng, (2014) selected three land-uses types including planted forest, waste land and crop land from Mafang Village of Changwu County at Weibei dryland to detect the changes of soil organic matter. Feng (2014) found that the content of soil organic matter were higher at forest and waste land than those of crop land and conclude that soil quality was improved after the crop land converted to forest.

1.4.4 Farmers' income

Many studies have found that farmers' net income has been improved after participating in GfG. In 2000, Uchida et al.(2005) conducted a survey of 144 participating households in 16 randomly selected villages in Ningxia and Guizhou. The result shows that the average real net income of households saw a significant increase since they participating in the GfG program. From 1999 to 2000, the average real net income of farmers in Ningxia Province increased from Yuan 2694 to 3969, and it increased from Yuan 3961 to 3969 in Guizhou Province, with a growth rate of 75.75% and 8% respectively. However, Uchida et al.(2005) also point out that most of the increase of income was due to subsidies form the government. Peng et al. (2007) also did a research on participants' net income in Zhangye City in western Gansu Province by assessing the costs and benefits to farmers, and found that the net income of participants increased over time. The composition and structure analysis of total income from 2002 to 2004 shows that, farmers' main sources of income are government subsidies and migrant workers' income, accounting for 49.15% and 40.10% of total income respectively. There are also other sources of income include 9.29% from local wage, 1.27% form livestock and 0.19% form seedling fees (Peng et al. 2007). Peng et al.(2007) concluded that GfG freed labor form agriculture and increased the migration, which helped transforming the local economy.

Zhang and Liu (2005) did a research about the impact of GfG in total incomes in Hebei Province, Shanxi Province and Inner Mogolia Province form 1998 to 2003, and found a positive impact on farmer's income. However the income growth generated by GfG is much slower than the descriptions by Peng et al. (2007), form 1.8% in 2000 to 25% in 2003. Xu et al. (2010) used a survey in three provinces where the GfG was first implemented to examine the implementation and impact of GfG and lead to a similar result as Zhang and

Liu(2005). Xu et al. (2010) found some evidence shows that GfG has positive impact on farmers' total income, especially in the income of cropping and husbandry. However, same as Zhang and Liu (2005), this result is still not enough to support the government's claim of great success of GfG (Xu et al. 2010).

Shi and Wang (2011) did a long-term economic assessment of Mizhi County, which is located in the northern part of Shaanxi Province, the result did not support Uchida et al. (2005)'s discovery that farmers' income was highly dependent on government subsidies. The purpose of Shi and Wang (2011)'s study is to determine whether GfG changes the income structures of rural households after 10 years' implement. The results show that the income of migrant workers contributes the most to households' income, nearly 50% of households received more than 50% of their net income from migrant works, which is far more than government's subsidies. The reason is that most young farmers choose to work in urban areas or find jobs locally after losing their land.

Table 5 Composition and structural change of household incomes over time

Year	Quantity (Yuan)					Percentage	
	Total	Agriculture	Off-farm	Subsidy	Other	Agriculture	Off-farm
Shaanxi							
1999	3848.0	2413.7	1108.3	326.0		0.63	0.29
2000	4,375.6	2,533.4	1,320.9	521.3		0.58	0.30
2001	4,501.7	2,566.9	1,426.7	508.1		0.57	0.32
2002	5,187.8	2,653.5	1,714.6	819.8		0.51	0.33
2003	5,400.5	2,458.7	1,739.8	1,201.9		0.46	0.32
2004	6,091.3	2,688.0	1,863.7	1,539.5		0.44	0.31
2005	7,290.6	2,388.5	2,764.4	1,854.1	283.6	0.33	0.38
2006	8,205.9	2,819.3	3,163.5	1,928.8	294.3	0.34	0.39
2007	9,294.7	3,130.5	4,178.6	1,493.8	491.9	0.34	0.45
2008	9,825.4	2,880.7	4,589.9	1,783.6	571.2	0.29	0.47
Sichuan							
1999	4,951.2	3,108.2	1,762.4	80.5		0.63	0.36
2000	5,580.3	3,217.5	2,111.0	251.8		0.58	0.38
2001	5,948.2	3,286.7	2,380.0	281.5		0.55	0.40
2002	6,591.0	3,439.6	2,747.9	403.5		0.52	0.42
2003	7,196.1	3,616.9	3,053.4	525.8		0.50	0.42
2004	7,709.0	3,881.8	3,261.4	565.8		0.50	0.42
2005	7,570.0	3,427.4	3,163.3	723.4	255.9	0.45	0.42
2006	8,540.3	3,847.2	3,651.6	767.0	274.4	0.45	0.43
2007	11,571.5	5,070.5	5,616.2	594.8	290.0	0.44	0.49
2008	12,445.6	5,316.8	6,157.8	554.4	416.6	0.43	0.49

*Source: Yin and Liu (2011)

*"Other" means local welfare compensation and assistance to the poor and disabled. *Unit: Yuan in 1994 constant price

Yin and Liu (2011) conducted multiple rounds of surveys with longitudinal dataset of two provinces in western China, Shaanxi and Sichuan. The data set covers 1461 households in six counties in two provinces for 10 consecutive years, from 1999 to 2008. As shown in table 9, although agricultural income showed an increasing trend from 1999 to 2008, the growth rate was far lower than off-farm income. Total household income in Shaanxi Province increased from 3849 Yuan in 1999 to 9825 Yuan in 2008. The off-farm income had made the greatest

contribution to this increase, which rose from 1108 Yuan to 4590 Yuan during the same period. On the other hand, agricultural income increased only 480 Yuan (Yin and Liu 2011). The situation was similar in Sichuan, with total incomes increased from Yuan 4,951 in 1999 to Yuan 12,446 in 2008. And the greatest contribution to the increase was made form off-farm income as well, which rose from Yuan 1,762 to Yuan 6,158, while agricultural income increasing more moderately, from Yuan 3,108 to Yuan 5,317. Overall, the share of agricultural saw a decline in both provinces, form 63% to only 29% in Shaanxi, and form 63% to 43% in Sichuan (Yin and Liu 2011). (Table 5)

Comparing with Sichuan province, there are more households in Shaanxi province participating GfG and more land were retired than in Sichuan province, so households in Shaanxi got tremendous benefits. According to Yin and Liu (2011), households in Shaanxi received an annual subsidy of up to Yuan 1,929 on average in 2006, which account for almost 23.5% of their total income in that year. In contrast, although participants in Sichuan can receive Yuan 70 per year more subsidy per mu, but the number of households and the area of in the land enrolled in GfG are less than that of Shaanxi, which brought less benefits. The average subsidy in Sichuan in 2006 was Yuan 767, accounting for 9% of the total yearly income (Yin and Liu 2011).

Table 6 Impact of the GFG on net household income and sources of income in Dunhua County.

County		Net annual income per capita (Yuan)	Income change	Source of income (Percentage)			
				Agriculture	Off-farm	Livestock	Economic Crop
Dashan	BP	2804	-31%	79.9	12.8	7.3	11.8
	AP	1924		69.5	17.1	13.4	24.5
Emu	BP	1980	9%	79.8	8.3	11.9	17.3
	AP	2156		62.7	17.4	19.9	22.7
Guandi	BP	2482	-13%	73.5	17.7	8.8	24.4
	AP	2152		73	16.7	10.3	35.4
Heishi	BP	1966	-15%	73.2	12.2	14.6	2.1
	AP	1664		59.4	15.7	24.9	3.5
Hongshi	BP	1023	57%	83.5	11.2	5.3	21.1
	AP	1606		82.2	12.0	5.8	25.6
Huangnihe	BP	2945	33%	78.7	17.8	3.5	61.9
	AP	3931		74.3	22	3.7	70.5
Shaheyan	BP	2820	25%	69.8	27.3	2.9	18.6
	AP	3532		64.5	32.1	3.4	28.4
Xianru	BP	1879	42%	73.7	11.9	14.4	37.6
	AP	2668		62.7	15.5	21.8	43.3
Average	BP	2237	13%	76.5	14.9	8.6	24.4
	AP	2454		68.5	18.6	12.9	31.7

*Source: Wang and Maclaren (2011) Note: BP = before GfG (1999), AP = after GfG (2003)

However, some researchers found that the income of participant households also experienced a decline in some areas. For example, Wang and Maclaren (2011) conducted a survey in Dunhua County located in the Changbai Mountains in northeast China and found that 58% of the households joint GfG felt that their income had declined after the program began. Table 6 compare the net income and the structure of income changes before and after joint GfG.

In the study of Wang and Maclaren (2011), the overall average net income of households has a growth of 13%, but in three of the eight townships it declined. Farmers in Dashan Township experienced the largest absolute and percentage decline (31%) in net income. The net income between the participating plots and the non-participating plots shows no significant difference ($p > 0.05$) in seven of the eight townships. Only in Xianru Township, the net income from the plots set aside was more than double that from participating plots. Wang and Maclaren (2011) also found that households with declining incomes are more likely to claim that government action has forced them to convert their land. Families with higher income and more economic resources to cope with changes were apt to a more positive view of land use conversion.

However, Uchida et al. (2007) argued that only looking at families participating in the GfG is not sufficient, because GfG is not necessarily the only reason for the increase in average income and asset value and it is very likely that the income of non-participants also increased. Therefore, the changes of both income levels and the income structure of participants and non-participants should be expected because of three reasons:

1. The overall income level of China's residents has increased during the period of GfG.
2. The GfG program had brought financial input to villages or countries, thus changing the opportunities available to families in the area.
3. The prices of goods or labor changes with the passage of time.

Thus, simply observing participants' income over time is, to some extent, unreliable, because we cannot assume that all changes are cause by GfG, and such research method is likely to bring some misleading information.

Some researchers compared the changes among participants and non-participants living closely in a certain period. Xu, Bennett et al. (2004) compared income changes between participants and non-participants in three provinces of China, Shaanxi, Gansu and Sichuan between 1999 and 2003. The results show that, the average net income growth rate varies widely among the three provinces. In Shaanxi, the income growth rate of participants and non-participants is almost the same. In Gansu, the income growth rate of participants was slightly slower than that of non-participants. In Sichuan, the income of participants grew much faster than that of non-participants. However, the overall statistical analysis shows that the impact of GfG on participants' income was no significant difference with non-participants.

Xu et al. (2010) found that participants would shift more investment, both money and labor, from corpping to animal husbandry, proving that GfG did contribute to the restructuring of agricultural production. In Shaanxi, the cropping income of non-participants grew by 35%, but that of the participants increased only by 12% (including subsidies). In Gansu, the income of both participants and non-participants declined, at 26% and 32% (including subsidies) respectively. And the cropping income of both groups in Sichuan dropped by 30% (Xu et al. 2010). On the contrary, the growth rate of animal husbandry of participants was higher than that of non-participants. In Shaanxi, the average household per capita income from animal husbandry increased by more than 1,055%, while non-participants only increased by 183%. In Gansu, participants' income from animal husbandry increased by 1783%, while non-participants only increased by 600%. In Sichuan, this number was 837% and 500% respectively (Xu et al. 2010). However, the total income between participants and non-participants in different regions does not change regularly. Xu et al. (2010) reported that in Shaanxi, the total income of participants and non-participants increased by 41% and 42% respectively; in Gansu, this number was 2.3% and 12% respectively; in Sichuan, the number was 26% and 17% respectively. Xu et al. (2010)'s results in all three provinces are different with this thesis.

Yao et al. (2010) pointed out that, the impact of GfG on the income growth and labor migration depends on the project extent, local economic development and government leadership. Therefore, the income growth for cropping and husbandry, thus total income, in different regions can be expected to be various.

Yao et al. (2010) chose three counties, Wuqi, Dingbian and Huachi, located on the Loess Plateau to investigate changes in households' income between 1999 and 2006. These three counties are adjacent but belong to different jurisdictions, so as to reflect the variations in political environment, project extend and economic development.

Table 7 The jurisdictions of three countries.

County	City jurisdictions
Wuqi	Yan'an municipality, Shaanxi province
Dingbian	Yulin municipality, Shaanxi province
Huachi	Qingyang municipality, Gansu province

*Source Yao et al. (2010)

Table 8 Per capita average income of surveyed households in Wuqi, 1999 and 2006

Type of income	Non-participating households		Participating households		Between group income difference	
	1999	2006	1999	2006	1999	2006
Crop production income	5,591	5,788	3,733	4,653	1,859**	1,136
Animal husbandry income	1,162	1,948	3,575	1,409	-2,413**	539
Off-farm income	2,475	2,916	10,404	13,785	-7,930	10,869***
Other income	0	5,411	61	6,778	-61	1,367
Total income	9,228	16,064	17,773	26,625	-8,544***	10,561***

Source: Yao et al. (2010)

Notes: ***, ** represent significance levels of 1 % and 10 %, respectively.

Table 9 Per capita average income of surveyed households in Huachi and Dingbian, 1999 and 2006

Type of income	Non-participating households		Participating households		Between group income difference	
	1999	2006	1999	2006	1999	2006
Crop production income	2,176	4,511	2,475	4,615	-299	-104
Animal husbandry income	2,371	1,591	1,358	1,265	1,012	326
Off-farm income	6,409	5,568	6,642	9,912	-234	-4344
Other income	1,459	1,708	487	535	972***	1,172**
Total income	12,414	13,379	11,962	1,6327	1,452	-2,948

Source: Yao et al. (2010)

Notes: ***, ** represent signifi cance levels of 1 % and 10 %, respectively.

In August 2007, Yao et al. (2010) conducted a survey of 200 randomly chosen households in each of the three counties, including basic household characteristics, production, consumption, income, and farmland retirement and conversion. The data revealed that there was little difference in the number of laborers, the average amount of education in years, and the average age of household head between participating and non-participating households. On the other hand, noticeable differences existed in family size, cultivated land, and years of schooling of household heads (Yao et al. 2010). Yao et al. (2010) surveyed 200 randomly selected households in three counties, and collected data form household characteristics, crop and animal production, consumption, income and farmland conversion. The data show that there is no significant difference between the number of

labors, the average number of years of education and the average age of participating and non-participating families. However, there are significant differences in household size, cultivated land and education level of family leader. Table 8 and table 9 illustrate the per capita average income of surveyed households in Wuqi, Huachi and Dingbian, 1999 and 2006.

Yao et al. (2010) divides income into four categories, including agriculture (coming from producing corn, potatoes, and other minor crops), animal husbandry (raising livestock, predominantly goats), off-farm income (construction work and service work in local towns or large cities), and other sources (family properties, poverty alleviation or other subsidies form the government). Then they studied the changes in different sectors and used the Different-in-Different model to detect the impact of GfG. Table 8 compares per capita income of the participant and the non-participant household groups in Wuqi in 1999 and 2006. Except for participating households' income from animal husbandry, all categories of income increased during the period under consideration. Both groups have increased their agricultural income and the income gap between the two groups has decreased. In 1999, the crop production income of the non-participants was higher than that of the participants by Yuan 1,859 while in 2006, the gap between the two groups was reduced to Yuan 1,136. It seems that the production efficiency of the participating households has been greatly improved, for the crop production income saw a considerable increase even though the cultivating land was reduced (Yao et al. 2010).

The income of animal husbandry increased for the non-participating households, but decreased a lot for the participating households, from Yuan 3575 to Yuan 1409.Both groups have increased their income form off-farm employment, but comparatively participants had increased more. However, Yao found that before the implementation of the GfG project, the income of the participants was higher than that of the non-participant. From 1999 to 2006, the two groups of households had increased almost the same amount of other income (Yao et al. 2010).

The results of families surveyed in Huachi and Dingbian was similar but a little difference with of Wuqi. In 1999, the crop production income of participating households was slightly higher than that of non-participating households, while it was roughly the same in 2006. Considering that participating households has a considerable amount of land converted, we can conclude that participating households can greatly increase the productivity of the remaining land. Animal husbandry income also has slight differences in the three counties. In Wuqi County, the income of animal husbandry of participating households was reduced by more than half, while it only decreased slightly in Huachi and Dingbian. However, different form Wuqi, the income of animal husbandry of non-participants also declined in these two countries. The authors speculate that the decline in non-agricultural income of the non-participants of farmers may be due to their concentration of more labor in crop production. The results show that the income of the non-participating households only slightly increased, while the income of the participating households increased significantly. In 1999, the income of the participating families was slightly lower than that of the non-participants. However, in 2006, the participating families had already reversed this situation, and their income was much higher than that of the non-participating households.

Yao et al. (2010) also tried to incorporate both internal and external variables to study the impact of GfG by finding the econometric relationship between various source of income and different variables and found that (Table 10, 11):

For the crop production income, all of the variables contribute positive effects and add up to a significant increase at Yuan 1240. Without considering the impact of other variables, participating GfG contributed Yuan 131.11 for crop production income compared to non-participating households, which is not a large amount but is significant at 99% level. In addition, there are Yuan 619.3, 170.2 and 251.3 contributed by a better economic condition, a larger program extent and a stronger political leadership respectively at the 99% significance level. The education level of the household head also has a great influence on the crop production income. The data

shows that each additional year of education of the household head brings Yuan 83.55 on Crop production income (Yao et al. 2010).

Table 10 Regression results of income and off-farm employment based on the model with specific variables for regional variation

	Crop production income	Animal husbandry income	Off-farm income	Other income	Off-farm employment	Total income
Status of participation	131.11	-2445.52	3170.06	382.16	0.09	5397.04
	6.23	-2.67	1.54	0.14	3.05	3.87
Economic condition	619.27	202.64	187.94	-269.32	0.25	286.52
	5.90	1.04	2.63	-0.68	8.00	2.35
Program extent	170.25	73.69	62.95	-145.46	0.12	175.97
	2.57	0.63	2.63	0.05	2.15	1.97
Political leadership	251.33	68.18	55.18	-50.79	0.07	91.63
	9.08	1.14	2.16	-0.05	11.48	2.39
Education of household head	83.55	191.92	522.17	138.29	0.02	1059.97
	67.11	1.26	1.61	1.22	1.35	2.83
Family size	8.37	507.66	191.12	1309.85	0.14	1867.99
	2.11	1.05	0.19	3.63	3.60	2.02
Number of laborers	190.59	258.93	-1792.95	-498.13	0.07	1376.97
	2.07	1.62	-1.17	-0.59	1.76	3.13
Non-agricultural employment	187.41	-606.91	9191.11	126.79	****	11046.10
	21.71	-1.25	5.09	0.20	****	3.44
Per capita cultivated land	984.56	-159.15	-328.14	252.31	-0.02	231.62
	2.59	-0.34	-0.33	0.69	-4.19	0.13
Intercept	-543.62	1726.65	7536.26	-596.58	0.49	3052.57
	-0.18	0.99	0.94	-0.23	1.54	0.21
R^2	0.58	0.40	0.25	0.20	0.48	0.15

*Source: Yao et al. (2010)

According to the regression of animal husbandry income, the participation status was negatively correlated with the income of the livestock. Compared with non-participating households, the income of the participating households in animal husbandry is decreased by Yuan 2445.5 at the 95% significance level (Yao et al. 2010). Economic condition and political leadership have little impact on livestock income. Education of household head, family size and number of laborers have positive effects on animal husbandry income, but not statistically significant. Variables like per capita cultivated land and non-agricultural employment have a negative but statistically insignificant effect (Yao et al. 2010).

Off-farm income is positively related to the degree of education of parents participating in the family. Households head who have one additional education year can increase their annual off-farm income by Yuan

522.2. Participating in the GfG led to an increase of Yuan3170.1 in annual off-farm income, because the participating families had more free labor free from the farm work. And one additional Non-agricultural employment could contribute Yuan 9191.11 for off-farm income and significant at 99% level (Yao et al. 2010).

Table 11 Regression results of income and off-farm employment based on the model with no specific variables for regional variation

	Crop production income	Animal husbandry income	Off-farm income	Other income	Off-farm employment	Total income
Status of participation	122.46	-3971.27	2917.93	565.01	0.049	5026.51
	8.54	-2.57	1.52	0.49	2.29	0.87
Regional dummy	1958.19	542.02	339.88	-1127.19	0.25	1078.85
	89.73	0.35	2.10	-0.99	2.51	0.19
Education of household head	83.59	224.34	505.97	137.02	0.02	1114.41
	44.32	1.47	1.59	1.23	1.14	1.95
Family size	24.38	601.25	140.50	1311.07	0.183109	2000.34
	2.28	1.23	0.14	3.67	3.55	1.20
Number of laborers	115.83	659.75	-1476.44	-462.69	0.054522	3888.79
	13.94	1.19	-1.28	-1.15	1.99	1.89
Non-agricultural employment	197.71	-777.09	9482.34	104.49	****	10314.91
	20.86	-1.18	6.87	0.22	****	4.18
Per capita cultivated land	975.99	-128.01	-344.01	208.88	-0.03	267.79
	83.44	-0.27	-0.35	0.61	-2.50	0.15
Intercept	230.06	1056.75	5139.92	-684.59	0.29	10802.55
	3.96	0.36	0.83	-0.32	0.91	0.98
R^2	0.38	0.26	0.24	0.12	0.11	0.14

*Source: Yao et al. (2010)

Participation in GfG has a positive impact on off-farm employment, for participating in GfG will result in the transfer of 0.09 units of labor from agricultural production to non-agricultural employment, under the same conditions (significant at 95% level) （Yao et al.2010）. The education of household head have a slightly positive effect on off-farm employment but insignificant for statistical analysis. In addition, off-farm employment was positively affected by family size and the number of family laborers, and negatively affected by per capita cultivated area. Yao et al. (2010) concluded that family size, number of laborers and per capita cultivated land determined the amount of surplus labor the family has. Furthermore, households who own large cultivated area are very unlikely to cultivate intensively, which make it more difficult to have enough labor for off-farm work. The development of the local economy is positively correlated with off-farm employment as a key factor. Economic condition, program extent and political leadership has an effect of 0.45 in total, which means there is 0.45 unit of labor shift out of farming with these three variables increase by one unit. This has further confirmed the hypothesis

of Yao et al. (2010): the realized transfer of surplus farming labor depends on both internal and external conditions, coupled with program participation (Yao et al. 2010). And all the variables has a positive correlation with total income. The variables that contribute the most to total income are the Family size, Number of laborers, Non- agricultural employment and education of household head.

Although the addition of GfG has a significant positive effect on crop production income, but the extent of the effect is small compared to other variables. These results show that if better management practices and investment methods are accepted, and if there is a strong regional leader to lead farmers to change production mod, then the retired of farmland will not necessarily lead to a decline in crop yields and income. However, participating in GfG has a significant negative impact on livestock husbandry, almost ten times greater the combined positive effects of other variables. Obviously, the restrictions imposed by GfG on grazing and feeding have severely affected the livestock industry, even with local governments and farmers work hard to maintain its vitality (Yao et al. 2010).

Meanwhile, participation in the GfG has a strong positive impact on non-agricultural income and total income, and is sufficient to offset the restrictions on livestock husbandry. In addition, participation in the GfG has accelerated the transfer of local agricultural labors, which greatly stimulated off-farm employment opportunities and generated the income growth. Moreover, these positive effects have been reinforced by better economic development, larger program extent, and stronger political leadership.

1.4.5 Conclusions of literature review

According to the literature review, the Chinese government has set different amounts of compensation based on the average income of farmers in different regions. Later, the government realized that the corruption issue and adjusted the way to pay compensations. The background of political and public opinion in China a decade ago is very sensitive and not suitable for criticizing the government. So there are a few literatures mentioned the corruption exist during GfG, but nobody discussed the operation method or the amount of any corruption. Furthermore, GfG program is not end during the time of surveys. These surveys do not tell if there are still shortfalls that have not been resolved after the end of the program.

The ecological consequences of the GfG have generally been positive, especially in relation to biodiversity and the improvement of soil conditions. Most studies mentioned that the biodiversity index of soil fauna was significantly higher in converted forestlands and significantly increases with the increase of vegetation species. In addition, most studies indicated the physical improvement of soil, including soil fertility, porosity, and nutrients. Soil erosion and river sedimentation also slowed down. However, we cannot conclude that the GfG program had a positive ecological impact on all the regions because of the absence of nation-wide studies with the consideration of the diversity of ecological, climatic, and socio- economic conditions in China.

Many researchers studied the changes in income levels among GfG participants, and compared the changes to those of non-participants. The conclusions are complicated. Participants' incomes have increased in many areas, but there are still some areas where income declines. In some cases, non-participants earn more than participants and have larger increases of income. Some researchers (e.g. Uchida et al. 2005) have found that GfG subsidies constituted a relatively large part of participants' total income; while others (e.g.Yin and Liu 2011) have learned that the income from off-farm wages formed the largest part of total income. As pointed out by Yao et al. (2010), The impacts of GfG varies because of differences in leaderships, local opportunities, and environmental and ecological conditions.

2 Purpose of the study

2.1 Research aim

So far, there are still several tasks in GfG that have not been fully studied yet. First and foremost, the sustainability of GfG is still a big concern after the cut off of the national subsidies. Furthermore, very few researchers studied farmers' opinions. Most studies focused on farmers' willing of participating GfG before its implementation but no research focus on farmers' evaluation of GfG after it ended. And there is also no research that answers the question if the GfG program increased the environmental consciousness of participants.

The aim of this thesis was to find out whether Grain for Green program could bring participants enough income, better ecological environment, better environmental consciousness, satisfaction, happiness and a better life after the program ended. This research should contribute to a better understanding of the impact and the assessment of GfG program.

2.2 Research questions

1. Whether farmers could obtain enough income from the retired farmland after the national subsidies were cut off.
2. Whether GfG could improve the ecological environment in the long term after the program ended.
3. Whether farmers will continue with the land changes or revert their land back to farmland after the subsidies end.
4. Whether local farmers feel satisfied about Grain for Green program in relation to income, the environment, local policy and their current life.
5. Whether GfG program increases the environmental consciousness of local farmers.
6. Whether Participants received 100% subsidies of GfG.

2.3 Research hypothesis

1. Participants have more or similar incomes than non-participants.
2. The ecological indicators in participating villages are better than in non-participating villages.
3. Most of the participants continue the land changes of GfG and do not revert the land to pre-GfG use.
4. Participants feel more satisfied about Grain for Green program, the environment, local policy and their current life than non-participants.
5. Participants have better environmental consciousness than non-participants.
6. Participants have received 100% subsidies of GfG.

3 Material and Methods

Villages and Farmers in Dingbian County in Yulin City were chosen for data collection. Yulin has the typical ecological conditions for GfG, with severe land degradation and soil erosion. Yulin is also one of the first city that joined GfG program.

Yulin City, located in Northern part of Loess Plateau, is the northernmost city in Shaanxi province. Farmers in Yulin City had very low agricultural incomes (Hori and Kojima, 2008). In 1999 each household only has about 0.64 ha of farmland on average. In addition, the farmland in Yulin City is usually separated into small plots by fluctuant ground. Those disconnect small plots make large size machines unavailable to operate which means more time and money for cultivation. The government estimated more than 50% of farmland was experiencing desertification or located on slops in Yulin, and 68% of the farmland should be targeted by the GfG. Till 2003, there were 300 hectares of farmland and 1,812,800 hectares of devastated land had been transferred into grassland or forest. The converted land covered about 13.4% of total agricultural land of Yulin City (Hori and Kojima 2008). Till 2008, over 226,700 ha of forest had been afforested and over 2 million farmers had joint the GfG.

This thesis contains research on three aspects of the sustainability of GfG program, which are ecological aspects, farmers' income and residents' attitudes. Soil organic matter, soil pH, soil physical structure assessment and biodiversity were chosen as indicators of ecology. The impact of GfG program on residents' income and attitudes were collected by interview. Another interview with victim households was conducted in order to illustrate the details of corruption.

10 villages in Dingbian County were chosen as research objectives. 5 villages participated GfG program and 5 villages didn't. 5 different fields were selected in each village to detected ecological indicators. 5 families in each village were chosen for interview. See Table 1 for sample size.

Table 12 The sample size of this thesis

	Participant	Non-participant	Total
Villages	5	5	10
Families	25	25	50
Fields	25	25	50
Barren land	5	7	12
Farmland	11	12	23
Grassland	9	6	15

The barren lands are the abandoned lands without management. The farmlands are the lands cultivated with crops and the grasslands are the lands covered by artificial grass with management. The originally plan was to evenly distribute the sample size of each variable, however during data processing, issues will appear due to the difficulties in traffic. So fields were selected randomly in each village and two-way ANOVA method was used for data analysis. Forest is another variable in land purpose in the original plan, but the forest area in villages is limited because of corruption.

3.1 Soil analysis

Soil organic matter (SOM) plays a role of capillary rise of water, soil pore space and water retention. Soils with good percentage of organic matter allow plants to maximize recovery of plant nutrients, and raise the yield and reduce the soil erosion. 5 point of soil samples in 0-20cm soil layer were collected in each field, following five-point sampling method. That is, the center point of the diagonal line is first determined as the central sampling point, and the four points on the diagonal line which have the equal distance to the central sampling point were

chosen as the other four sample points. Then intensively mix these five samples as one and test SOM in laboratory. The soil organic matter will be tested by loss-on-ignition method. (Salehi, A.H. et al. 2011) (See appendix 8.3)

Random choose one point of each field and assess the for soil structure. Visual soil assessment (VSA) will be used to evaluate this indicator (See appendix 8.1). (Shepherd, T.G. 2009)

Soil pH shows the acid-base equilibrium inside soil, and is an indicator of plant livability. Large amount of chemical fertilizer use would break soil the acid-base equilibrium. The optimal pH in soil is the natural pH, 6-8 refer to the loess soil in the study area.

5 point of soil samples in 0-20cm soil layer were collected in each field, following five-point sampling method. Then intensively mix these five samples as one and test pH in laboratory.

International standard was used as testing method: ISO 10390:2005 using a glass electrode in a 1:5 (volume fraction) suspension of soil in water (pH in H2O), in 1 mol/l potassium chloride solution (pH in KCl) or in 0,01 mol/l calcium chloride solution (pH in CaCl2). (See appendix 8.2)

3.2 Insect survey

Pitfall traps were used to collect the insects on the ground. 1 traps transects was set on each field. Each traps transect were consist of 4 pitfalls. The first pit fall was placed in the landscape element at 1m from the field margin. The second, third and fourth pitfalls were placed in the crop at 10, 20 and 30 meters from the field margin. Then the species variety and number of insects in the trap were counted after 48 hours after placed.

3.3 Questions of Interview

5 participating village and 5 non-participating village were randomly chose in Dingbian County, and 5 families in each village were randomly selected for interview.

Table 13: Questions of Interview

Parameters	Questions
Background	How many people are in your family?
	How old are you?
	What's the education level of the head in your family?
Agricultural resource	How much land does your family have?
	How much land is retired?
	Do you have livestock in your family? How much is it?
	Do you use intensive planting in your family?
Labor distribution	How many people in your family does the farm work?
	How many people in your family work in the city?
Income	What is the crop production income of your family last year?
	What is the livestock income of your family last year?
	What is the income from migrant work of your family last year?
	What is the income from local wage or local business last year?
	Have you received full subsidies from GfG?
	Does the GfG project increase the income of your family?
Environmental consciousness	Do you support farmland retirement and stop grazing? Why?
	Do you think it is beneficial to implement GfG?
	If yes, what are the benefits?

	Now the GfG subsidy is cut off. Have you converted your retired farmland back? why?
Happiness and attitude (Score 1-10)	To what extent are you satisfied with GfG program?
	To what extent are you satisfied with environment?
	To what extent are you satisfied with local policy and political leader?
	To what extent are you satisfied with your family's income?
	To what extent are you satisfied with your life (total)?

A comprehensive score was given based on the response of local farmers to the four questions of environmental consciousness. See appendix 8.4 for the scoring criteria.

In the beginning, weather farmers convert the retired land back was regarded as one of the criteria for environmental awareness. However, most of the local farmers did not know that they had the right to convert the land back after the end of GfG. The reason is that the local government did not inform farmers that they have this right. The government's corruption issue will be discussed later.

3.4 Difference in differences (DID) model

The income and attitude of local farmers is not only affected by participating status of GfG, but also affected by subjective or objective factors. So this thesis followed Yao et al. (2010)'s method to use the difference in differences (DID) model to quantify the program's impacts on farmers' income and farmers' attitude towards GfG. The DID model could derive less-biased results and incorporate both internal and external variables into its impact determination (Yao et al. 2010). DID model could not only detected the impact from a broader set of variables but also could quantify how much impact did each variable contribute to the dependent variable.

3.4.1 Model of household's income

It is assumed that the households' income is depended on participating status, production pattern, education year of household head, the land area and land type own by the family and the amount of labor in the family. Production pattern means whether the family use intensive planting in agriculture, that is the family entrusted all the land to one or two family members. The selection of crop species of each household is not included in this model because farmers in the villages choose nearly the same corp.

The concrete model is as follows:

$$Y_i = \alpha + \beta P_i + \gamma E_i + \delta Z_i + \varepsilon F_i$$

Where Y is a dependent variable representing households' total income; i denote the household; P is a dummy variable representing the families' production pattern, taking the value of 0 for non-intensive planting and 1 for intensive planting; E is the education year of household head; Z is a group variables representing the size and type of land owned by the family such as how much land the family have, how much land of the family have the irrigation system, greenhouse area and retired land; F, also a group variables, denote the number of labor owned by the family, including the family size and off-farm employment; and α is the error term.

3.4.2 Model of farmers' opinion of GfG

It is assumed that farmers' attitude of GfG is effected by participating status, farmers' awareness of environment, and their satisfaction of income, political leader, environment and their current life. The degree of

happiness in life were used as a variable in order to make an objective result. Because people who are satisfied with their current life were expected to give a higher score than people who are dissatisfied with their current life.

The concrete model is as follows:

$$Y_i = \alpha + \beta G_i + \gamma \mathrm{A} + H_i$$

Where Y is a dependent variable representing households' attitude of GfG; i denote the household; G is a dummy variable representing the participating status whether the family participating GfG, taking value 0 for non-participating and value 1 for participating; H is a group variables representing the happiness of different aspects including income, policy, environment and their total life; andα is the error term..

All units of measurement in this thesis were using Chinese units, for 15 mu=1 ha and 7.68 Yuan=1 Euro.

4 Results and Discussion

4.1 Ecological indicators

The result of two-way ANOVA was showed as profile plots in figure 1. The mean score of visual assessment of barren land in non-participating village is 0.286 while the mean score of which in participating village is 3.800. The difference of mean score of farmland between non-participating and participating village is smaller but still significant, which is 1.750 versus 2.636 respectively. And there is also a large difference between two groups of grassland, (2.333 versus 4.667 respectively). The visual score of all three type of land has a significant difference

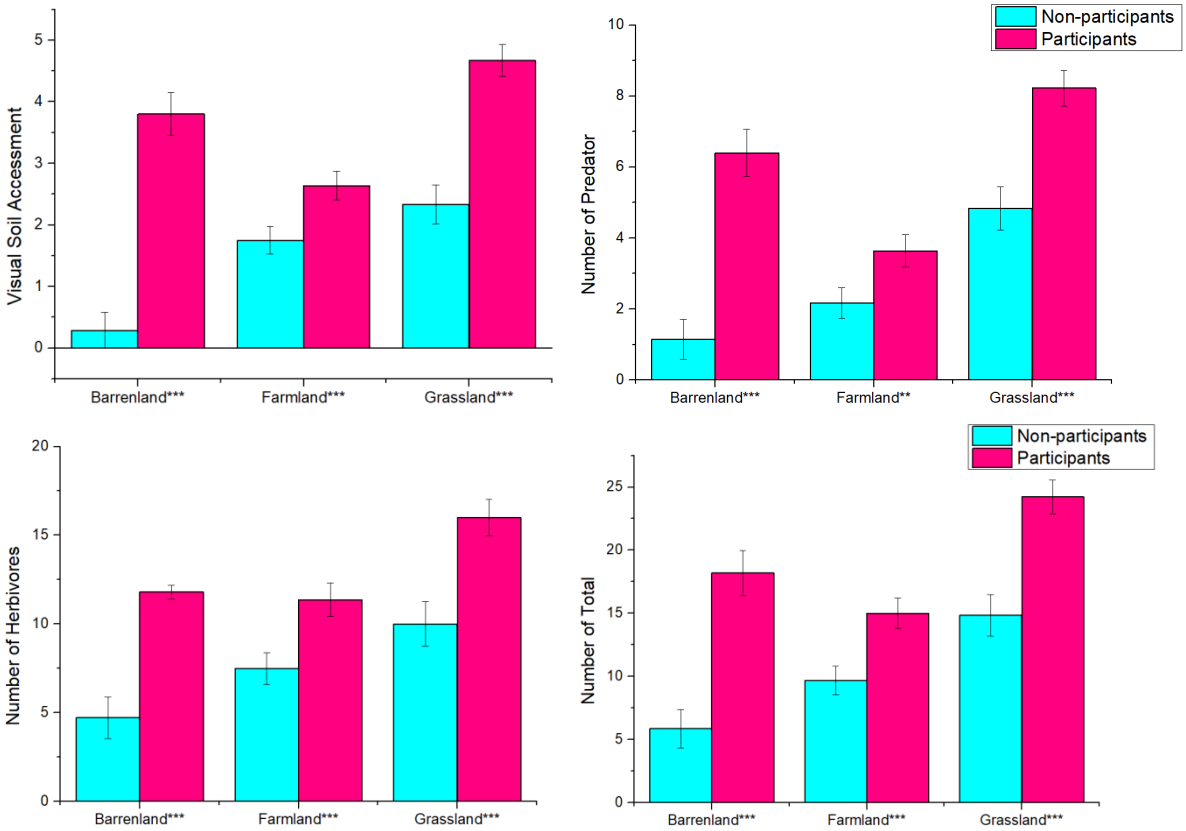

Figure 1 Result and error bars of two-way ANOVA of VSA and biodiversity

*, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

The mean numbers of predator in all three purpose of land in participating village are higher than non-participating village. The differences are 5.257 in barren land (1% significance), 1.469 in farmland (5% significance), and 3.389 in grassland (1% significance) respectively. The amount of herbivores in participating village is also larger than non-participating village. The differences are 7.086 of barren land, 3.864 of farmland and 6.000of grassland respectively, and all three differences are significant at 1% level. The total number of creatures caught by pitfalls in participating village is still significantly higher than non-participating village. The mean numbers of each purpose of land are 18.200 of participating village versus 5.857 in non-participating village of barren land, 15.000 versus 9.667 of farmland and 24.222 versus 14.833 respectively, and all the differences are significant at 1% level.

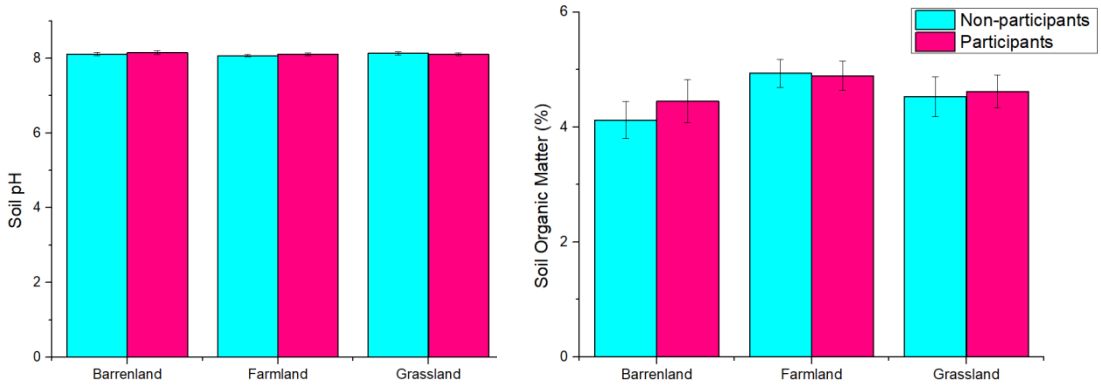

Figure 2 Result and error bars of two-way ANOVA of pH and Soil Organic Matter

*, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

For the chemical characteristic of soil, although there are some differences of soil pH between participating and non-participating villages, but there is no significant in statistics. And the pH differences among three type of land do not have any statistic difference as well. The soil organic matter don't have a statistical significant between participating village and non-participating village. The only significant difference we can observe form soil organic matter is between barren land and farmland in non-participating village (at 5% level), because farmers add organic manure in there farmland.

4.2 Farmers' income

Table 14 Independent t-test of income

	GfG	N	Mean	Sig. (2-tailed)
Income per person per year	Non-participants	25	12075.12	.019
	Participants	25	7757.74	
Corp Income per mu	Non-participants	25	569.95	.019
	Participants	25	263.96	
Family's total income	Non-participants	25	93630.00	.004
	Participants	25	55508.00	

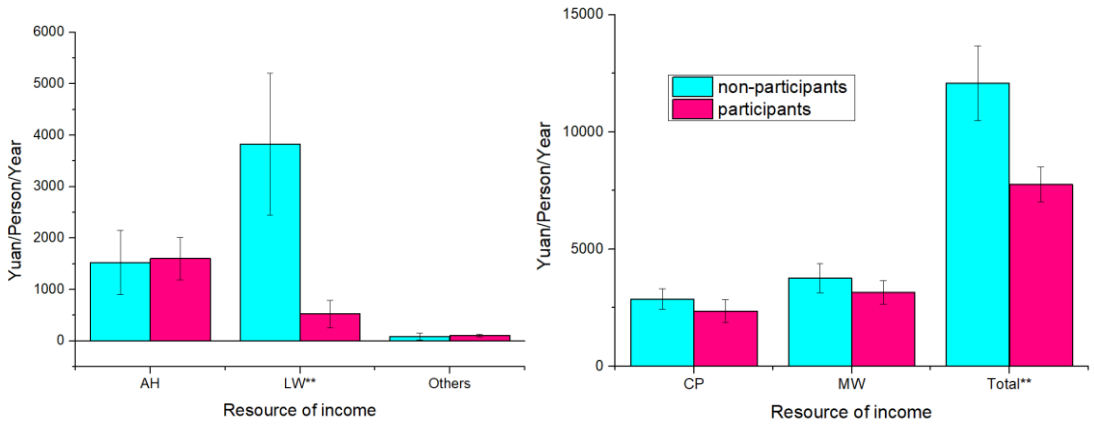

Figure 3 Error bars of different resource of income per person per year.

Vertical axis represents the amount of income, for 7.8 Yuan=1Euro. AH means animal husbandry; LW means local wages; CP means crop production; MW means migrant work; *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

According to independent t-test, the mean of annual real income per person of Non-participants in 2016 is 12075 Yuan, which is significantly higher than Participants (7758 Yuan). And the Mean Corp Income per mu of Non-participants is also significantly higher than Participants, with 570 Yuan versus 264 Yuan. The mean family's total income for non-participants is 93630 Yuan and that for participants is 55508 Yuan (significant at 1% level). The income structure of these two groups, which described in Figure 3, is also different.

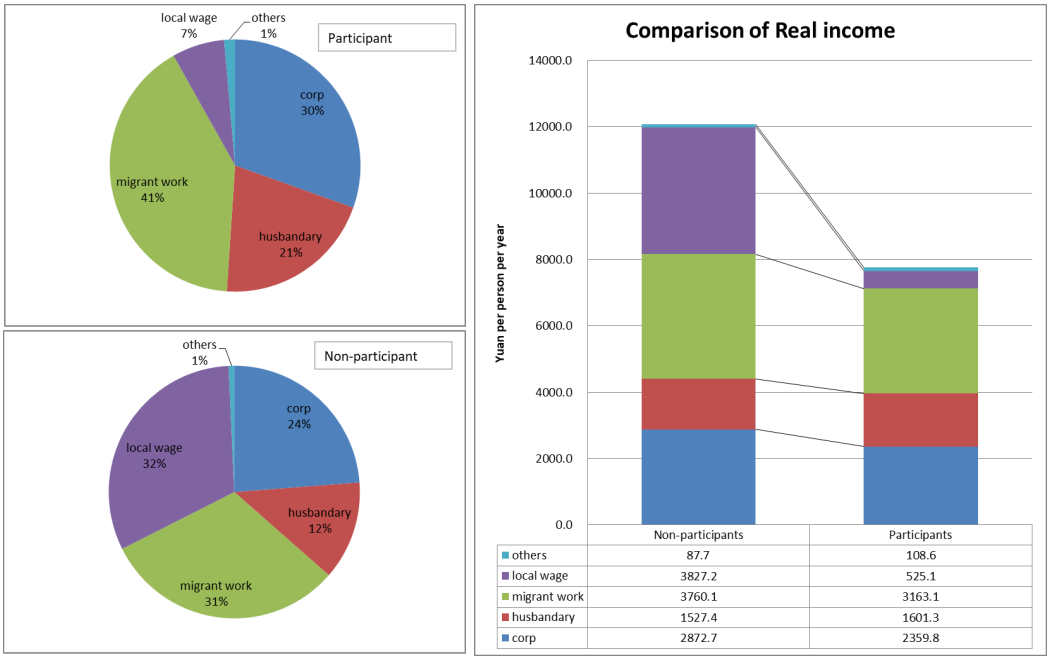

Figure 4 The income structure of participants and non-participants.

Crop production income comes from producing corn, potatoes, and other minor crops; animal husbandry income comes from raising livestock, predominantly goats; migrant work income is the salaries form working in large cities; local wage is the income from construction and service work or local business; other income is derived from sources such as poverty alleviation subsidy

According to the survey, the main source of income of households is corps, livestock, migrant work and local wage. The pie charts describe the composition and structural difference of household incomes between program participants and non-participants in 2016. Migrant work was the primary income of the households participating GfG, which takes 41% of total income. Corp and husbandry contribute 30% and 21% of total income respectively, while only 7% was attributed to local wage. For Non-participant group, migrant work is still one of the largest sources of income, but its share is much smaller than it is in Participant group, which only takes 31% of total income. And local wage accounts for another large proportion of income of Participant group, which takes 32% of total. The income generated by Corp accounts for 24% of total, which does not have a big difference compared to Participant group. But husbandry's share of income of Non-participants is lower than Participants, at only 12%.

However, during my interview, many farmers said corruption and many injustices had been encountered in the process GfG, which is discussed in 4.6. Meanwhile, due to government's corruption, participation in GfG has had a significant negative impact on farmers' income. The main purpose of the Chinese government's subsidy to farmers is to hope that farmers can obtain income through the established forest after the subsidy ends. However, in the selected villages, most of the farmers did not receive government subsidy for tree seedlings. Consequently, villagers missed an important source of income.

The bar chart and the error bar chart disaggregate the real revenues per capita for participating and non-participating households. Compared to participants, non-participants were able to gain a higher level of total revenue. Not surprisingly, non-participants earned about 1.5 times as much income on crops as participants, because considerable amounts of the farmland of participants were transferred into forest and grassland (significant at 10% level). The income form husbandry and migrant work for these two groups were approximately equivalent. However, there is a significantly difference in local wage.

The average local wage of non-participants in 2016 was 3827.2 Yuan, about 7 times that of the participants (525.1 Yuan). Some of the interviewees mentioned that, more and more households chose to cooperate with emerging agricultural service companies for intensive and mechanized cultivation. Those remaining labors choose to find part time work or do business locally, which contribute more income to their family. However, most of the participating villages are located on sloping lands and hilly areas, which lead to a worse transportation than non-participating village. Furthermore, a large amount of farmland in the participating villages has been retired, and the government conceals farmers' right that they can convert the land back to pre-GfG use. So there are more people in participating villages choose to migrant to big cities and fewer people stay at home, which resulting in the reduction of local business opportunities. According to the interview, 28.9% of people in 25 families in non-participating villages are migrant to big cities, while in participating villages the percentage is 36.2%. In conclusion, fewer needs of intensive cultivation, inconvenient transportation and less population caused the remaining labors in participating villages hard to find jobs or do business locally.

4.3 Environmental consciousness and Farmers' satisfaction

Table 15 Independent t-test of environmental consciousness and happiness.

	Non-participants	Participants
Environmental consciousness	1.60	1.76
Satisfied with political leader and policy	3.60	3.52
Satisfied with current life	6.96***	5.06***
Satisfied with environment	5.84	6.24
Satisfied with income	3.94	3.50

*, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

The independent t-test shows that there are no significant difference between non-participants and participant in Environmental consciousness, which means joining GfG program didn't significantly increase farmers' awareness of environment. The happy of political leader and policy also don't have significant difference between participants and non-participants, which are predictable, because all the villages are belong to same county and has a same policy. But the both participants and non-participants gave a very low score of political leader and local policy. However, there is a considerable difference of happiness of current life between two groups, which significant at 1% level. It seems that whether to participate in the program is one of the important indicators that affect the overall happiness of local farmers. The happiness of environment and income between non-participants and participants don't have a significant difference. Although non-participants have significantly higher income than participants, but the satisfaction of income between two groups don't have a significant difference. It seems that the relative high income of non-participants still fail to meet their need or desire for living, so both groups gave low scores (around 3.7).

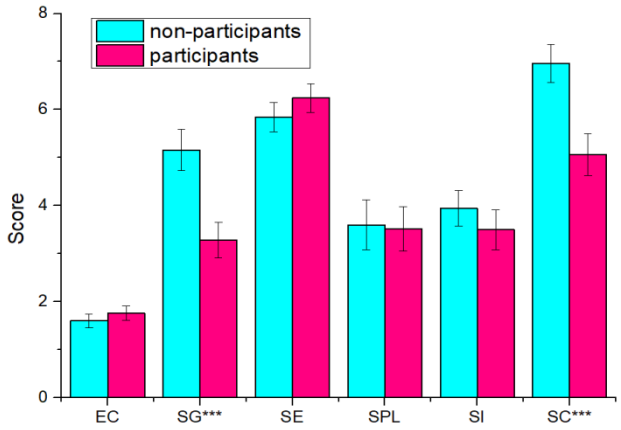

Figure 5 Environmental consciousness and Farmers' satisfaction.

EC means Environmental consciousness; SG means Satisfied with Grain for Green program; SE means Satisfied with environment; SPL means Satisfied with local policy and the political leader; SI means Satisfied with family income; SC means Satisfied with current life; *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

4.4 Sustainability of land changes

Whether the farmers will continue with the land use changes is an important indicator of sustainability of GfG program. Some researchers afraid that farmer would cut down the trees for short-term profit or revert the land back to the pre-Grain for Green land uses once the subsidies end (Hori and Kojima 2008).

According to my interview, although most of participating farmers are dissatisfy with their income brought by GfG (they scored 3.5 out of 10 on average), but no household revert their land back. The main reason of this situation is not that farmers do not want to replant on their land, but that the do not know they have this right. The government of Dingbian County has concealed that local farmers could choose to replant on their land after the Grain for Green program end.

4.5 Difference in differences model

4.5.1 Income

Table 16 Linear regression of total income.

	Total income （Yuan/year）
P: Production pattern	18324.51(1.913)*
E: Education year of household head	4638.19(3.920)***
Z_1: Total land own by the family (mu)	281.80(1.688)*
Z_2: Land with irrigation system (mu)	395.02(1.145)
Z_3: Greenhouses (mu)	-5477.20(-.824)
Z_4: Retired land (mu)	-1097.23(-3.330)***
F_1: Family size	5591.61(3.933)***
F_2: Off-farm employment	2949.30(1.201)
α： Error	-36675.44(-2.770)***
R^2	0.776

*First row is the name of variables and the second row is the estimated coefficient, and the figure in the brackets is the t statistic value. *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively. All units of measurement were using Chinese units, for 15 mu=1 ha and 7.68 Yuan=1 Euro.

Production pattern means whether the family use intensive planting in agriculture, that is the family entrusted all the land to one or two family members. Land with irrigation system means how many mu of land in this family could have artificial irrigation but not rely on the rain. Greenhouses means how many mu of greenhouses the family owned. Retired land means how many mu of land has joint the GfG program and convert to grassland or forest. Off-farm employment means the number of people in the family don't do the farm work but migrant into cities or get jobs locally.

First and foremost, the production pattern has a considerable positive effect on households' income. Households who adopt an intensive planting model earn Yuan 18324.51 more than households using a conventional production model, which significant at 10% level. Secondly the education year of household head also has a significant positive effect on families' income, with one more year of schooling leading to an increase of Yuan 4638.19, which significant at 1% level. Unsurprisingly, the land area owned by the family also has a positive influence on the income, for each extra mu of land in the family could contribute Yuan 281.80of income (significant at 10% level). The irrigation land area also have a positive effect on income but not significant. However the result shows that greenhouse area has a large negative effect on income, but not significant. A possible reason for this result is that only one family in 50 families adopts greenhouse cultivation and lead to an insignificant and negative coefficient. The area of retired land has a considerable negative influence on households' income, for one extra mu of retired land lead to a decrease of 1097.23 Yuan which significant at 1% level. This result shows that participating GfG have a negative impact on households' income. Furthermore, family size has a large positive effect on the income, for each more people in the family contribute 5591.61 Yuan of families' income (significant at 1% level). The influence of off-farm employment on the total income is also positive, with each off-farm employment could contribute 2949.30Yuan of income but not significant.

The error term α is -36675.44 and significant at 1% level which means there are still some other variable could influence the income and not included in this model. For example, the economic condition of the migrant city should largely influence the income. Apparently the people who migrant to Shanghai(one of the biggest city in China) will get better salaries than those people migrant to Yanan(a small city near Dingbian, Yulin) with similar personal ability. In addition, the ability to seize business opportunities is also an important variable in determining households' income. For instance, Mr. Han's family in Jiayaoxian village (one of the participating village), has opened an agricultural service company and sell pen technologies (how to feed the sheep and goats in captivity) to local farmers. Mr. Han's family earned an average of 13333 Yuan per person in 2016, which is an extremely high income in the villages surveyed. However, those variables are very difficult to quantify or collect data, so they are not contented in this model.

4.5.2 Households' attitude of GfG

Dependent variable Y is based on the score of the question "To what extent are you satisfied with GfG program?" representing households' attitude of GfG. Participating status is a dummy variable representing the participating status whether the family participating GfG; Environmental consciousness is the score of the environmental consciousness evaluation according to several questions, see appendix 8.5 about the scoring criteria and the details. The propose to add this variable is to determine whether people with a high environmental consciousness will give a different score comparing to low environmental consciousness people. H is a group of variables representing the happiness of different aspects including income, policy, environment and their total life. The scores of H are according to the questions "To what extent are you satisfied with environment?" "To what extent are you satisfied with local policy and political leader?" "To what extent are you satisfied with your family's income?" "To what extent are you satisfied with your life (total)?" respectively.

According to the Households' attitude regression, the evaluation of GfG by local farmers was significantly influenced by the participation status, environmental consciousness and local political leaders and all these three sets of data are significant at 1% level. Participating status have an enormous negative effect on households' attitude, for participants scored 1.549 points less than non-participants on average. This result shows that there are very big problems in the implementation of the GfG project, which has led to the dissatisfaction of participating households. Secondly, environmental consciousness also has a considerable negative effect on farmers' evaluation. It seems like the higher environmental consciousness the farmer has, the lower score he (or she) will gave on GfG, which means people with a better environmental consciousness could find more shortcomings of GfG program. Farmers with a high level of environmental awareness gave 0.746 points lower than those with medium environmental awareness on average. Farmers with medium environmental awareness also scored 0.746 points worse than farmers with low environmental awareness. This result shows that farmers with high environmental awareness are more likely to discover the defects of the GfG project. The evaluation of local political leaders is also an important variable that influences the evaluation of the GfG program. When the score of political leaders rises 1 point, the evaluation of the overall project will increase by 0.65 (significant at 1% level). In the same way, if the public is dissatisfied with local political leaders, such as corruption, the evaluation of the overall project will also have a significant decline.

Table 17 Linear regression of household's attitude

	Households' attitude
G: Participating status	-1.549 (-4.505)***
A: Environmental consciousness	-0.746 (-3.112)***
H_1: Satisfied with income	0.125(1.197)
H_2: Satisfied with political leader and policy	0.650(7.410)***
H_3: Satisfied with the environment	0.038(0.352)
H_4: Satisfied with current life	0.063(0.745)
Error	2.864 (3.079)***
R^2	0.801

*First row is the name of variables and the second row is the estimated coefficient, and the figure in the brackets is the t statistic value. *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively.

4.6 Interview with victims of government's corruption

In order to investigate the corruptions, three families were appointed to discuss this issue. They are all victims of government corruption. According to the interview, the corruption of GfG almost covered the entire township. Although most of farmers were more or less affected by corruption, but most people are reluctant to take risks to fight against the local government.

In 2003, when the local government of Xuezhuang Township received the state policy, it chose to block the news at the first time. Instead of broadcasting the policy of GfG to the public, it notified a small number of people who had "Guanxi", a Chinese word which means the people use their personal relationship to gain illegal profit, with the government officials. These people went to contact the local farmers as soon as they got the information of GfG and try to lease the farmers' land by fair means or foul. Many local farmers thought their sloping and barren land were low-producing and choose to lease their land for a long time at a very cheap price of 20-30 yuan / year / mu, and the subsidy for GfG was 180 yuan/year/mu. Then the "Guanxi" people got a large area of leased

land to claim the project of GfG and got huge amount of subsidies from the local government. When farmers received the news of GfG, the “Guanxi” people had already transferred large areas of land.

By using this type of method, which not only avoids the supervision from the central government, but also did not violate any existing laws at all, because the “Guanxi” people are also farmers and have the right to participate in GfG, and the victims could not find the evidence to prove the local officers really received money from “Guanxi” people.

When farmers who did not sign leasing contracts with “Guanxi” people wanted to claim their land for GfG, and some farmers who leased part of their lands to “Guanxi” people wants to take more lands to declare GfG because of the considerable subsidies, but their subsidies were withheld by the local government, only 60% of the subsidy is received. In contrast, “Guanxi” people who occupy farmers' land can get 150% of the subsidy from the government.

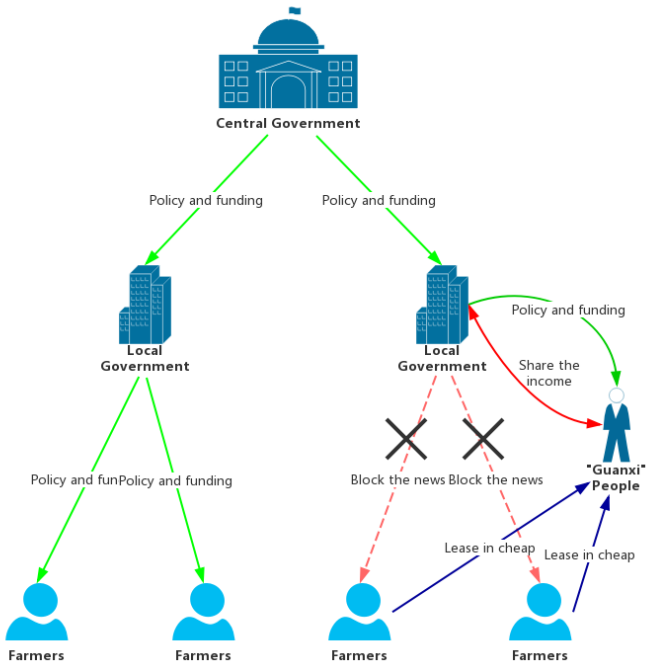

Figure 6 The model of corruption of Xuezhuang Township government in Dingbian County.

The left side is the official distribution method of policy and subsidies of GfG. The right side is the distribution method in Xuezhuan Township.

Furthermore, interviewees mentioned that some officer form Xuezhuang Township also siphoning off the seedling subsidy which should have paid to the farmers. First of all, those officers released pressure to the local farmers about their obligations in GfG that farmers must ensure the survival rate of the trees. And the government would be imposed heavy fine if the trees died too much. However, they could offer an opportunity for local farmers who do not want to pay the fine. Secondly, they compared the different subsidies for retiring the farmland to grassland and forest. The households who return their land to forests could get cash subsidy at 180 Yuan/mu/year for ten years and one-time seedling subsidy at 50 Yuan/mu. The households who return their land to grassland only get cash subsidy at 180Yuan/mu/year for only three years with no seedling subsidy. Thirdly, they ask local farmers to “cooperate” with them, which means if local farmers do not plant any trees in their retired land but claimed those land as forests, and help them to cheat to the Forest Bureau, they will give farmers 50% of seedling subsidy, 60% of grain subsidy for 10 years and help those farmers to pass the inspections. Instead of realizing the income that a grown forest could bring, many farmers simply choose to get cash and avoid the labor

work for planting and taking care of trees. However, farmers who did not want to “cooperate” with those officers did not receive their seedling subsidies and full gain subsidies as well. Those officers said they can choose a discount subsidies or nothing. Consequently, only “Guanxi” people get the seedling subsidies and a large amount of retired land claimed as forest was still remained as grassland. See appendix 8.5 for the photographs

The interviewees said they did not believe they would win the local government in the court because of the lack of law knowledge and low education level. So they prefer sending representatives to Beijing to petition to central government.

The central government accepted the petition and gave the local government in Xuezhuang Township a serious warning and ordered local government to issue subsidies to farmers. However, the local government ignored the order and changed nothing. In addition, local government even sent one of the representatives into the prison for 10 days with no reason.

The interviewees said that people from the township government had been stalking the villages and restricting them to visit Beijing again since they returned from Beijing for a long time. Farmers had also found Medias to report their dilemma. That the township government was very humble towards the media, but no practical action has ever been taken to solve the farmers' problems. Until the point of this interview, local farmers have not received the subsidies they deserve from GfG yet and the corruptors remain unpunished as well. This is one of the main reasons for the local farmers' dissatisfaction with the policy.

Does the local government know the dissatisfaction from local farmers? And how does the local government solve the problems mentioned in GfG? Some interviews inside the local government were conducted to show the government’s opinion and efforts for GfG. See appendix 8.6 about the details.

5 Synthesis

5.1 Ecological indicators

The mean creatures caught by the pitfall in all three purpose of land in participated village are significantly higher than non-participated village ($P<0.01$). In participated village, grassland has the largest biodiversity, followed by wasteland and farmland. In non-participated village, grassland also has the largest number of creatures caught by pitfall, but the number in farmland is higher than it in the barren land. The reason is because biodiversity in the ground is higher with more vegetation species and better vegetation coverage. And this result is similar with Liu et al, (2011) and Li et al, (2012).

Figure 7 The barren lands in participating village (Chengjuan village, left) and non-participating village (Wangzhaizi village, right)

In non-participated village, the barren lands are normally abandoned farms because of the heavy soil erosion and desertification with bared soil. The barren lands in participated village are also abandoned farms but fail to claim the GfG. These lands also have no management even though they normally have less desertification because of the weed coverage.

The result shows that GfG program did significantly increase the biodiversity and the physical soil structures, but the soil chemical characteristics didn't have a significant difference between participated and non-participated villages. This result is different with Luo et al. (2003), Yang et al. (2006) and Feng, (2014). According to the three literatures, we can conclude that with proper management, GfG program has significantly improved the physical and chemical characteristics of the soil. The explanation for the different result would be that the chemical properties, such as organic matter, of the soil require years of accumulation. However, due to corruption issues in the selected villages, the retired land has not been properly managed. Most of the land that should be changed to forest was only grassland, and no one maintain it regularly. See appendix 4 about the photographs according to the GfG contract, those lands should be all covered by forests, but basically grass only.

Most of the lands in participated village are covered by weeds, but most of the lands in non-participating village are exposed. If vegetation coverage was used as another indicator of ecological and environmental impact of GfG, it can be expected that there will be very significant differences between the participated and non-participated village. The satellite photographs, which can be used for village scale GIS analysis, are over budget for this project. The relatively high vegetation coverage benefits the restoration of the soil physical characteristics such as soil structure and soil porosity in participated villages because of the root system of the grass. Although the VSA (Visual Soil Assessment) method is a subjective measurement, it is also a simple, rapid, and effective method to evaluate soil physical characteristics. Moreover, better vegetation cover provides habitat for insects and predators, resulting in the biodiversity in participated villages significantly higher than it in non-participate villages in all three different purpose of lands.

5.2 Economic indicators

The key to achieve GfG's long-term goals is whether it generates financial incentives for participants. So the minimum subsidy required by the GfG can at least offset the opportunity cost of the retired land. Once the subsidy is over, farmers should earn more from their forests than farmland before GfG or farmers would revert their land back. Although the government of Dingbian County has concealed relevant rights of farmers, but this thesis cannot indicate that there are related issues in other regions.

According to the literature review, the GfG has not increased the income of all farmers in all regions, the introduction of GfG still has brought about a certain degree of restructuring of the local economy (Wang and Maclaren 2011). In general, household income is still dominated by agriculture. But the importance of agricultural income has declined after the GfG was introduced, because some agricultural land has been converted to grassland or forests, resulted in a decline in overall agricultural income. Agricultural income accounted for 76.5% of total household income on average before the implementation of GFG and for 68.5% after. Unexpectedly, off-farm income increased very slightly, from 14.9% to 18.6%, which may indicate that most of the existing opportunities in the local area have already been taken, and that local residents rarely have migrant people working in cities (Wang and Maclaren 2011). On the other hand, the contribution of animal husbandry income increased from 8.6% to 12.9% on average, which is a very important source of income in some counties such as Heishi, Xianru and Emu. Compared with other sources of income, the contribution of economic crops income, including tobacco, flax and other crops, to total income has a considerable increase.

The result of this thesis shows that the non-participants have significantly more total income, which is consistent with some literatures (e.g. Xu,(2004) and Bennett et al. (2004)) The most significant difference in

income between the two groups comes from wages. The average local wage per person of non-participants is about seven times of participants. This result is inconsistent with most literatures that can be found. Major reason would be the different level of transportation and remaining labors. Most of the non-participate families choose to cooperate with agricultural service companies and using intensive and mechanized cultivation. Those remaining labors choose to find part time work or do businesses locally thus create local jobs for more people. However, most of the participated villages are located on slope lands and hilly areas. Large amounts of the cropland were retired, which means more difficult to find local agricultural and machinery service. In addition, more people in participating villages choose to migrant to big cities and fewer people stay at home, which results in the reduction of local business opportunities.

The result of linear regression of this thesis shows that the production pattern, education year of household head, land owned by the family and the family size have a significant positive impact on total income. This result is partly consistent with Yao et al.'s (2010). And the area of retired land has a significant negative impact on total income, which means participating GfG considerably decrease the households' income.

Although Yao et al. (2010) also studied at Dingbian County, but the result is still different with this thesis. The reason may because:

1. The latest data of Yao et al. (2010) is collected on 2006 but the data in this project is collected in 2017. In 2007 the Chinese government adjusted its subsidy policy and started a new round. The state of the local economy may have changed a lot in ten years.
2. Yao et al. (2010) didn't mention the corruption issue nor the specific township where the data was collected. They data of Yao et al. (2010) may not collected in Xuezhuang township or the corruption may occurred in the new round after 2007.

There are many internal and external factors that can affect the income of farmers. So the diversity of findings should not be surprised, given the social and environmental heterogeneity of China. According to the literatures discussed above, GfG program has had a positive impact on the income of most farmers in most areas. But in Dingbian County, GfG have a large negative impact on incomes in participated farmers. The most significant variables which effect in household income in Dingbian County are the production pattern, family size and education year of household head. According to Yao et al. (2010) we can believe that government corruption has a great negative impact on residents' income, but my study only covers one county in Shaanxi Provence, so we cannot figure out the specific extent of the effect. But it is enough to conclude that the corruption is the main reason leading to the reduction of residents' income and evaluation.

5.3 Farmers' happiness awareness and the attitude on the GfG program

The result shows that non-participants give a significant higher score on the happiness of current life, which means participating GfG program decrease the happiness of current life. No significant differences was found on the happiness regarding to the environment, which indicates that participants didn't feel that GfG has improved their living environment. The satisfaction of income and the policy between two groups don't have significant difference. The environmental consciousness between two groups has no significant difference as well, which means the GfG program did not significantly increase the farmers' awareness of improving the environment.

Linear regression of households' attitude of GfG shows that participants are more dissatisfy with GfG program. And people who satisfy with political leader and policy are willing to give a higher score of GfG program. This result indicates that households' attitude are largely affected by local leader. And people with a high environmental consciousness are more likely to discover the shortcomings of GfG program.

During the interview, many farmers mentioned corruption and many injustices that encountered in the process GfG. Corruption had an unimaginable long-term impact on local farmers' long-term incomes and environmental

rehabilitation. So we can conclude that the corruptions still exist during the implement of GfG program. This result matches with Du (2012), who argued that the corruptions did not completely disappear. Du (2012) also pointed out that the abuse of power by officers in local authorities had increased during GfG. According to the interview in the government, the government actually knows that there are many problems in the implementation of the GfG, and that farmers are dissatisfied with the government. The government is offering free agricultural technology guidance and provides subsidies for new technology to compensate for the deficiencies in the program. Although the lecture was not well received by local farmers, but we can see the government's efforts on it.

6 Conclusion

The GfG program did significantly increase the biodiversity and the physical soil structures, but the soil chemical characteristics didn't show significant difference between participated and non-participating villages. The main reason is the chemical properties of the soil, such as organic matter, require years of accumulation. However, due to corruption issues in the selected villages, the retired land has not been properly managed. Most of the land that should have been planted as forest is only grassland, and no regularly maintenance was kept. The GfG program in Dingbian County has significantly improved some ecological indicators which can be improved in the short term.

Meanwhile, due to government's corruption, participation in GfG caused a significant negative impact on farmers' income. The main purpose of the Chinese government's subsidy to farmers is to hope that farmers can obtain income through the established forest after the subsidy ends. However, in the selected villages, most of the farmers did not receive government subsidy for tree seedlings. Consequently, the forest had never been grown and the villagers lost an important source of income. Furthermore, more and more non-participated households chose to cooperate with emerging agricultural service companies for intensive and mechanized cultivation. This greatly improved production efficiency and liberated the workforce. Those liberated labors choose to find part time jobs or do some local business, which contribute income to their family. The participated villages are located on sloping lands and hilly areas, and a large amount of farmland in the village has been retired. In addition the government conceals farmers' right that they can convert the land back to pre-GfG use and lead to more people choose to migrant to big cities and fewer people stay at home. The worse transportation and fewer populations bring fewer opportunities than non-participated village. Consequently, the participants have significantly less income than non-participants after the program has ended.

The attitude of farmers to GfG program is largely influenced by the satisfaction of local political leaders, which lead to participating farmers has a lower evaluation on GfG program than non-participants due to corruption issue. Participants also have significant less satisfaction on current life. The happiness of the environment of participants is slightly higher than non-participants but not significant, same as the environmental consciousness. Both groups have low satisfaction with income. Although participants were dissatisfied with the income, but no one revert the land back to the pre-Grain for Green land uses when the subsidies end because no one knows they have the right.

However, comparing to the huge area that GfG covered, this project only covered 10 villages in one county. Thus the conclusion cannot illustrate the impact of corruption for the entire GfG program. However, it is clear that there are many management problems exist during implementation. Without the government corruption problem, the Grain for Green program could have spent less money to achieve the same effect, or spend the same amount of money to achieve better results.

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8 Appendix

8.1 Visual soil assessment (VSA)

1. Discuss the visual indicators we use to tell if a human or animal is healthy (sufficient energy, body shape). Explain that a visual soil assessment (VSA) uses visual indicators as a way to assess soil quality (health).

2. Read the article Soil properties and discuss soil structure and soil porosity with students.

3. Discuss the land use and land cover around the school. Sites might include areas of heavy use such as playing fields, walking paths between buildings and undisturbed spots like out-of-bounds areas or along the fence lines. Draw out students' ideas about how land use may have affected the soil.

4. Choose two sites to test – the first from a relatively undisturbed area, the second from a high-use area.

5. At the first chosen site, spread the sheet of plastic out and place the plastic box next to it.

6. Dig out a 20 cm cube of topsoil with the spade. (Many spades are approximately 20 cm in width so cut a square with the spade to remove the soil.) Place this cube of soil to one side – it is no longer needed. Using the edge of the hole as one side, make three more cuts to create a second cube.

7. Hold the soil cube at the height of 1 metre. Drop it a maximum of three times into the plastic box. Empty the broken soil from the box onto the plastic sheet each time the soil cube is dropped. If any large clods break away after the first or second drop, drop them individually again once or twice. If a clod shatters in small pieces after the first or second drop, it does not need to be dropped again. Don't drop any piece of soil more than three times. Gently separate each clod from the roots. Part it by hand along any visible cracks.

8. Transfer the soil onto the large plastic bag and grade it so that the turf is at the top, followed by the coarsest clods and moving down to the finest aggregates (the crumbs) at the bottom. This provides a measure of the aggregate-size distribution. Have students compare the resulting distribution of aggregates with the three photographs in Visual scoring of soil structure under pasture and record the visual score on the student handout VSA scorecard.

9. Remove a spade slice of soil from the side of the hole. Fold it in half lengthwise to break it into two pieces. Examine the exposed face for soil porosity. Have students compare it with the three photographs in Visual scoring of soil porosity under pasture and record the visual score.

10. Have students carefully sort through the soil sample used to assess soil structure and count the earthworms, paying particular attention to the root section, and record the visual score on the VSA scorecard. Use the photograph in Visual scoring of earthworm count under pasture as a reference.

11. Return the worms to the hole. Cover with some loose soil. Mark the hole with a sports cone to alert others to an unsafe site. Leave the plastic sheet of aggregates where it is.

12. Move to the second site. Dig out the 20 cm cube as before. Mark the hole with a sports cone. Take the cube of soil from the second site back to the first site. Repeat the visual soil assessment. Place the two plastic sheets of soil side by side and discuss any differences.

13. Photograph the results (optional). Return the soil to both holes. Place the turf on the top and step on it firmly so the turf is level with the ground.

Reference: Shepherd, T.G. (2009). Visual Soil Assessment. Volume 1. Field guide for pastoral grazing and cropping on flat to rolling country. 2nd Edition. *Horizons Regional Council, Palmerston North*. 119 p.

8.2 Determination of pH by potentiometry

1. **Principle of the method**
   The pH is measured with a pH/mV meter. After extraction (See chapter 1) of the air-dried soil sample the pH is measured in the settling suspension.
2. **Range and detection limit**
   The pH between 3-11 can be measured.
3. **Interferences**

No interferences are expected.

4. Precesion and accuracy

The reproducibility of determinations by this procedure in two seperately prepared suspensions shall satisfy the following demands:

pH range	Acceptable variation
pH < 7	0.15
7.00 < pH < 7.50	0.20
7.50 < pH < 8.00	0.30
pH > 8	0.40

5. Apparatus

5.1 pH/mV meter.

5.2 Combined electrode.

6. Reagents

6.1 Buffer Solution, pH 4.00 (20°C).

6.2 Buffer Solution, pH 7.00 (20°C).

7. Procedure

Measure the temperature of the suspension and take care that the temperature of the buffer solutions and the soil suspensions, differ not more than 1°C. Shake the suspension thoroughly just before the measurement and measure the pH in the settling suspension. Read the pH after equilibrium has been reached. Note the values to 2 decimal places.

Remark:

- Equilibrium may cosidered reached when the pH measured over a period of 2 seconds varies not more than 0.02 pH unit. The time taken to establish equilibrium is usually a minute or less, but may depend on number of factors including:
- The value of the pH, at high pH values it is more difficult to reach an equilibrium.
- The differences in pH between samples.
- The quality of the electrode.

8. Calibration and standards

Calibrate the pH meter as described in the manufacturer's manual, using the buffer solutions pH 7.00 and pH 4.00.

9. Effects of storage

Store the moist soilsamples at 4 degrees Celsius, but not too long.

Reference: ISO 10390:2005, Soil quality, Determination of pH by potentiometry.

8.3 Determination of organic matter by loss-on-ignition

1. Principle of the method

a) The organic matter of the soil and plant samples is assessed gravimetrically by dry combustion of the organic material in a furnace at 500-550 °C. the loss in the weight gives an indication of the content of organic matter in the sample.

2. Apparatus

a) Drying oven

2.2 Furnace, capable of producing and maintaining a temperature of at least 500°C.

2.3 Weighing balance

3. Procedure

a) Heat a crucible during 1 hour in a drying oven at 103°C. Weigh the empty crucible hot at three decimals (A).Then weigh out precisely about 20 g soil in the crucible (W).
b) Put the crucible into the drying oven at 103°C, for at least 8 hours. Weigh the hot crucible with the dry sample (B).
c) Put the put the crucible in the furnace and raise the temperature gradually from room temperature to 550°C. Maintain this temperature during at least 3 hours. Then cool off the furnace to about 150°C and put the crucible in the drying oven at 103°C, for about 1 hour. Then weigh the hot crucible with the ash (C).

4. Calculation

First the dry matter content of the sample can be calculated in %:

$$\frac{B-A}{(A+W)-A} * 100\%$$

The organic matter content of the sample in % is:

$$\frac{B-C}{B-A} * 100\%$$

Reference: Salehi, A.H. et al.(2011) *Refining Soil Organic Matter Determination by Loss-on-Ignition* (Pedosphere, Vol.21), 4, 473-482

8.4 The scoring criteria of environmental consciousness

8.4.1 High environmental consciousness (Score 3)

The interviewed people can realize the benefits to the environment from GfG program; can realize the benefits of environmental improvements for their lives; and can give one or two examples. They support GfG not because the subsidies. They can treat the defects in government's management and the benefits of the beneficial of the GfG project itself respectively. They have a positive attitude for environmental restoration programs.

Example:

What do you think of GfG? Do you support farmland retirement and stop grazing?

Chinese: 退耕还林是个好项目，应该做。我年轻的时候没有水也没有电，那时候人们为了活命就使劲砍树，砍了以后烧柴、炼铁、最后把森林砍光了，也没有人管。坡地上的林子砍光了，就在坡上放羊，最后羊把草也啃光了。我就一直觉得，我们这一代的人把山把林子吃干净了，那下一代的人靠什么生活？现在政府让我们种树，绝对是好事，给子孙后代留个活路。

Translate: GfG is a good project and it should be done. When I was young, there was no water and no electricity. At that time, people tried hard to cut down the trees in order to survive. We burned wood, made iron, and finally cut down all the forest but no one managed it. People grazing sheep on the slopes after trees were cut off. Finally, the sheep emptied the grass. I have always felt that people in our generation consume mountains and forests, and what would the next generation depend on? Now that the government has let us plant trees, it is absolutely a good thing to leave a living method for future generations.

Do you think it is beneficial to implement GfG?

Chinese: 有好处，肯定有好处。别的不说，这几年风沙比以前小多了。 而且现在我们这边的地都种不了庄稼，太贫瘠，也没水浇地，全靠化肥撑着。很多时候一亩地就收 100 斤荞麦，还不够肥料钱。所以很多人都不种地了，把家里的地荒着，他自己进城打工去。现在国家帮你种树，还给你补贴。我们等于是拿着国家的钱给咱自己的孩子造福。咋不好？

Translate: There are definitely advantages and benefits to implement GfG. Most obviously, in recent years the sand storm was much smaller than before. The land in our area is now too barren to grow crops and there is not enough water to irrigate. Farmers have no choice but rely on fertilizer only. Usually, the yield of buckwheat is 50 kg per mu (equals to 750kg per ha), which is not even enough to pay fertilizers. So many people choose to migrant and working in cities, with their land abandoned. Now the nation helps us grow trees and give us subsidies. We are holding the nation's money for the benefits of our children. Why is it bad?

Now the GfG subsidy is cut off. Have you converted your retired farmland back? Why?

Chinese: 你这娃娃不懂事，都收了国家的钱了怎么可能把地再改回来。本来种树种草就是因为国家关心咱们老百姓，结果补贴没了你就想把树砍了。我不干这事，丧良心。

Translate: Be moral, kid. Since we have received the money of the government, we must keep our promise. The only reason that the nation introduces this policy is taking care about people's future life. It is immoral to cut down trees after subsidies end. I won't do it.

Did you know that this is a national policy and that you have the right to convert the land back to its original purpose after the GfG project?

Chinese: 你这娃娃净在这胡说，别的政策我不懂，退耕还林我能不懂吗。你看现在乡政府成天号召封山禁牧跟植树造林，谁砍树放羊就罚谁，政府怎么可能让你再把地种回去。

Translate: Stop nonsense kid. The GfG policy is the only one policy I familiar a lot. Now the township government has advocated every day to ban grazing, planting trees and afforestation. Whoever cuts trees and graze sheep will be punished. It is impossible that government allow you to replant on the retired land.

If, if the government allows you to convert your land back, will you?

Chinese: 允许也不会，现在种草没有钱，种地就有了？国家发展经济，就为了能给老百姓一口饱饭。现在日子好了，国家给各种补贴能让你吃饱饭，你要是想吃肉喝酒，那得靠自己努力。国家不可能给你补贴一辈子吧。娃娃我给你讲，咱们不能占国家便宜，该种树就种树，该种草就种草，没有补贴也种。这些积下来都是阴德福报。

Translate: I won't. The income from cropping is not much stronger than grassland (nothing). The country develops its economy in order to keep people away from poverty. Now that our life is good, the state can give various subsidies to keep the people away from starvation and cold. But if you want to eat meat and drink wine, you have to work hard on your own. The state can't give you subsidies for a lifetime. Kid I tell you, we cannot covet for the small benefits that should not be obtained. I will plan grass and trees even without subsidies.

8.4.2 Medium environmental consciousness (Score 2)

The interviewed people can realize the benefits to the environment from GfG program and can give one or two examples. But they **cannot** realize the benefits of environmental improvements for their lives or next generations. They **do not** treat the defects in government's management and the benefits of the beneficial of the GfG project itself respectively. They hold a negative attitude for GfG or environmental restoration if they are not satisfied with subsidies.

Do you support farmland retirement and stop grazing? Why?

Chinese: 你要问我支不支持，不支持，肯定不支持，但是我说了也不算。

Translate: If you ask my personal opinion, my answer is no. I am not support it, but I am not in charge.

Why don't you support it?

Chinese: 因为退耕还林没有意义，退了的耕地又不能种，现在国家也不给钱了。

Translate: Because It does not make any sense to return farmland to forests. The land is no longer available since retired, and now the subsidies are cut off.

So do you join GfG? Have you return any farmland to forest or grassland?

Chinese: 我们没有，我们村子都不参加的，政府不给名额。但是我大闺女家退了二十多亩，都是草地，本来政府说要种林子，结果一直都没种起来。

Translate: My family didn't join GfG, actually all this village can't participating GfG. But my first daughter's family has about 20 mu of retired land, all of them are grassland. The government planned to grow trees in the land, but till now there are no trees.

Do you think it is beneficial to implement GfG?

Chinese: 要是说一点好处没有也不对。现在咱们的土地越来越瘦，种上草种上树养个几十年估计土地还能变肥。现在政府种林子种了十几年了，风也小了，都是林子把风挡住了。但是我觉得咱们政府看不到老百姓需要什么。给下一代造福？能造啥福？下一代的人谁还种地？我跟我老伴辛辛苦苦一辈子，就是为了能把娃娃们送到城里上学。然后在城里工作找对象。你看看现在农村，没有水，没有电。前几年刚刚通上电了，但是电费贵的用不起。自来水管也修了，但是水管里不淌水，就放那好看。要我说，这些生活问题不解决，收入问题不解决，我们根本养不起下一代。活着都困难，谁还考虑死了以后刮不刮风下不下雨？

Translate: We cannot say that returning farmland to forests has no benefit at all. The land here is becoming increasingly barren, and if landed with grass and trees for decades, it is estimated that the land will become fertile again. Now the government has planted forests for more than ten years. It is obviously that wind is smaller than before because the forests have blocked the wind. But I think our government does not know what the people really need. Benefit to next generations'? Why? Who in the next generation wants to stay here and do farming? My wife and I worked hard all my life to send the children to school in the city, hoping them working and getting married in the city after graduate. Look at the countryside now, no water, no electricity. A few years ago, electricity was just connected, but the electricity bill was too expensive to use. The water pipe was also repaired, but the water pipe was not drowning, just look good. I think that we cannot even raise next generation if the government does not solve the problems of life and income. Who is still thinking about the environmental problem after dying if it is difficult to live?

8.4.3 Low environmental consciousness (Score 1)

The interviewed people **cannot** realize the benefits to the environment from GfG program even with a hint. They also **cannot** realize the benefits of environmental improvements for their lives or next generations. They **do not** treat the defects in government's management and the benefits of the beneficial of the GfG project itself respectively. They hold a negative attitude for GfG or environmental restoration if they are not satisfied with subsidies.

Do you support farmland retirement and stop grazing? Why?

Chinese: 国家政策嘛，我肯定是支持的，不支持也没办法。

Translate: It is a national policy, so I have to support it, with no other choice.

So personally you don't support GfG, if it's not a national policy?

Chinese: 对，不支持。我们把耕地都退了，那我们家吃什么？

Translate: No, I am not support it. Where does our family's income come from, with all the farmland retired?

So do you join GfG? Have you return any farmland to forest or grassland?

Chinese: 退了 30 亩，但是没种树，全都是草地。只有关系户才能种树。

Translate: There are 30 mu of land retired, but all of the land are return to grassland, no forest. Only people who have relationship with government officers could get trees.

Why are you joining GfG, if you don't support it?

Chinese: 因为当时觉得国家给的补贴很多，有粮食还有钱，比种地的收入高多了。后来国家不给粮食了，全都换成钱。再后来补贴的金额一直没变但是钱都毛了。现在补贴都断了，我就是觉得被政府坑了。

Translate: Because in beginning, the state gave a lot of subsidies, including food and money, which was much higher than the income of farming. Later, there was no food anymore and all subsidies were replaced by money. The amount of subsidy hasn't changed since then but the price of goods has been increasing. Now, all the subsidies have been cut off. I just feel that I had been cheated by the government.

Do you think it is beneficial to implement GfG?

Chinese: 对国家有好处，但是对咱老百姓一点好处都没有。

Translate: It is beneficial for the government but not for people at all.

What kinds of benefit do you think the nation could gain form GfG?

Chinese: 土地回收啊，以前的土地都是归老百姓种的，现在国家给你几个钱就把土地收回去了。

Translate: I think that the nation is doing this to confiscate farmers' land with quite low expense.

Do you think GfG is benefit to the environment?

Chinese: 环境能有啥变化，我在这个村子里过了一辈子，人都是那些人，事都是那些事，有啥变化？

Translate: I lived in this village for my whole life, with same people and same things. Why would the environment change?

No no, I am talking about the natural environment rather than the social environment. Do you think there are any changes for natural environment?

Chinese: 是，草和树多了很多，以前山坡坡上看着光秃秃的，现在绿了不少。

Translate: Yes, there are more grass and trees than before. The hill looks bald in the past and now it looks green.

Do you satisfy with these changes?

Chinese: 说不上满不满意，不当吃不当穿的。

Translate: I don't know. It (vegetation coverage) cannot buy food or clothes.

Now the GfG subsidy is cut off. Have you converted your retired farmland back? why?

Chinese: 我是想过把土地转换回去，但是政府不让啊。所以那些地现在就在那里荒着。其实荒着就荒着吧，前些年还好，这几年庄稼都不值钱，不种还好，种地还净赔钱。

Translate: I thought about converting the land back, but the government didn't allow it. So those lands are now abandoned. Actually I don't care whether the lands are abandoned or not, because the crop harvested in the land are not enough for fertilizer these years.

8.5 Pictures of farmers' land and GfG contract

Figure 8 The picture of farmers' GfG contract (left column) and the photograph of farmers' land (right collum).

According to the GfG contract, these lands should be all covered by forests, but basically grass only.

8.6 Government's opinion and efforts for farmers' dissatisfaction, prohibition of animal grazing as an example

Some farmers mentioned that the government has introduced prohibition of animal grazing to protect the environment and that all herding must be kept in captivity. However, the sheep in captivity requires higher feed quality and are highly susceptible to diseases. Local farmers do not have the means to raise enough fodder for captivity and are not able to take risks as well. As a result, many farmers choose to graze secretly, or to reduce the number of sheep for inadequate feed supply. But the government does not consider the difficulties of local farmers. Once grazing is discovered, the government will confiscate some of the farmers' sheep or impose heavy fines, thus adding to the financial burden on local farmers.

In order to investigate this problem, I made an interview to the leader of Xuezhuang Township, Mr. Li, who is the head of the local government. Mr. Li said that stop grazing is one of the basic policies of GfG, which is conducive to environmental restoration and soil conservation. And grazing is a very inefficient way to raise sheep, because it requires more land and labor to feed the same number of sheep than captivity. When I talk about the concerns of farmers, he mentioned that the government had already considered the impact of stop grazing on local farmers when this policy was published. First of all, this policy will increase the cost of animal husbandry. Farmers need to import additional forage to feed and more money to build folds and shelters. Secondly, farmers need to master more knowledge and technology to prevent diseases and balance the nutritious of feed. However, the government has also introduced policies to address these problems. First and foremost, the government encouraged farmers to work together to set up agricultural production cooperatives, which working as small agricultural production companies set up by several householders, and provide unsecured interest-free loans. And the government will reward the company that reached a certain scale or have innovation in technology, such as exemption from some taxes or granting the honorary title like "Model Worker" or "Outstanding enterprise". Furthermore, the government regularly arranges 2-3 lectures on agricultural technologies every year, which including plant protection, crop cultivation, animal alimentology and pathology. The lecturers are experts and professors hired by the government from universities and research institutes. They will teach local farmers agricultural knowledge and technologies, and give advises for production. And the government would give small gifts to encourage local farmers to attend the lectures or semi-compulsorily require at least one representative of each household to attend. There happened to be a lecture during my stay in the township. So Mr. Li invited me to attend the lecture together with the local farmers to get a better understanding of the work of the government.

The lecture was issued by two professors form Northwest A&F University, one of the best Agricultural Universities in China, and the main content of which is animal breeding techniques including the construction of flocks, veterinary, animal pathology and nutrition balance. However, personally I thought this lecture was too difficult to farmers, because the professors added too much content to the three-hour lecture. For example, professors introduced the building structure of three different types of sheep flocks, the symptoms of twelve diseases, laboratory identification of pathogens and methods of prevention and control. In addition, the lecture also introduced nutrient balance of five common breeds of sheep and four types of artificial insemination technologies. Even though I was a master student of Organic Agriculture, I could only understand 70% of the lecture. Personally I think this lecture is suitable for undergraduate or master degree students majoring in agriculture, and the knowledge of pathology and laboratory research is unnecessary to farmers. So I randomly selected 20 people among listeners and made a quick survey to investigate acceptance of this lecture. The questions and the answers were showed in Table 18

Table 18 The education level, the acceptance and the answers of the listeners.

What's your educational level?						
Primary school or lower	Junior high school	Specialized Secondary school	High School	College degree	Bachelor degree or higher	No answer
2	4	7	4	1	0	2

How much do you understand about the agricultural knowledge and techniques involved in this lecture?									
10% or less	20%	30%	40%	50%	60%	70%	80%	90%	100%
2	5	6	4	1	0	1	1	0	0

Will you apply the recommended techniques in the lecture to actual production?			
Yes	2	No	18

Why or why not? (You can give multiple reasons)	
Yes, I believe these new techniques will increase my income form livestock.	2
Yes, I think these new techniques are more environmentally friendly than conventional method.	1
No, the knowledge required for these techniques is beyond my ability.	11
No, I don't have enough money to invest and apply new techniques.	8
No, I don't think these new techniques will increase my income form livestock.	6
No, I don't think I can master these techniques by only listen a lecture.(practical guidance was needed)	4
No, I totally (or almost) don't understand what the lecturer was talking about.	3
No, the main reason I listen to this lecture is the government ask me to do.	2

According to the survey, most of the listeners' educational levels are between junior high school and high school. Only one interviewer has college degree and nobody have bachelor or higher degree; most of the listeners think they can understand less than 50% of the lecture; only 2 people can understand 70%-80%. Only 2 people mentioned that they would actually apply the recommended techniques in the lecture.

Interviewers also gave various reasons for their choices. The two people who are going to apply new techniques think that the new method would bring much more income than conventional method. One of them even mentioned a highly awareness of the environment. Eleven people said that they don't think they can master the recommended techniques even if they would spend a lot of time to study. Eight people mentioned that money is the most serious problem. Although the government will provide loan for agricultural production cooperatives, but local farmers still need to afford 30% of total investment, which is still unaffordable for them. Six interviewers are not convinced that the new techniques will boost their incomes. They mentioned that the government began encouraging farmers to accept pen technologies and to form agricultural production cooperatives five years ago, but there has been no successful case so far. Many cooperatives had been dissolved because of poor management or conflicts among the founders. Four interviewers were quite interesting in new techniques but they still refused to apply, because there are only 3 lectures every year and nobody could master new skills without practical guidance. Five people in the interview hold a relatively negative opinion for the lecture and local policy. Three of them thought they couldn't understand the lecture (at all), and two of them were unsatisfied with the compulsory.

I also made a quick interview with one of the lecturer, Professor Xu, and asking her opinion of farmers' attitudes and feedbacks for this lecture. Professor Xu said, in fact, the government has hired many experts and professors to conduct agricultural training for farmers participating GfG. Because of the very wide coverage of GfG, comprehensive training for all farmers is almost impossible. She herself has 30-40 similar lectures for farmers in different countries every year. Scheduling three lectures a year in Xuezhuang Township is already the best arrangement that can be done under existing conditions. So the lectures could only cover as many aspects as

possible which look like quick introductions and lead to low acceptances. However, the purpose of the lectures was not to make farmers handle relevant knowledge immediately, but to give them a basic understanding and awareness of agricultural science. Even if a few farmers accepted new technologies and succeeded, such success stories can serve as role models and encourage and attract more farmers to join. This situation may take years, but as a Chinese proverb said, “Great haste is not always good speed”. In addition, professor Xu was satisfied with the result of the survey. Two out of 20 randomly selected people can accept the new technology, which means that about 6-7 people of the 67 listeners of this lecture could be expected to apply these technologies to actual production. Xu said that, there are a lot of experts and researcher working on farmers’ education, and there will be more students devoted themselves to this career. In conclusion, she thinks that make a negative conclusion simply form the numbers is inapposite. And instead she saw a bright future form the result of my survey.