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# Stakeholders' Perceptions towards Land Restoration and Its Impacts on Ecosystem Services: A Case Study in the Chinese Loess Plateau

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**Abstract:** To combat land degradation and deterioration issues, the Grain to Green project (GGP) was implemented on the Chinese Loess Plateau in 1999 and substantially altered the land cover by converting slope farmland into forest and grassland. To effectively achieve sustainable land restoration management and avoid stakeholder conflicts, this study aimed to understand how local stakeholders perceived the current land restoration process and expectations for future land restoration policy, as well as how stakeholders assessed the GGP impacts on local ecosystem service changes. We investigated the perspectives of 150 stakeholders representing five stakeholder groups including farmers, governmental officers, citizens, tourism operators and forestry practitioners using questionnaires administered in 2021 in the Yan'an area of the Chinese Loess Plateau. The survey results indicated a 72% support rate of stakeholders for the current GGP, with government officers reporting the highest value and tourism practitioners reporting the lowest. The support rate for future land restoration decreased to 51%. While majority of the stakeholders considered that the GGP had stimulated regulation and cultural ecosystem services, they also perceived negative impacts on grain production, livestock production, water yield and water quantity. Factors influencing farmers' decision-making on recultivating the restored forest in the future were found to be economically driven. We recommend policy makers to improve the compensation standards and duration for farmers and increase the diversity of restoration tree species, and the involvement of participatory processes is suggested for future land restoration policy-making.

**Keywords:** land restoration policy; stakeholder perception; payment for ecosystem services; ecosystem services change; farmers' willingness



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## 1. Introduction

Due to its strongly dissected landscape, high soil erodibility, intensive rainfall and human activities, the Chinese Loess Plateau has experienced severe soil erosion and land degradation issues from the late 1960s [1,2]. To manage these issues, many land restoration programs at different scales have been implemented on the Chinese Loess Plateau starting from the 1970s [3]. In 1999, one of the world's largest-scale land restoration projects, the Grain to Green Project (GGP), was initiated nationally in China to reverse the ecological degradation by stopping slope cultivation and restoring arable land to forest and grassland [4,5]. Ecologically, the introduction of GGP benefits transformed the Loess Plateau from a carbon source into a carbon sink in 2008, improving regulating services and vegetation cover simultaneously [1,6]. As an incentive-based program, the GGP has provided financial incentives to those who supplied ecosystem services, i.e., so-called payments for ecosystem services (PES) [7]. Subsidies were given to farmers by local GGP offices as

compensation for the restoration. This GGP-exploited PES scheme has directly engaged millions of rural households as core agents for the implementation of the project [8].

During the implementation process of landscape restoration, participatory approaches have been increasingly adopted by environmental authorities worldwide [9]. To effectively achieve sustainable land management, it is very important that stakeholders in the land restoration program are fully involved, including in the decision-making, project framing and the implementation process phases [10]. Stakeholders are individuals or groups of people that affect or are affected by the actions and results of an initiative [11]. The benefits of involving stakeholders can be summarized as obtaining a better understanding of the situation through different points of view, integrating local knowledge, enabling the empowerment of the local population and avoiding top-down approaches [12]. Ecosystem services are defined as flows of materials, energy and information that are directly or indirectly provided by ecosystems to human society, which are usually categorized into provision, regulating and cultural services [13]. Provisioning services include goods and products that we physically obtain from ecosystems, for example, food, water, raw materials, etc. Regulating services are necessary services to maintain ecosystem functions, for instance, erosion control, sediment retention, habitat quality, etc. Cultural services such as a landscape's aesthetic value provide spiritual pleasure to human beings [14].

Stakeholders' perceptions of ecosystem services change is an indicator of policy implication. Moreover, science-policy agreements such as the Inter-governmental Science-Policy Platform on Biodiversity and Ecosystem services (IPBES) and the Convention on Biological Services (CBD) have the assessment process work with indigenous land local knowledge (ILK), with an emphasis on the importance of knowledge from key stakeholders, and encourage stakeholders' involvement during the ecological-policy-making process [15]. Farmers are essential stakeholders for carrying out ecological restoration, as they directly participate in land restoration programs, including changes in their own land and subsidies that affect their household income [16]. Ignoring local people's interests and excluding them from the planning, management and decision-making process of the restoration has been found to be a main source of conflict between people and the environment [17,18]. Stakeholders' perceptions and willingness in achieving landscape restoration is essential for sustainable policy-making and landscape management [19].

To better achieve sustainable land restoration and eliminate the conflict between stakeholders and restoration policies, many previous papers have studied the perception of farmers on the Grain to Green program. One of these investigations, conducted by Cao et al., (2009), discovered that more than half of the participating farmers supported the GGP at the interviewing year of 2007 [20]. Due to the introduction of the GGP, farmers' income sources, living styles and environmental awareness have been altered; meanwhile some farmers have been alleviated from poverty [21,22]. Factors influencing the long-term success of restoration can be various, and how to build up a win-win opportunity between farmers and landowners is the key issue to achieving future management [23]. According to studies undertaken in the Chinese Loess Plateau, building up a continuous compensation system with specific regulations for restored-cropland households may help the sustainable management of the GGP project [24,25]. Most recently, since the GGP has dramatically altered the landscape of Loess Plateau and enhanced its vegetation cover, how subsidies are currently being adapted by farmers and what is the compensation process in the future has been less of a concern to the public. Additionally, farmers are not the only stakeholders in the GGP. In previous studies, less attention has been drawn to the other stakeholders involved in landscape restoration. The GGP itself is of huge societal importance for every citizen in the Loess Plateau, and their opinion and knowledge are essential for local land restoration. Residents have been involved in the surrounding environment for centuries and have retained ecological knowledge and activities that facilitate land restoration [26].

Hence, it is essential to understand stakeholders' perceptions towards current landscape restoration, their personal interests on ecosystem services and what their opinions are of the GGP impacts on local ecosystem services as well as their expectations for future

land management policy. Currently, a continued expansion of the restoration forest in the Chinese Loess Plateau is envisioned for the future. When a restoration is planned, a full range of points of view and the knowledge of stakeholders needs to be considered to limit the risk of failure [27]. In addition, at the beginning of the GGP, Uchida et al. (2005) found that there remained uncertainties as to whether farmers will reconvert the restored land back to cultivation after the program ends [28]. Cao et al. (2009) surveyed 2000 GGP participant farmers in Shaanxi province, China, and 37.2% of them planned to recommence cultivation once the subsidy ended in 2018. Recultivation on slope land may lead to severe land erosion and consequently to soil and water loss. Hence, it is important to understand the likelihood of farmers recultivating their restored forest. Therefore, in our study, the main objectives were explained as: (a) to understand stakeholders' perceptions towards current land restoration policies and their future preferences of policy improvement; (b) to discover the factors influencing farmers' decision-making on recultivating the restored forest; and (c) to investigate stakeholders' perceptions of GGP impacts on local ecosystem service changes.

## 2. Materials and Methods

### *2.1. Framework*

In this study, we applied the framework from Figure 1 to determine stakeholders' perceptions towards the current and future Grain to Green project in the Yan'an area. The activities comprised: (1) stakeholder identification; (2) questionnaire design; (3) interviews; (4) statistical analysis. Five stakeholder groups were identified, and two formats of questionnaires were designed with five sections in total. A total of 157 interviews were conducted, and we applied the Kruskal–Wallis tests and binary logistic regression to determine the perception variances between the different stakeholder groups.

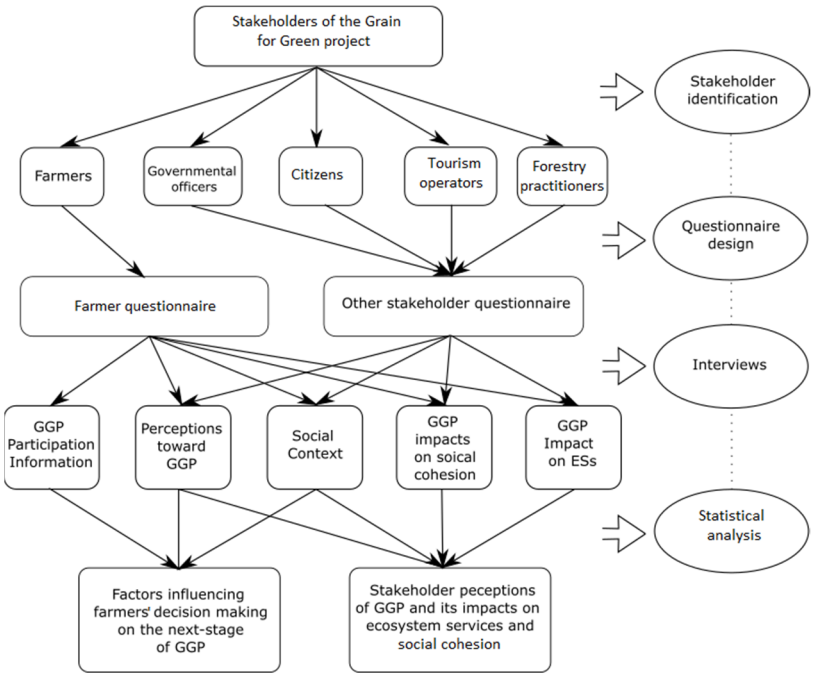



**Figure 1.** Framework of the social investigation.

### *2.2. Study Area*

The study area of Yan'an (Figure 2) is located in the northern Shaanxi province on the south-central part of the Chinese Loess Plateau at the latitude 35°21′–37°31′ N and longitude 107°41′–110°31′ E. Yan'an is a prefectural-level municipality covering an area of 37,030 km$^2$. It is a typical hilly area in the Loess Plateau that consists of multiple deeply incised valleys. The main soil type is calcareous cinnamon soil [29]. Yan'an belongs to a

semi-humid, warm temperate climate zone with a continental monsoon circulation, with average annual temperature of 9.9 °C and annual precipitation of 510.7 mm. The population of the Yan'an area is around 2.3 million, and the gross domestic product (GDP) in 2018 was 156 billion RMB. In 1998, the Yan'an area was selected as the first experimental site to start the national GGP land restoration project in its north-western Wuqi county. The Grain to Green project was officially initiated in 1999 nationally and covered all 13 counties of the Yan'an area. Yan'an has implemented vegetation restoration for nearly 20 years and has restored around 7200 km$^2$ of degraded land [30].

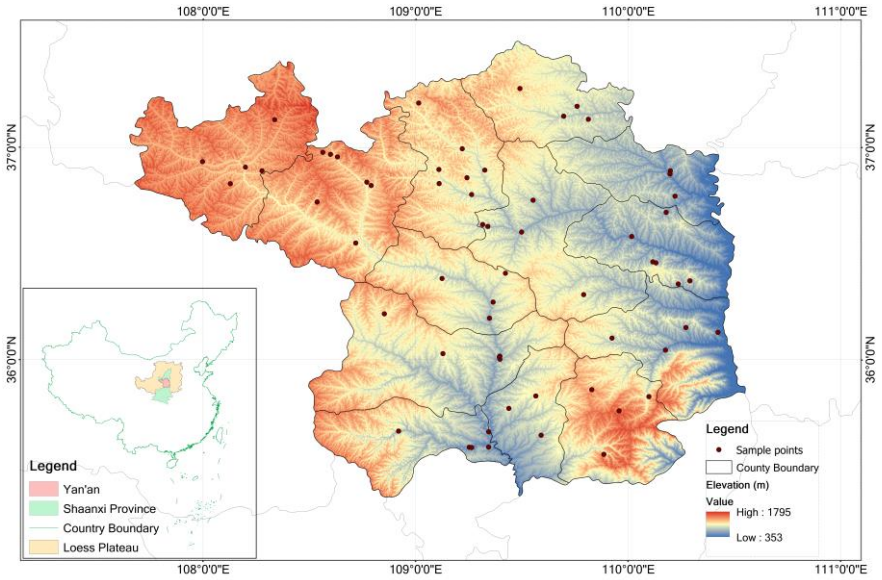



**Figure 2.** Questionnaire sites in the Yan'an area.

### *2.3. Data Collection*

#### 2.3.1. Identification of Key Stakeholder Groups

A pre-investigation was conducted in March 2018 in Ansai county of the Yan'an area in order to identify the key stakeholder groups regarding the impacts of GGP implementation. The pilot data contained 52 questionnaire surveys and meetings with different stakeholders from urban to rural areas. According to our primary data collection, we identified five stakeholder groups to be investigated based on their involvements in the GGP: farmers, government officers, citizens, tourism operators and forestry practitioners. Farmers were directly involved in the implementation of the GGP, government officers were the policy-makers and executors of the GGP policy, while citizens, tourism operators and forestry practitioners were potentially influenced by the GGP due to changes in ecosystem services and policies.

#### 2.3.2. Questionnaire Design

As farmers directly participated in the GGP and were involved in more policy interventions compared to other stakeholders, for instance, subsidies, land rights and restoration maintenance, the questionnaires were designed into two formats, one for farmers and one for other stakeholders. The farmers' questionnaire contained 48 items and was divided into five sections (Supplementary S2). The first section was designed to collect the basic information of farmers' GGP participation, including the participation year, restoration area and subsidy amount received. The second section was semi-structured and aimed to elicit farmers' perceptions toward the current and future implementation of the GGP. The third section listed thirteen ecosystem services including four provisioning services, five regulating services and three cultural services. Ecosystem services were described in a comprehensible way for easier understanding, and subsequently farmers were asked to state their impression of the impacts of the GGP on the listed services on a five-point scale:

obvious increase, increase, not sure, decrease and obvious decrease. The fourth section aimed to understand the impacts of the GGP on farmers' household incomes and social cohesion. The fifth section recorded the social context of farmers regarding gender, education years, household size, family income, etc. The questionnaire for other stakeholders was simplified from the farmers' questionnaire, and consisted of part of the second, third, fourth and fifth sections of the farmers' questionnaire (Supplementary S3).

#### 2.3.3. Stakeholder Interviews

The data collection took place in March 2021. All stakeholders were randomly surveyed in each county of the Yan'an area. Farmers were investigated in the rural area randomly in random villages while other stakeholders were surveyed in the urban area. As the majority of the farmers were low-educated (illiteracy and primary school education accounted for 57 %), we collected the farmers' questionnaire through oral communication by questionnaire. Each farmer interview took around half an hour to one hour. Thirteen GGP offices in each county of the Yan'an area were visited. We interviewed the officers about local GGP implementation information with open questions regarding the existing problems and future plans. Citizens were randomly selected in the urban area. Tourism operators were interviewed at tourist attractions and travel agencies in the town while the forestry practitioners interviewed were mainly nursery owners and employees of local forest fire bureaus.

### *2.4. Statistical Methods*

We applied the Kruskal–Wallis one-way analysis of variance (ANOVA) to compare the variances between stakeholder groups. In the ANOVA result, the null hypothesis was that the variances between populations were the same, while a significant ($p < 0.05$) Kruskal–Wallis test result rejected the null hypothesis and indicated that at least one sample stochastically differed from other samples. When significant ANOVA results were determined, Duncan's post hoc test was utilized to determine which sample was distinct from others. In this study, the survey results of social context, perceptions towards GGP and its impacts on ecosystem services and social cohesion were analyzed by the Kruskal–Wallis test. Furthermore, we used binary logistic regression to determine the factors influencing farmers' willingness to recultivate their restored land. Additionally, stakeholders' perceptions of the impacts of the GGP on local ecosystem service changes were compared with ecosystem service quantity changes using the model results from [31] using Pearson's linear regression. The Kruskal–Wallis one-way ANOVA and binary logistic regression were conducted using SPSS 25.0 for Windows. Figures were drawn using SigmaPlot 14.0 and Pearson's linear regression was executed by R 4.0.5.

## 3. Results

### *3.1. Social Context of the Stakeholders*

Collectively, we investigated stakeholders from sixty locations and collected one hundred and fifty effective questionnaires out of one hundred and fifty-seven (effective rate 95.54%), including one hundred and three farmer questionnaires and forty-seven from other stakeholders: fifteen from citizens, thirteen from government officers, and eleven and eight from tourism and forestry practitioners, respectively (Table 1). Approximately 56.7% of the respondents were male. According to the Kruskal–Wallis ANOVA test, there was a significant difference between the age of the farmers and other stakeholders. Other stakeholders were on average almost 13 years younger than farmers. The respondents' ages were concentrated between 31–50 years, whereas the farmers' ages were usually between 51–70 years. Furthermore, there was an obvious gap between the education level of farmers and other stakeholders. Most other stakeholders had senior high school or college education while farmers tended to be illiterate or with primary school education. The average income of stakeholders was RMB 3920 (around RMB 7.8 is equal to EUR 1 at the time of writing), and it again differed significantly between farmers and other stakeholders.

In summary, farmers were older with a lower education level and less income compared to other stakeholders.

**Table 1.** Social contexts of the survey participants.

| Basic Information | Total | Farmers | Other Stakeholders | *p*-Value |
|---|---|---|---|---|
| Participants | 150 | 103 | 47 | |
| Male | 56.67% | 55.34% | 59.57% | |
| Female | 43.33% | 44.66% | 40.43% | |
| Age (years) | 53.55 ± 11.01 | 57.58 ± 9.85 | 44.72 ± 7.84 | 0.001 |
| Below 30 | 2.00% | 0.97% | 4.26% | |
| 31–50 | 36.00% | 19.42% | 72.34% | |
| 51–70 | 57.33% | 72.82% | 23.40% | |
| Above 70 | 4.67% | 6.80% | 0.00% | |
| Education level (years) | 8.01 ± 4.91 | 6.14 ± 4.27 | 12.11 ± 3.59 | 0.001 |
| Illiteracy | 18.67% | 27.18% | 0.00% | |
| Primary school | 24.00% | 30.10% | 10.64% | |
| Junior high school | 26.00% | 26.21% | 25.53% | |
| Senior high school | 20.00% | 16.50% | 27.66% | |
| College | 10.67% | 0.00% | 34.04% | |
| Master | 0.67% | 0.00% | 2.13% | |
| Family monthly income (RMB) | 3920 ± 4996 | 2728 ± 3092 | 6531 ± 7035 | 0.001 |
| Below RMB 1000 | 23.33% | 32.04% | 4.26% | |
| RMB 1000–3000 | 34.67% | 40.78% | 21.28% | |
| RMB 3000–5000 | 24.00% | 16.50% | 40.43% | |
| RMB 5000–10,000 | 11.33% | 6.80% | 21.28% | |
| RMB 10,000–20,000 | 4.67% | 3.88% | 6.38% | |
| Above RMB 20,000 | 2.00% | 0.00% | 6.38% | |

### *3.2. Stakeholders' Perception of the GGP*

The results of stakeholders' perceptions towards current and future land restoration are displayed in Figure 3. According to the farmers' survey results, 65% of the farmers supported the current GGP policy, around 15% of the farmers remained neutral and approximately 20% of the farmers opposed the land restoration. Meanwhile, the main reasons for the farmers' attitudes towards the GGP were answered in the open questions. For those supporting the GGP, 23% of the 103 farmers responded that the yield of previous slope farming was very low, and 14% of the farmers thought that the GGP reduced farming labor work. Farmers who opposed the GGP mainly did so due to income reasons; 20% of the total number of interviewed farmers pointed out that the implementation of the GGP had decreased their household income due to reduced cash crop production, while two farmers replied that grazing activities were forbidden. As for other stakeholders, a unanimous response was found among the government officers in that all the respondents supported the GGP policy. Meanwhile, the majority of citizens, tourism operators and forestry practitioners showed a supportive attitude towards previous land restoration and the opposition rate was approximately 10%. In the open question section, 55% of the respondents claimed that land restoration had improved the local ecological environment and reduced soil and water losses, and 15% of the stakeholders replied that the air quality had been improved. However, 13% of the respondents declared that the GGP had decreased local agricultural acreage, and one tourism practitioner opposed the land restoration due the lack of diversity in the restored plant species.

Compared to the stakeholders' perceptions towards the current GGP, as shown in Figure 3b, we observed an obvious increase in dissenting opinions from stakeholders towards future land restoration. A total of 54% of the farmers showed positive attitudes towards future GGP plans, while 27% remained uncertain, and the rest (18%) stayed negative. As for the reasons behind this, 19% of the farmers claimed that they supported the future GGP but there was already no sloping farmland left for restoration, and 9% of

the respondents reflected that they were too old and not fit for future restoration work. As for governmental officers, three officers reflected there was still severe soil and water loss existing in their administration area and argued that it is essential to continue restoration for soil retention. The perceptions of citizens towards the current and future GGP remained similar, while a more opposite attitude was determined in the tourism group compared to Figure 3a. The increased risks of forest fires were the main reason raised by forestry practitioners who opposed future land restoration.

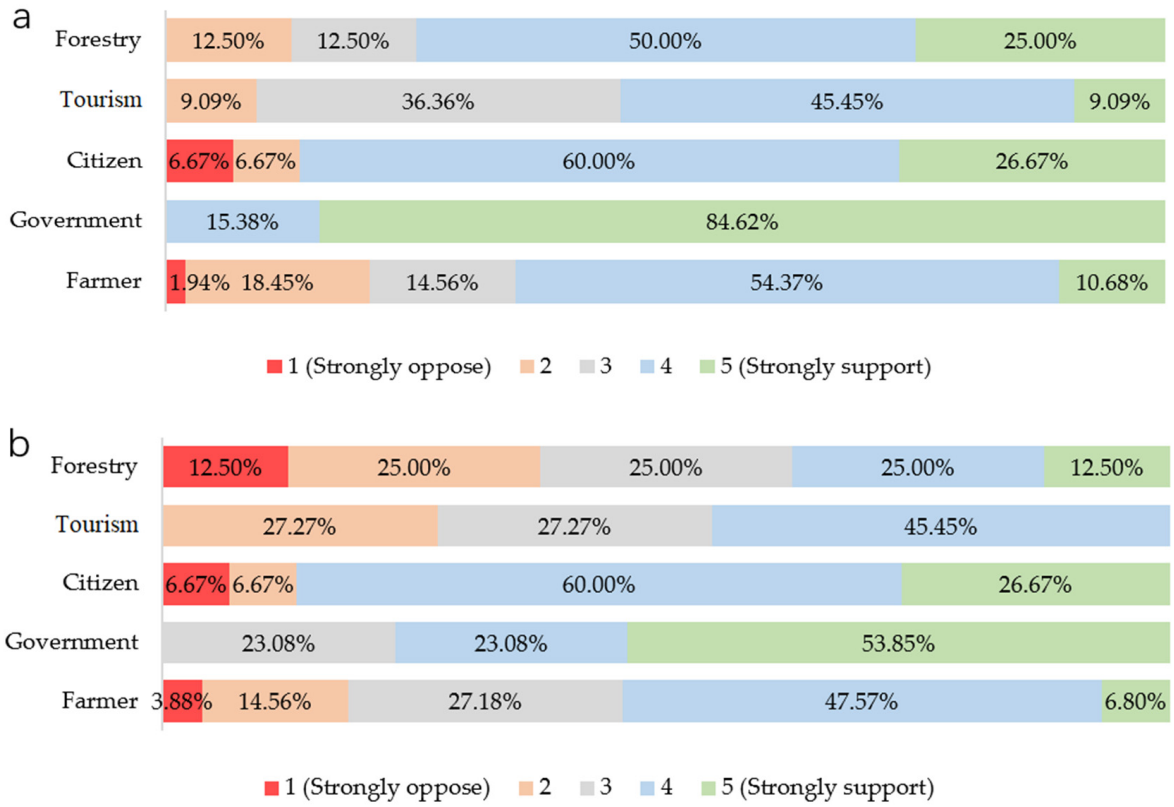



**Figure 3.** Stakeholders' perceptions towards current (**a**) and future (**b**) GGP implementation.

The social impacts of land restoration were also determined from the surveys. In Table 2, the results of stakeholders' perceptions on the six statements are displayed. In general, all the stakeholder groups considered that the implementation of the GGP had had positive impacts on improving the awareness of environmental protection. Government officers strongly agreed with these statements while farmers and forestry practitioners had comparably significantly lower values. Stakeholders stayed neutral about the relations between the GGP and local job opportunities. Stakeholders recognized that the implementation of the GGP was highly efficient, and the highest value was given by government officers. The majority of the stakeholder groups disagreed with the statement that the GGP had improved their income, while only government officers displayed a positive attitude. During the survey investigation in rural areas, the abandonment of arable land was not commonly observed, meanwhile farmers, government officers and citizens denied the relationship between land abandonment and the implementation of the GGP. It was believed by farmers, government officers and citizens that the introduction of land restoration had caused a population outmigration issue, and that reduced farmland in the rural area might be the cause of outmigration due to a lack of an income source.

**Table 2.** Stakeholders' perceptions on the social impacts of the GGP. Note: values ranging from 1 to 5 indicate opinions from "strongly disagree" to "strongly agree". All values are mean ± SD; same letters behind values indicate a significant variance between each other in the raw data.

| Statements | Total | Farmer (n = 103) | Government (n = 13) | Citizen (n = 15) | Tourism Practitioner (n = 11) | Forestry Practitioner (n = 8) | *p*-Value |
|---|---|---|---|---|---|---|---|
| GGP improved my environmental protection awareness | 3.85 ± 0.7 | 3.78 ± 0.69 a | 4.54 ± 0.52 ab | 3.87 ± 0.64 | 3.91 ± 0.7 | 3.63 ± 0.74 b | <0.01 |
| GGP stimulated local job opportunities | 2.89 ± 0.75 | 2.84 ± 0.65 | 3.31 ± 0.85 | 2.93 ± 1.22 | 3.09 ± 0.7 | 2.5 ± 0.53 | 0.12 |
| GGP implementation efficiency is high | 3.65 ± 0.89 | 3.61 ± 0.94 | 4.31 ± 0.63 a | 3.4 ± 0.74 a | 3.73 ± 0.65 | 3.38 ± 0.74 | 0.05 |
| GGP improved my income | 2.69 ± 1.1 | 2.7 ± 1.09 | 3.54 ± 1.05 ab | 2.4 ± 1.12 a | 2.27 ± 0.79 b | 2.25 ± 1.04 | 0.02 |
| GGP induced the abandonment of cultivation land | 2.75 ± 0.84 | 2.73 ± 0.88 | 2.15 ± 0.8 ab | 2.8 ± 0.56 | 3.09 ± 0.3 a | 3.38 ± 0.92 b | 0.01 |
| GGP stimulated local population outmigration | 3.63 ± 0.95 | 3.75 ± 0.94 | 3.08 ± 1.12 | 3.4 ± 0.91 | 3.64 ± 0.81 | 3.38 ± 0.92 | 0.11 |

### *3.3. Factors Influencing Farmers' Willingness to Recultivate the Restored Forest*

The results on factors influencing farmers' decisions on whether to re-cultivate their restored forest are presented in Tables 3 and 4 and were based on Kruskal–Wallis' one-way ANOVA and binary logistic regression, respectively. From Table 3, the basic information on farmers' participation in the GGP is displayed. On average, 59% of the farmers' family cultivation land was restored, farmers received a 1495 RMB/mu (equal to 99,667 RMB/ha) subsidy in total and they considered the subsidy standard to be low (average scale = 2.53). While farmers estimated that the implementation of the GGP had caused a reduction in income by RMB −2861 annually, cultivation was still the main income source of 63.11% of the surveyed farmers. Overall, 82% of the interviewed farmers replied they would not recultivate the restored forest, whereas only 19 respondents still intended to cultivate. We received a response from twenty-four respondents explaining the reasons, and fourteen farmers explained that recultivation was no longer possible as the restored trees had grown up stoutly with big root systems, while five farmers considered themselves too old for additional cultivation work.

**Table 3.** Farmers' participation in the GGP, their willingness to re-cultivate their GGP forest and influencing factors. Note: values ranging from 1–5 indicate participants' opinions ranging from strongly disagree to strongly agree.

| Statements | Total | NO | YES | *p*-Value |
|---|---|---|---|---|
| Farmers' willingness to re-cultivate their GGP forest in the future | 103 | 84 | 19 | |
| Restored farmland/total land owned | 59.35 ± 27.96% | 60.87 ± 27.04% | 52.66 ± 31.64% | 0.250 |
| Degree of support for the current GGP policy (from 1 to 5) | 3.53 ± 0.98 | 3.65 ± 0.88 | 3 ± 1.2 | <0.01 |
| Farmers consider themselves forced to join the GGP (1 = No, 2 = Yes) | 1.30 ± 0.46 | 1.33 ± 0.47 | 1.16 ± 0.38 | 0.135 |
| Satisfaction with restored tree species (from 1 to 5) | 2.83 ± 0.94 | 3.37 ± 1.1 | 2.70 ± 0.86 | <0.01 |
| Degree of support for future GGP policy (from 1 to 5) | 2.17 ± 0.6 | 2.2 ± 0.6 | 2 ± 0.58 | 0.182 |
| Total subsidy received / total farmland restored (RMB/mu) | 1494.97 ± 574.75 | 1561.21 ± 547.46 | 1202.11 ± 615.54 | <0.01 |
| The GGP subsidy is high (from 1–5) | 2.53 ± 0.81 | 2.63 ± 0.8 | 2.11 ± 0.74 | <0.01 |
| The maintenance work is hard (from 1–5) | 3.3 ± 0.85 | 3.33 ± 0.81 | 3.16 ± 1.01 | 0.419 |
| GGP implementation has increased my spare time (from 1 to 5) | 3.79 ± 0.98 | 3.77 ± 0.97 | 3.84 ± 1.01 | 0.785 |
| GGP implementation has strengthened social cohesion (1–5) | 2.83 ± 0.98 | 2.86 ± 1 | 2.68 ± 0.95 | 0.492 |
| Participants' education years | 6.15 ± 4.27 | 6.29 ± 4.38 | 5.53 ± 3.78 | 0.487 |
| Adult man number/total family number | 45.94 ± 15.18% | 45.62 ± 14.27% | 47.37 ± 19.08% | 0.653 |
| Amount by which family annual income had changed with the GGP(RMB) | −2860.58 ± 10,938.78 | −1875 ± 5519.3 | −7217.89 ± 22,649.84 | 0.049 |
| Main income source (cultivation = 1, other = 0) | 63.11 ± 48.49% | 65.48 ± 47.83% | 52.63 ± 51.3% | 0.299 |
| Monthly family income (RMB) | 2728.16 ± 3092.35 | 2779.76 ± 3086.46 | 2500 ± 3192.87 | 0.724 |
| Participants' age | 57.58 ± 9.85 | 57.95 ± 10.2 | 55.95 ± 8.12 | 0.425 |
| Ratio of males | 55.34% | 55.76% | 57.89% | 0.806 |

Significant differences were found in support for the GGP, tree species, average subsidy, subsidy standard and income change between farmers who determined yes and no in terms of whether to recultivate on the restored forest. Comparably, farmers who were willing to recultivate the restored forest had a lower degree of support for the GGP, and the main differences between farmers' willingness to recultivate the restored forest were found in the income aspects. Tree species was also an important factor affecting farmers' decision-making on recultivation; the less satisfaction a farmer had, the more they would like to

recultivate their restored forest. There were 40 interviewed farmers who gave opinions on their preferred restoration tree species; 68% of the respondents preferred economic forests, for instance apple trees and pepper, while the rest pointed out pine trees and cypresses. Farmers who preferred to recultivate received on average 359 RMB/mu (23,933 RMB/ha) less of a subsidy compared to farmers who said "No" to recultivation; meanwhile, they considered the GGP subsidy to be low (average scale = 2.11). Additionally, the "YES" group estimated that the implementation of the GGP had caused an average reduction in their annual household income by −7218 RMB/a, while the reduced income for the "No" group was estimated to be −1875 RMB/a. From Table 3, it can be observed that the negative impacts of the GGP on farmers' incomes were the main reason influencing farmers' decision-making to recultivate the restored forest. The results of the binary logistic regression are presented in Table 4. The restoration ratio, support for the GGP, tree species, income source and family income were the factors influencing farmers' decision-making on whether recultivate their restored forest.

**Table 4.** Binary logistic regression results of farmers' willingness to re-cultivate their GGP forest.

| Statements | B | S.E. | Odds Ratio | *p*-Value |
|---|---|---|---|---|
| Restoration rate | 0.03 | 0.02 | 1.03 | 0.05 |
| Support for GGP | 0.81 | 0.40 | 2.25 | 0.04 |
| GGP was forced | 0.62 | 0.70 | 0.78 | 0.38 |
| Support future GGP | 0.47 | 0.60 | 1.59 | 0.43 |
| Tree species | −0.70 | 2.93 | 5.65 | 0.01 |
| Average subsidy (RMB/mu) | 0.00 | 0.00 | 1.00 | 0.20 |
| Subsidy standard | 0.71 | 0.45 | 2.04 | 0.11 |
| Re-planting work | 0.49 | 0.38 | 1.64 | 0.19 |
| Spare time | 0.12 | 0.35 | 1.13 | 0.73 |
| Social cohesion | −0.32 | 0.43 | 0.73 | 0.46 |
| Education level (years) | −0.05 | 0.10 | 0.95 | 0.62 |
| Labour ratio | 0.00 | 0.02 | 1.00 | 0.94 |
| Income change (RMB) | 0.00 | 0.00 | 1.00 | 0.04 |
| Income source | 1.59 | 0.82 | 4.91 | 0.05 |
| Monthly family income (RMB) | 0.00 | 0.00 | 1.00 | 0.05 |
| Age | 0.00 | 0.04 | 1.00 | 0.92 |
| Sex | −1.07 | 0.69 | 0.34 | 0.12 |

### *3.4. Stakeholders' Preferences for the Future GGP*

In this section, we described the open questions results regarding stakeholders' preferences on the future restoration policy (Figure 4). To sum up, the suggestions received by farmers were following the order by the many to the few: increase the subsidy standard (31%), extent the subsidy year length (27%), no suggestions (21%), free restoration plant selection (15%), technical support on tree planting and others (6%). Apparently, duration and amount of subsidy were the most concerned topics of farmers' future GGP preferences, free tree species selection and technical support occupied a small portion of farmers' demands. Other stakeholders put more concentration on the tree species diversity, while still a big portion (32%) of responses argued that the farmers' subsidy should be increased. 17% of the other stakeholders agreed on extending the forest restoration subsidies while 13% thought the restored forest area should be reduced. Comparably, regarding to future restoration policy, farmers were most concerned about their income from subsidies, while other stakeholders paid attention to the biodiversity value of future restoration forest.

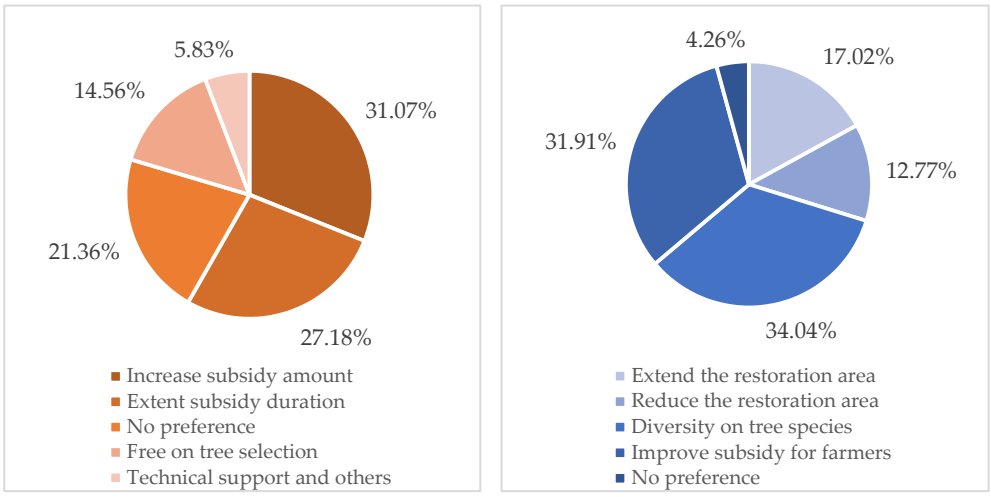



**Figure 4.** Share of farmers' (**left**) and other stakeholders' (**right**) preferences on future GGP.

### *3.5. Stakeholders' Preferences for the Future GGP*

In this section, we described the open questions results regarding stakeholders' preferences on future restoration policy (Figure 4). To sum up, the suggestions received by the farmers followed the order of the many to the few: increase the subsidy standard (31%), extend the subsidy year length (27%), no suggestions (21%), free restoration plant selection (15%) and technical support on tree planting and others (6%). Apparently, the duration and amount of subsidy were the most concerned topics of farmers' future GGP preferences, while free tree species selection and technical support occupied a small portion of the farmers' demands. Other stakeholders put more concentration on the tree species diversity, while still a big portion (32%) of responses argued that the farmers' subsidy should be increased. A total of 17% of the other stakeholders agreed on extending the forest restoration subsidies, while 13% thought the restored forest area should be reduced. Comparably, regarding future restoration policy, farmers were most concerned about their income from subsidies, while other stakeholders paid attention to the biodiversity value of future restoration forest.

### *3.6. Stakeholders' Perception of the GGP Impacts on Ecosystem Services*

In this section, the impacts of the GGP on ecosystem services were determined by different stakeholder groups; the results are presented in Figure 5. In terms of provisioning services, a decrease in grain production was recognized by all stakeholder groups, while an increase in fruit production was found by all stakeholders except farmers. Farmers reflected an obvious decrease in livestock production, while tourism practitioners pointed out an opposite opinion. According to the farmers, grazing is forbidden by the government due to the fact that goat grazing will destroy the root system of the restored nursery. Additionally, the regular fodder source for household livestock was crops on slope farmland. Due to the land restoration, the reduction in crop land had led to a lack of fodder for livestock. Therefore, the majority of the farmers chose to sell their household livestock after the restoration. Stakeholders declared uncertain attitudes regarding the land restoration impacts on timber production.

For regulating services, improved climate regulation, soil and water conservation and reduced hazard events were recognized by all stakeholders. The biggest divergence was found in terms of water quality and quantity between the different stakeholder groups. Government officers believed that the water quantity and quality was increased by the land restoration, while farmers and forestry practitioners sustained an objection, as they believed the water quantity and quality were both getting worse.

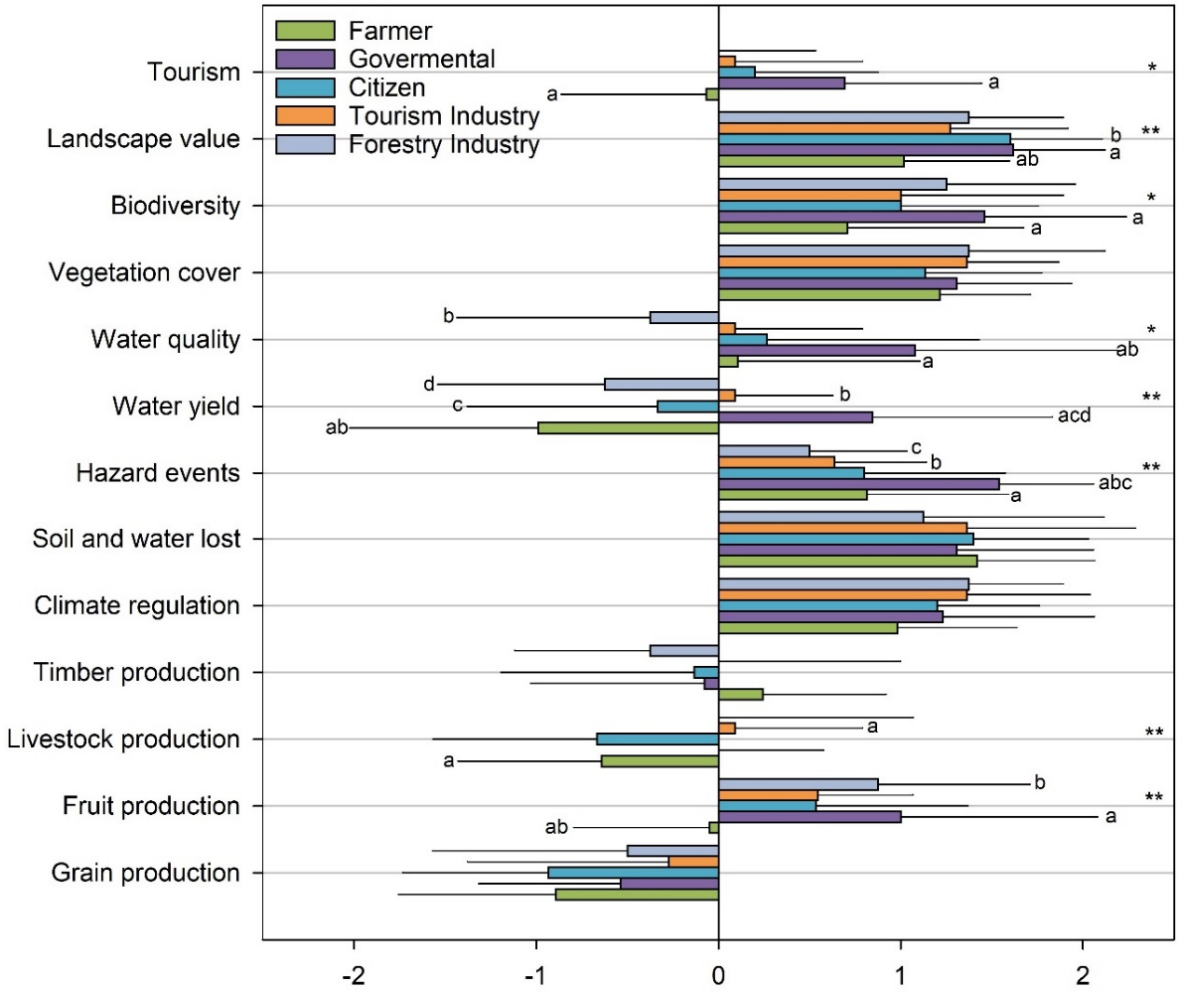



**Figure 5.** Stakeholders' perceptions of the impacts of the GGP on local ecosystem services. Note: in the x-axis, −2 = strong decrease; −1 = decrease; 0 = not sure; 1 = increase, 2 = strong increase. Values are mean ± SE. * indicates the significance of Kruskal–Wallis one-way ANOVA test between different stakeholder groups, * = $p < 0.05$, ** = $p < 0.01$, same alphabet letter behind value determines a significant difference between groups.

As for cultural services, the majority of the stakeholders interviewed considered that the land restoration had had positive impacts on improving the biodiversity and landscape value. Farmers claimed that more wild animals were witnessed in the mountain area, including wild birds and chickens, and even wild boars had started to appear in the mountain forest after the restoration. Tourism operators found a slight positive effect from the GGP on local tourism; however, government officers were obviously more certain about the positive impacts.

## 4. Discussion

In our study, according to the results from the stakeholder questionnaire, we observed that the support rate of stakeholders for the current land restoration policy was 72.00% (108 supported and strongly supported the GGP out of 150). For future land restoration policy, government officers reported the highest support value, while among tourism operators the support rate decreased to 50.67%. Stakeholders perceived that the implementation of the GGP had increased their environmental protection awareness, that the GGP had stimulated local population outmigration and that the implementation efficiency of the land restoration was high. The majority of the stakeholders considered that the GGP had stimulated ecosystem services in terms of regulation and cultural services. However, nega-

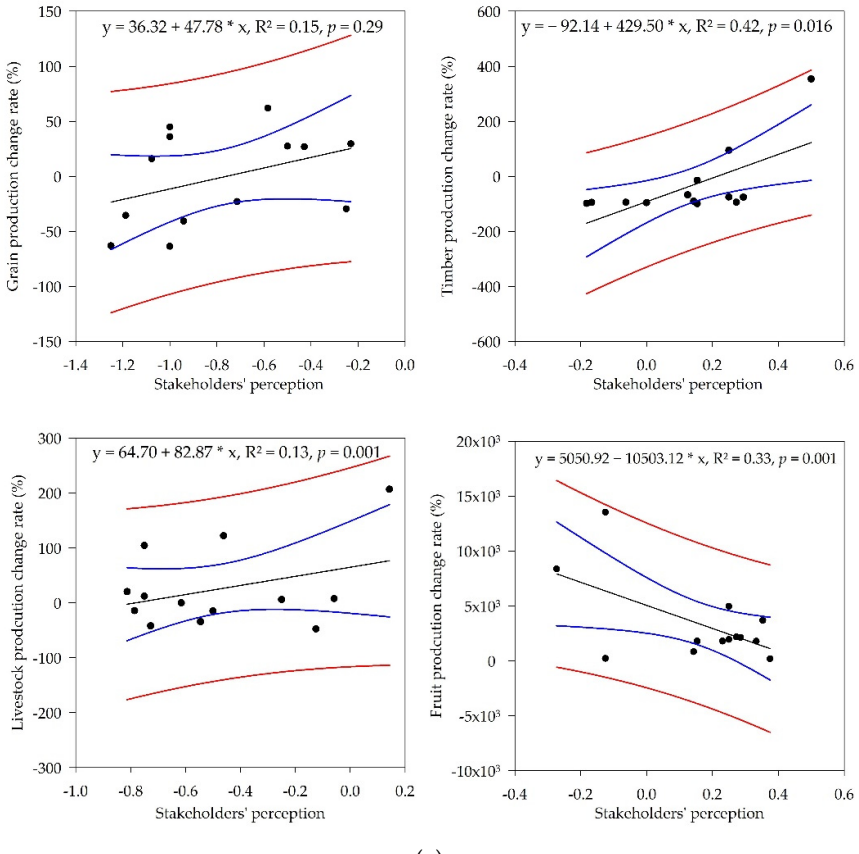
tive impacts were determined in terms of grain production, livestock production, water yield and water quantity. The factors influencing farmers' decision-making on recultivating the restored forest were found to be the restoration rate, support for the GGP, tree species selection, income impact by the GGP, income source and monthly income. We observed similarities between our study's results and previous studies, as well as new insights.

### *4.1. Comparison between Model Results and Stakeholder Perceptions*

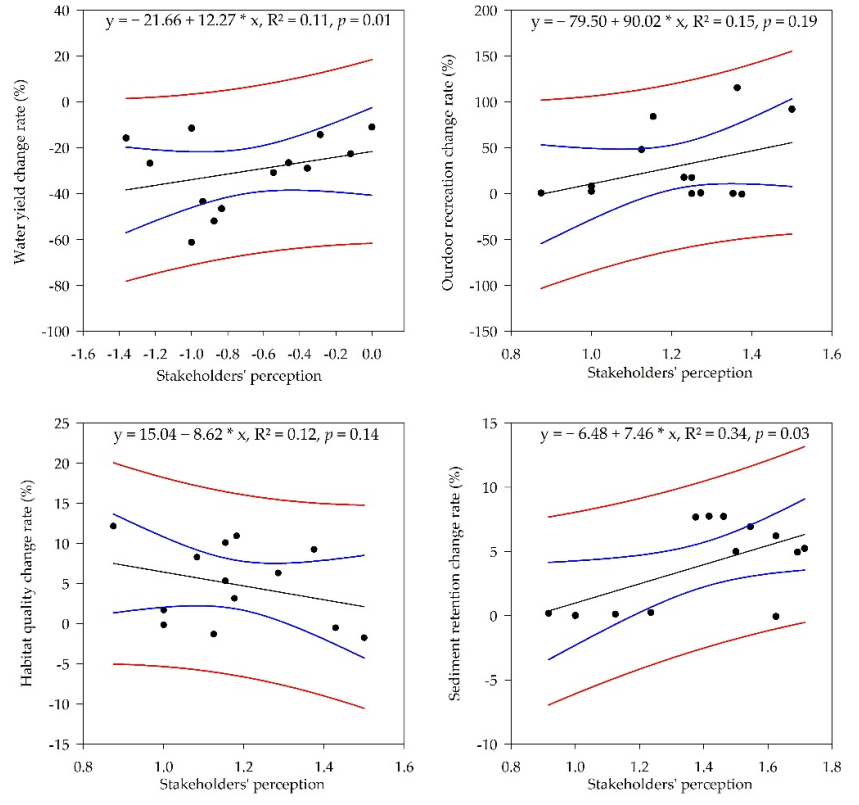
In this section, we compared two results of the impact of the GGP on ecosystem services, one being the biophysical changes from ecosystem service models and statistical year books [31] and the other being the cognitive results from the stakeholders' interviews. The objective was to understand whether the stakeholders' cognitive explanations differed from the physical transformation of ecosystem services. We compared the correlations between the ecosystem service change rates from 2000 to 2020 by biophysical models and the average stakeholder perception scales (from 1 to 5) of ecosystem service changes since the implementation of the GGP in the thirteen counties in the Yan'an area (Figure 6a,b). In the Pearson linear regression, every point indicated an average change in the value of ecosystem services in each county from 2000 to 2020 corresponding to the average stakeholder perception of ecosystem service changes in their county. In the figure, the positive correlation determined by the ecosystem service changes from the model results is matched with stakeholder perception and vice versa.

According to the figure, significant correlations ($p < 0.05$) were discovered in terms of timber production, livestock production, fruit production, water yield and sediment retention. For provisioning services, the values of grain production, livestock production and timber production change from the model results were consistent with stakeholder perception, as positive correlations were determined. A reduction in grain production was perceived by most of the stakeholders, but in some counties the grain production still increased during the land restoration according to the statistical yearbooks [31]. Additionally, according to Xu et al. (2006), the impacts of the Grain to Green project on China's grain production were very limited. The change in timber production varied between counties, while the stakeholder perceptions were similar to the model results. A reduction in livestock production was found in the majority of the counties, and stakeholders reflected this in similar scales. Fruit production was found to be dramatically increased after the restoration, while in terms of stakeholders' perceptions, this raise was low.

The majority of the regulating and cultural services results were found to be consistent between the model results and stakeholder perceptions; the only unmatched case was habitat quality. Water yield was found to be decreased from the ecosystem service models from −11.02% to −52.00%, and stakeholders determined the water reduction simultaneously from an average scale from −0.12 to −1.36 in the different counties. Although the correlations of outdoor recreation and habitat quality were not significant, stakeholders still perceived that the land restoration had had positive impacts on the landscape, and the model results supported this point of view. Sediment retention was determined to be enhanced from the model results, and stakeholders observed an obvious decrease in the soil and water lost from a scale from 0.92 to 1.71. In general, stakeholders were more sensitive to the change in provisioning and regulating services rather than cultural services, as more significant correlations were found. The implementation of the GGP policy directly reduced the household grain and livestock production as crop area was reduced and grazing was forbidden. Farmers occupied a big portion of the stakeholders, and their perception precisely reflected the impacts of the GGP on provisioning services. In addition, the consistency between stakeholder perception and the model results confirmed that the introduction of land restoration had altered the ecological functions from a biophysical aspect and that these impacts were perceived by local stakeholders.




(**a**)




(**b**)

**Figure 6.** (**a**) Correlations between results of ecosystem service models and stakeholder interviews. Note: x-axis represents average value of stakeholder perception in each county of Yan'an area, y-axis

indicates the change in ecosystem services values. Blue lines are 95% confidence band and red lines are 95% prediction band. (**b**) Correlations between results of ecosystem service models and stakeholder interviews.

### *4.2. Insights from Previous Studies*

Cao et al. (2009) revealed that farmers' support rate of the GGP was 63.8% in Shaanxi Province in 2005, while 37.2% of the farmers planned to recultivate the restored forest when the subsidy would end. After 15 years, as the majority of the subsidies for households had already ended, the farmers' support rate still remained similar at 66.02%. However, the farmers' willingness to recultivate the restored forest had dropped almost by half to 18.45% in 2021. The most direct reason for this willingness drop reported by the farmers was that the restored forest became dense, as it had grown for 20 years, and reclaiming the land converted to forest became irrational due to the massive cost. In addition, the average age of the interviewed farmers was almost 58 years old, and some farmers claimed they were too old for additional agricultural work. A study conducted near the Yangtze River found that 74.4% of the farmers held this opinion [32]. Meanwhile, it was found that farmers were increasingly shifting their labor endowment from on-farm work to off-farm work [33]. Currently, as 36.89% of the interviewed farmers' main family income sources were not cultivation, the diversity of the income sources may encourage farmers to seek for more job opportunities rather than stick to cultivation. Furthermore, before the land restoration, the major cash crops of slope farming were proso millet, maize and wheat, which were of low economic value in the market. As the slopes were under dryland farming and due to a lack of fertilizer and pesticides, the yield of slope farming was lower than that of flat-land farming. Thus, it is believed that the possibility of farmers to recultivate the restored forest is very low as it is economically unattractive.

Regarding environmental perceptions, Liu et al. (2010) compared the environmental attitudes among stakeholder groups, and government staff gave the highest scores [34]. Similar results were found in our study, in which government officers perceived the most positive impacts of the GGP among all the stakeholder groups. In our study, government officers in the Yan'an area tended to be overly optimistic in comparison to other stakeholder groups and even ignored common facts. For instance, a significant reduction in water yield has been determined in the Chinese Loess plateau in the past few decades [35]. In addition, the perceptions of local farmers and forestry practitioners responded with similar impressions in the Yan'an area, while only government officers considered that the water yield had increased. The farmers claimed that there used to be floods and landslides in the previous decades; however, after the land restoration the water level decreased obviously while consequently floods disappeared.

### *4.3. Existing Issues and Recommendations*

According to the stakeholder survey results and the investigation throughout the Yan'an area, we discovered two main issues with the current land restoration policy: (a) an insufficient and unsustainable compensation policy for the restored forest; and (b) a fragile ecosystem due to a lack of biodiversity. In 2004, an investigation in the southwest of China claimed that the impacts of the GGP on local food security and farmers' household incomes were critical issues [36]. During our investigation, after fifteen years, we discovered a similar issue. After the implementation of the GGP, farmers' main income sources altered from cash crops from slope farming to subsidies from the local GGP office. However, the majority of the farmers participated in the GGP in early 2000s and the subsidy lasted for sixteen years in total. Farmers reflected that the GGP subsidy had ended, and they now only receive around a 30 RMB/Chinese mu*year$^{-1}$ (equal to 256 EUR/ha/a) maintenance fee from the GGP office. In addition, the majority of the restored forests were ecological forests (apple, apricot, etc., i.e., mainly fruit trees), and farmers could barely obtain an economic

benefit from the slope land anymore. Therefore, currently, farmers harvest limited returns from their own restored land either from subsidies or from agroforestry products.

Based on the farmers' investigation of the 13 counties in the Yan'an area, the restored forest species were mainly robinia (*R. pseudoacacia*), apricot (*Prunus sect. Armeniaca*), hippophae (*Hippophae*) and caragana (*Caragana arborescens*), and usually for a certain area the restored plants were limited to one or two species (46% of the farmers reported the restored plant was only robinia). During our investigation journey, we observed the landscape of the restored forest was simple. For example, as shown in Figure 7, the most common species found in the mountain area was robinia. Although all the stakeholder groups agreed that the GGP had had positive impacts on biodiversity (Figure 4), improving the diversity of the restored tree species still occupied a big portion of future preferences (Figure 5). Wang et al. (2021) claimed that the implementation of the GGP increased the forest cover rather than improving habitat availability [37]. According to the farmers, there were increasing observations of wild animals after the restoration; however, the animal species were limited to wild mountain chickens and infrequent wild pigs. Due to farmers' rare visits to the restored forest after the restoration, the reduction in human activities might be a reason for the improved wild animal populations. However, a lack of biodiversity was commonly perceived by stakeholders and led to the restored forests being ecologically fragile. From the open questions, local government officers reported that the current issue they were facing were pests and plant diseases. Meanwhile, we observed widespread oil wells in the mountain areas in northeast the Yan'an area, which is damaging the local ecosystem (Figure 7). Farmers reported that the petroleum industry was a major cause of drinking water pollution.

**Figure 7.** Pictures of restored slope farmland (**left**, tree age 20 years) and oil drills in the mountain area (**right**), photographed by H.Chen.

Based on the meetings with GGP officers from the different counties, we understand that the GGP is a top-down policy delivered from the central government to the province level, and to the city, county, town and finally the village level, where village leaders convey the GGP policy to each household. Thus, farmers are passively involved in the land restoration and their voice can hardly be heard. According to the responses from stakeholders, many issues had been raised by land restoration policy, such as subsidy standards for the post-stage of the restoration and a lack of biodiversity of the restored forest. It is recommended for policy makers to enable the involvement of local people and understanding the current situation through indigenous and local knowledge from stakeholders. For instance, local GGP offices are encouraged to organize workshops to understand farmers' requirements in the late stage of restoration, for example to adjust the compensation standards or duration. In the next round of the GGP, increasing the diversity

of restoration tree species will be essential to help recover a more stable and sustainable ecosystem. Additionally, science-policy agreements such as the IPBES and CBD acknowledge that the importance of indigenous and local knowledge would build diversity in knowledge systems to support the international biodiversity assessment and policy making process [38]. Thus, introducing a more participatory policy and increasing the involvement of stakeholders is encouraged for the future land restoration policy-making process.

## 5. Conclusions

To conclude, according to the results from the stakeholder survey, we observed that the majority of the stakeholders supported the current land restoration, whereas almost half of the stakeholders supported the expansion of land restoration in the future. Stakeholders perceived that the implementation of the GGP had enhanced their environmental protection awareness and stimulated labor population out-migration. For preferences in the future, the subsidy duration and amount were the most concerned topics of farmers, while other stakeholders paid attention to the biodiversity value of future restoration forests. The household restoration area rate, the degree of support for the GGP, restoration tree species satisfaction, income influence from the GGP and household income sources were identified to be the factors influencing farmers decision-making on whether to recultivate the restored forest land. The majority of the stakeholders considered that the GGP had stimulated regulation and cultural ecosystem services; however, negative impacts were observed in terms of grain production, livestock production, water yield and water quantity. We recommend that policy makers adjust the compensation standards and duration for farmers and increase the diversity of restoration tree species to strengthen the stabilization of the restored ecosystem. Additionally, the involvement of participatory processes is suggested for future policy-making in order to understand the points of views from various stakeholders.

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/land11112076/s1.

**Author Contributions:** H.C.: data curation; funding acquisition; formal analysis; investigation; methodology; project administration; resources; software; visualization; roles/writing—original draft; writing—review & editing. L.F.: methodology; resources; investigation; supervision; validation; writing—review & editing. S.W.M.: funding acquisition; resources; supervision; writing—review & editing. F.W.: funding acquisition; supervision; writing—review & editing. C.J.R.: project administration; supervision. All authors have read and agreed to the published version of the manuscript.

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**Data Availability Statement:** Data will be provided on request.

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