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Article

Integrating Agricultural and Ecotourism Development: A Crop Cultivation Suitability Framework Considering Tourists' Landscape Preferences in Qinghai Province, China

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Abstract: Ecotourism and agricultural development have been proven to have synergistic effects, although few studies have employed a spatial planning approach to incorporate tourism growth into crop cultivation planning. This study constructed a theoretical framework of environmental suitability—farmland accessibility—tourist's landscape preferences for crop cultivation planning to link regional agriculture and ecotourism development. The spatial planning of rapeseed cultivation in Qinghai Province was chosen as a case study. The main research methods include an environmental suitability analysis based on remote sensing and Maxent modeling, a farmland accessibility analysis based on a GIS platform, and a landscape preference questionnaire survey of tourists. According to the survey's findings, almost 80% of tourists thought rapeseed flowers enhanced the beauty of natural landscapes. This demonstrated the enormous potential of rapeseed fields for fostering ecotourism. Based on environmental factors, the optimum region for rapeseed cultivation covered 5.38% of the study area, or roughly 6327 km^2. The comprehensive optimum zone, which encompassed both agricultural accessibility and environmental suitability, was equal to 12.63% of the study area's farming area, or around 929 km^2. This study's crop cultivation suitability framework can integrate agricultural and ecotourism development, with substantial implications for achieving coordinated economic, social, and environmental development.

Keywords: rapeseed; spatial planning; agricultural development; tourism development; ecotourism; Qinghai–Tibet Plateau

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1. Introduction

The sustainability of the food system remains a past, present, and future global concern [1,2]. A considerable amount of time has been dedicated worldwide to cultivating more land to supply the increasing need for food due to an ever-growing population [3]. Unfortunately, this expansion is the primary cause of global carbon emissions and biodiversity loss [4]. The scientific planning of crop planting using currently cultivated land by employing geographical knowledge is essential for achieving sustainable agriculture to guarantee the sustainable development of human society and address multiple goals, such as climate change mitigation, biodiversity protection, and ecosystem service enhancement [5–7]. Such planning can boost food output, assure food security, and optimize the spatial arrangement of crops. It can also effectively allocate and utilize resources. Additionally, it can encourage the creation of diverse rural industries, raise farmers' incomes, and stimulate rural economic development.

Ecotourism is defined as responsible travel to natural areas that both conserves the environment and enhances the well-being of local communities [8,9]. In many regions, agricultural landscapes are considered hotspots of cultural ecosystem services, exhibiting enormous potential for fostering ecotourism development [10,11] because crops with high landscape aesthetic value, such as rapeseed, not only provide food but also offer people enriching aesthetic experiences [12,13]. In addition, to ensuring food production, an increasing number of areas have recognized the promotion of ecotourism as a crucial choice for rural development [14]. Integrating agriculture with ecotourism to meet the needs of farmers, urban tourists, and government administrators not only addresses the urgent demands for agricultural economic growth and tourism industry innovation, but also creates new economic growth opportunities for farmers, thereby elevating their income [15–18]. Moreover, ecotourism contributes to the conservation of unique natural landscapes and improves the ecological culture and regional image of residents [19]. Furthermore, the application of remote sensing technology and a geographic information system (GIS) can effectively identify the environmental suitability of crops and the accessibility for tourists, thereby providing valuable spatial planning references for the integration of agricultural and ecotourism development.

However, current planning often focuses solely on the environmental suitability of crop cultivation and overlooks the adaptability of agricultural landscapes to support ecotourism development. By evaluating the environmental suitability of crop cultivation, researchers can determine the impact of environmental factors on crop yield, thereby identifying the regions suitable for crop planting [20,21]. For instance, Zhao et al. evaluated the spatial distribution and variation of climatic suitability zones for soybeans in China from 1961 to 2017 and found a decrease in the consistency between climatic suitability and actual yields [22]. In a study in India, Singh et al. found that the climatic suitability of rainfed-rice growing sites is expected to decline by 15–40% by 2050 [23]. Some non-food species with high economic value, such as cotton [24], saffron [25], oil palm [21], and citrus groves [26], were also extensively evaluated for their environmental suitability based on the climatic, topographical, and soil conditions required for growth. The results can help to plan and implement regional sustainable agricultural policy [26]. Unfortunately, the majority of plans simply consider how well-suited crops are to the environment, and they pay less attention to how well-suited agricultural landscapes are to support the growth of ecotourism.

Some studies that focused on the accessibility or visual quality of natural landscapes provided ideas for integrating agricultural landscapes into tourism development [27,28]. Inglis and Vukomanovic examined changes in aspen visibility in landscape pathways and expected changes in the distribution of quaking aspen forests in the Colorado Rocky Mountains as a result of future climate change [29]. Lu et al. also used landscape visibility as an accessibility characterization indicator to quantitatively assess cultural services in the upper Minjiang River [30]. However, few studies have focused on the accessibility and visual quality of agricultural landscapes. Natural landscapes such as grasslands and forests are difficult to regulate spatially by human means. However, through a thorough evaluation of its environmental suitability and accessibility, crop cultivation on farmland can optimize its spatial distribution. This can provide tourists with the opportunity to view beautiful agricultural landscapes. Previous studies have shown that understanding tourists' travel behavior and preferences can support sustainable tourism strategies [31,32]. Landscape preference surveys can provide insights into visitors' perceptions of the visual quality of different landscapes, thus guiding landscape planning [33,34]. The cultural services of farms can be strengthened by planning crop planting while considering tourists' landscape preferences, which can support ecotourism development.

Rapeseed is one of the most important oil crops, playing a key role in food security and industrial production [35]. In Qinghai Province, where the average altitude exceeds 3000 m, it is one of the few suitable crops for cultivation. The Qinghai–Tibet Plateau is a crucial region for biodiversity conservation, and it offers crucial ecological services, including water conservation, carbon sequestration, and the prevention of wind erosion, for Asia and even the entire world [36]. Due to its unique significance, Qinghai's development therefore adopts a general tone of "ecological protection". The main goal of Qinghai's development is to encourage the creation of an ecological civilization. The creation of an "international ecological tourism destination" has been proposed as an ambitious goal, with the twin objectives of fostering sustainable economic and social development along with environmental protection. Agricultural settings, like yellow rapeseed fields, provide tourists with unique aesthetic and cultural experiences in addition to the view of the distinctive plateau natural landscape [37]. By creating agricultural landscapes that align with tourists' preferences, the region can attract more tourists and generate economic benefits while preserving the environment. Based on optimizing agricultural cultivation to enhance food production, integrating agricultural cultivation planning and ecotourism development is a priority for the high-quality development Qinghai Province.

This study proposed an environmental suitability–farmland accessibility–tourist's landscape preferences framework for spatial optimization to integrate agricultural and ecotourism development (Figure 1). For the purpose of putting this theoretical framework into practice, this study selected the agricultural region in the province of Qinghai as the study area. The comprehensive suitability of integrated agricultural and ecotourist development was determined by identifying the environmental suitability of rapeseed cultivation and the accessibility of farmland. Tourist interviews served as the foundation for an investigation of farmland accessibility and explained the function of rapeseed fields in the growth of ecotourism by examining landscape preferences. While planning the layout of agricultural production, it is crucial to take tourists' preferences for the landscape into account in order to promote reciprocal promotion between agriculture and ecotourism. A sustainable approach that benefits both sectors, as well as the area as a whole, can be achieved by prioritizing the growth of ecotourism alongside agriculture.

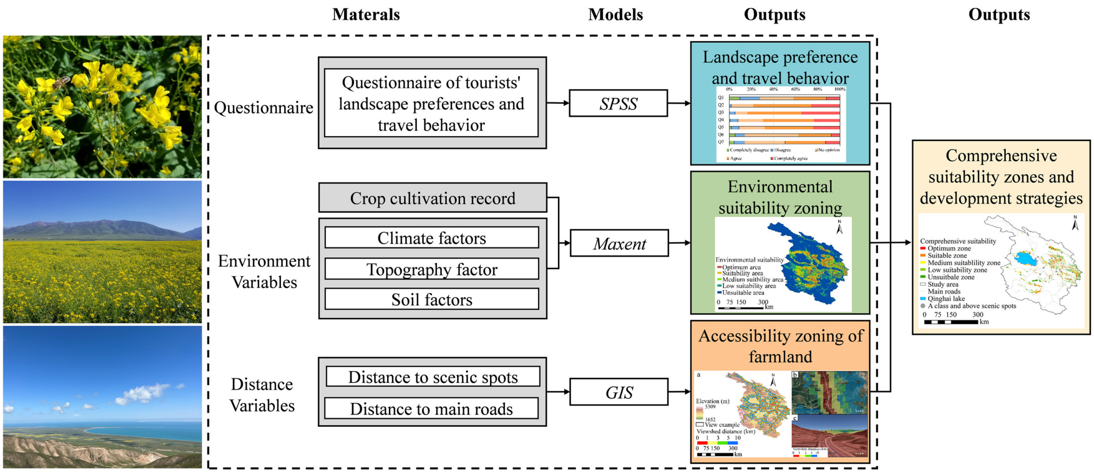

Figure 1. Environmental suitability–farmland accessibility-tourists' landscape preferences framework for spatial optimization to integrate agricultural and ecotourism development.

2. Materials and Methods

2.1. Study Area

The study area is located in the northeastern part of the Qinghai–Tibet Plateau, including the three autonomous prefectures of Haibei, Hainan, and Huangnan, and the cities of Xining and Haidong in Qinghai Province (Figure 2a). It covers an area about 117.6 thousand km^2 and has about 7358 km^2 of farmland. This region encompasses rich tourism resources with many famous attractions, such as Qinghai Lake, Amidongsuo, and Menyuan rapeseed fields. Its topography is complex and diverse, mainly showing a high west–low east distribution. It has a highland continental climate, with many hours of sunshine and strong radiation. Some areas receive about 400 mm of annual precipitation, which is suitable for growing crops such as wheat, rapeseed, plateau barley, and others. In Qinghai Province, rapeseed is the most widely grown crop, encompassing roughly 25% of the farmland. Around 95% of the rapeseed produced in Qinghai Province is grown in the study area, which is also the main rapeseed growing area. With its summertime blossoms, rapeseed is not only a significant crop in this region, but also provides a striking visual display.

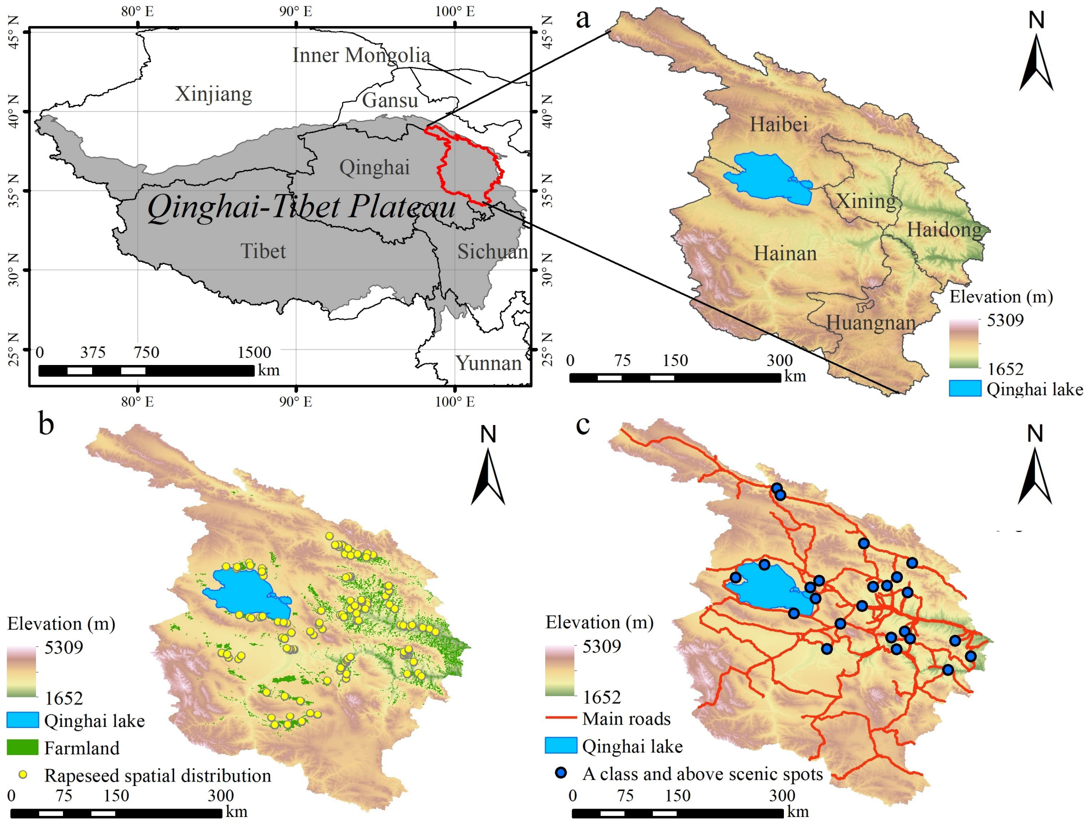

Figure 2. Location of the study area: (**a**). five cities of the study area; (**b**). rapeseed spatial distribution points; (**c**). scenic spots and main road distribution.

2.2. Questionnaire Survey of Tourists' Landscape Preferences

A questionnaire survey was conducted in the area around Qinghai Lake to understand tourist preferences. The results of the questionnaire survey indicated that tourists possessed a strong desire to visit rapeseed fields. Almost 40% of visitors were willing to make efforts to visit these fields because they enjoyed the aesthetic value that rapeseed added to the travel route. These findings provided a foundation for examining farmland accessibility and supported the idea of merging agricultural and tourism development.

The questionnaire included the basic information, travel behavior, and landscape preferences of tourists. This was determined through literature review, expert consultation, and presurvey (Supplementary Questionnaire). To ensure that the respondents held a sufficient understanding of the natural landscape and rapeseed blooms in the study area, the official survey was conducted with tourists who had viewed the rapeseed fields. The questionnaire survey was conducted in August 2021 in Menyuan, Gangcha, and Gonghe counties and in areas along the way to these destinations. Eight trained graduate student interviewers were organized to visit the study area. A total of 128 questionnaires were returned, 115 of which were valid, with a valid return rate of 89.84% (Table 1). Cronbach's alpha coefficient was used to assess the internal consistency of the scale questions ($\alpha = 0.753$). The Kaise–Meyer–Olkin test (KMO = 0.711) and Bartlett's test of sphericity ($p = 0.000$) were used to test the reliability of the questionnaire [38]. Therefore, the reliability and validity of the questionnaire were good and met the requirements of the analysis.

Table 1. Summary of the sample demography ($N = 115$).

Demographic Factor	Type	Frequency	Percentage (%)
Gender	Male	58	50.43
	Female	57	49.57
Age	≤25	31	26.96
	26–40	44	38.26
	41–50	26	22.61
	≥51	14	12.17
Marital status	Married	68	59.13
	Unmarried	47	40.87
Education	Junior high school and below	12	10.43
	High school	34	29.57
	Bachelor's degree	53	46.09
	Master degree and above	16	13.91
Income	≤2000	23	20.00
	2001–6000	40	34.78
	6001–10,000	32	27.83
	≥10,001	20	17.39
Family size	≤2	4	3.48
	3	61	53.04
	≥4	50	43.48

2.3. Environmental Suitability Assessment for Crop Cultivation

To assess the suitability of crop cultivation, this study employed the widely used Maxent model for ecological niche modeling. The Maxent model, based on the principle of maximum entropy, allows for the prediction of species suitability in various geographical regions using data on species occurrences and environmental variables [39]. In previous research, the Maxent model has been extensively applied to predict the distribution range of plant species, showcasing exceptional performance in the field of ecology [22,40]. The strengths of the Maxent model lie in its capacity for nonlinear modeling and robustness, enabling us to gain a comprehensive understanding of the relationship between crop cultivation and environmental factors [41]. Therefore, we chose the Maxent model as the tool to evaluate the suitability of crop cultivation, providing robust scientific evidence and bolstering decision-making processes. The main mathematical principle of the Maxent model is as follows [42].

$$max_{p \in c} H(P) = -\sum_{x,y} \widetilde{P}(x) P(y|x) \log P(y|x) \tag{1}$$

$$s.t.\ E_p(f_i) = E_{\widetilde{p}}(f_i),\ i = 1,\ 2, \ldots,\ n \tag{2}$$

where the output of x is y, and the characteristic function is $f_i(x,y)$, $i = 1, 2, \ldots, n$. $H(P)$ denotes the uncertainty of x under y conditions, $P(y|x)$ is the probability distribution assumption of y when x takes a certain value, $\widetilde{P}(x)$ is an estimate of the cumulative distribution function of x, and $E_{\widetilde{p}}(f_i)$ denotes the expectation of $f_i(x,y)$ with respect to $\widetilde{P}(x)$. The output of the Maxent model is the probability of distribution (p-value) of the species. This can be transformed into raster data, with probability values from 0 to 1, indicating the environmental suitability of a species for different raster cells. The higher the value, the more suitable the raster cell is for a species.

Based on the Indicators and Names of Climate Resource Zoning for Plateau Agriculture and Animal Husbandry in Qinghai Province (http://www.qinghai.gov.cn/ (accessed on 21 November 2021)) and the suggestions of Maxent model developers (https://biodiversityinformatics.amnh.org/open_source/maxent/ (accessed on 10 October 2021)), we selected 22 factors pertaining to climate, topography, and soil which are closely related to the growth of rapeseed as potential variables affecting the suitability of rapeseed cultivation. These included 16 climate factors, 3 topography factors, and 3 soil factors (Table 2, Figure S1). Strong collinearity between environmental variables may lead to the misinterpretation of model outputs in the Maxent model [43]. Therefore, we used SDM toolbox 2.4 to calculate the Pearson's correlation coefficients between two of the 22 environmental variables, eliminated the highly correlated variables ($|r| \geq 0.8$), and retained the important variables [44]. Finally, 8 environmental factors were used in the model predictions: ≥10 °C accumulated temperature, the temperature of the warmest month, the total amount of precipitation from April to September, aspect, slope, soil pH, available soil water capacity class, and soil bulk density. We further calculated the VIF values of the 8 factors using the "*cor*" package on the R studio platform. The results showed that the VIF values of the 8 variables were lower than 4, i.e., there was no significant covariance feature among them (Table S1).

Rapeseed is planted in regular plots and its flowers are bright yellow, making it easy to identify on remote sensing images based on color and landscape pattern shape. This study collected 121 distribution sites for rapeseed planting on the Google Earth platform based on two field surveys carried out in August 2021 and July 2022. These distribution points were utilized to forecast environmental suitability (Figure 2b). A total of 25% of the rapeseed distribution points were randomly chosen to represent the model's accuracy, while the remaining 75% were utilized to assess training data during the model simulation. In this work, a receiver operating characteristic curve (ROC) was used to assess the correctness of the results of the Maxent model simulation [45]. The area under the curve (AUC) is the specific measure of the accuracy of the simulation results [42]. The AUC values often fell between 0.5 and 1, and the greater the value, the more accurate the simulation of the model. There were typically five categories: 0.5–0.6 (poor), 0.6–0.7 (fair), 0.7–0.8 (good), 0.8–0.9 (very good), and 0.9–1 (excellent) [40,46]. To validate the accuracy of our environmental suitability assessment results, we conducted a comparison with the established rapeseed cultivation areas. These existing cultivation areas were derived from the China 2017–2021 rapeseed map dataset, which boasts a 20 m resolution and was generated using Sentinel data (https://zenodo.org/record/7047270 (accessed on 14 September 2023)). The dataset producers have reported an impressive average overall accuracy rate of 94.9% [47].

Table 2. Potential environmental factors affecting the growth of rapeseed in the study.

Factor Type	Factor Name	Number	Calculation Method	Data Resource
Climate factor	Precipitation (mm) of wettest month	1	Average July precipitation from 1988 to 2017.	The 1 km monthly precipitation dataset for China (1901–2017) from the National Tibetan Plateau Data Center [48,49].
	Monthly precipitation (mm) from April to September (growing season)	5	Average monthly precipitation for April, May, June, August, and September from 1988 to 2017.	
	Total precipitation (mm) from April to September (growing season)	1	Sum of average monthly precipitation for April, May, June, July, August, and September from 1988 to 2017.	

Table 2. *Cont.*

Factor Type	Factor Name	Number	Calculation Method	Data Resource
	Temperature of warmest month (°C)	1	Average July temperature from 1988 to 2017.	The 1 km monthly mean temperature dataset for China (1901–2017) from the National Tibetan Plateau Data Center [49,50].
	Monthly temperature (°C) from April to September (growing season)	5	Average monthly temperatures for April, May, June, August, and September from 1988 to 2017.	
	Temperature (mm) from April to September (growing season)	1	Average temperatures for April, May, June, July, August, and September from 1988 to 2017.	
	≥0 °C accumulated temperature (°C·d)	1	The sum of the daily average temperatures above 10 degrees Celsius (≥0 °C) for each day of the year.	Meteorological background datasets for China from the Resource and Environment Science and Data Center (https://www.resdc.cn/ (accessed on 15 October 2021)).
	≥10 °C accumulated temperature (°C·d)	1	The sum of the daily average temperatures above 0 degrees Celsius (≥0 °C) for each day of the year.	
Topography factor	Elevation (m)	1	——	Google Earth Engine platform (original data source is the USGS).
	Aspect (°)	1	——	
	Slope (°)	1	——	
Soil factor	Soil pH	1	——	HWSD, Harmonized World Soil Database (https://www.fao.org/soils-portal (accessed on 15 October 2021)).
	Available soil water capacity class	1	——	
	Soil bulk density (g/cm^3)	1	——	

Note: All data were resampled to 1 km precision raster data. Temperature and precipitation data are average values from 1988 to 2017.

2.4. Landscape Visibility Assessment

This study evaluated the suitability of the promotion of different rapeseed fields on ecotourism development by assessing the landscape visibility of farmlands. This approach considered the characteristics of the study area and drew upon previous research findings. The vast and open plateau terrain of Qinghai Province provides tourist with ample opportunities to appreciate the scenic beauty while driving or riding. Furthermore, landscape visibility analysis has been widely utilized to study the aesthetic experiences derived by tourists from natural landscapes [27]. Adopting the perspective of tourists, we analyze the landscapes visible along roads and at points of interest to comprehensively assess their aesthetic value and accessibility [30]. Additionally, the results of our questionnaire survey further confirm the high attractiveness of rapeseed fields to tourists. Therefore, this study defined landscape accessibility in terms of the viewshed distance between natural scenic spots and the main road network. Visible distance is affected by factors such as the observer and terrain [51]. According to road traffic safety standards, 1 m is the average eye height of a car driver and passenger under normal circumstances, so this height was set as the observation height on the road [29]. In scenic areas, we set the viewing height to 1.7 m. Nearer visible objects are of greater significance than distant objects [52]. 10 km is generally considered to be the distance of maximum visibility; therefore, we set the maximum visible distance to 10 km [53]. Areas up to 10 km are further categorized into visibility classes based on distance and proximity, in accordance with previous studies [54]. Finally, the accessibility of the landscape was classified into five zones according to the visibility distance (D): nearby area ($D \leq 1$ km), proximity area (1 km $< D \leq 3$ km), medium distance area (3 km $< D \leq 5$ km), farther area (5 km $< D \leq 10$ km), and remote area (10 km $\leq D$).

A total of 25 natural scenic spots above class A (Table S2), along with major roads, were selected as view areas for tourists, thus identifying the areas visible to tourists during their travels. The scenic spot data were obtained from the Qinghai Provincial Bureau of Statistics [55]. The main roads included the traffic arteries of the third-level and above, which were the most heavily traveled roads, and the data were obtained from the National Catalogue Service for Geographic Information (https://www.webmap.cn/ (accessed on 24 November 2021)). Figure 2c showed the spatial distribution of the scenic spots and main roads in the study area. In this study, we determined the landscape's visibility using DEM data, the coordinates of scenic spots of class A or above, and information on the road network. Using the ArcGIS 10.5 platform, the visibility toolbox was used to calculate the visibility distances.

2.5. Comprehensive Suitability Zoning Methodology

This study integrated environmental suitability and landscape accessibility to evaluate the comprehensive suitability of rapeseed cultivation on farmland in the study area. The comprehensive suitability zoning class of a farmland patch was determined by the lowest level of environmental suitability and landscape accessibility. For instance, if a farmland patch exhibits optimal environmental suitability, but a more remote accessibility zone, then its comprehensive zone is a low suitability zone (Figure 3).

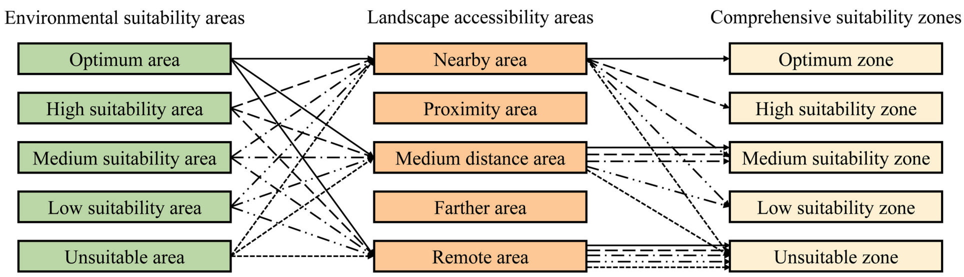

Figure 3. Comprehensive suitability zoning criteria of rapeseed cultivation based on environmental suitability and landscape accessibility. Different lines were used to differentiate between the final combined suitability zoning and the separate environmental suitability zoning and accessibility zoning results.

3. Results

3.1. Validation of Crop Environmental Suitability Assessment

In the Maxent model run, we employed commonly used parameters, i.e., the number of maximum iterations was 500, the max number of background points was 10,000, the convergence threshold was 0.00001, and the prevalence was 0.5 [56]. Our repetition number was 10.

The ROC curves obtained after a single run and ten runs are shown in Figure 3. The black, red, and blue lines in the figure indicate the ROC curves for the random distribution of rapeseed, the test data, and the training data, respectively. The results of a single run of the model showed an AUC value of 0.926 for the training data, indicating that the model performed well in regards to prediction, and the results were credible (Figure 4a). To improve the robustness of the results, we repeated the model 10 times using the same variables and methods (Figure S3). The accuracy of the model prediction was good, with an average training AUC of 0.984 and a standard deviation of 0.001 (Figure 4b). The final rapeseed environmental suitability (p-value) results were the average of ten runs. The estimates of the relative contributions of the environmental variables to the Maxent model are presented in Table S3. Additionally, Figure S2 shows how environmental factors affected Maxent's prediction findings.

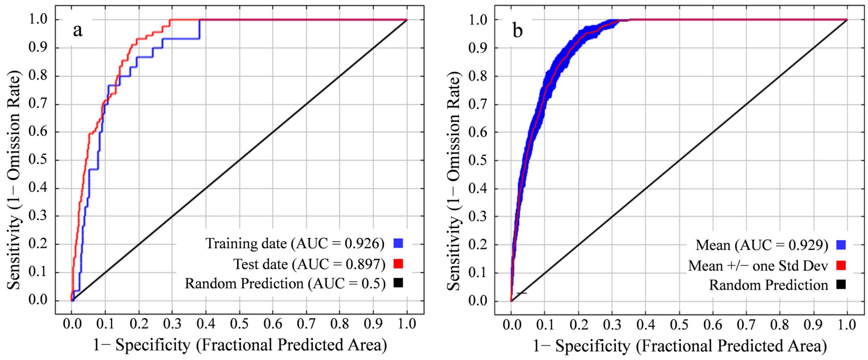

Figure 4. ROC curves for one run (**a**) and ten runs (**b**) of the Maxent model to predict rapeseed distribution.

3.2. Environmental Suitability of Rapeseed Growth

We acquired the findings of the environmental suitability zoning for rapeseed agriculture, as shown in Figure 5, based on the outcomes of the Maxent model simulation. Using the natural breakpoint approach and the *p*-value, the study region was classified into five separate environmental suitability zones for rapeseed cultivation (Table 3). The area statistics showed that the optimum area accounted for 5.38%, the suitable area accounted for 9.49%, the medium suitable area accounted for 8.72%, and the low suitable area accounted for 15.28% of the study area. Unsuitable areas accounted for the largest area of 61.13%. When considering the proportions of farmland area, more than half of the farmland exhibited a high suitability for rapeseed cultivation. The optimum area occupied 26.52% of the farmland area, while the suitable area covered 33.13%. In terms of spatial distribution, the optimum and suitable areas were mainly distributed in the central part of the study area and the eastern part of the river valley. The northeastern region of the research area, particular Menyuan County, was highly suitable for rapeseed cultivation. Most of the northern and southern regions encompass high altitudes, with poor agricultural potential for rapeseed cultivation. We further analyzed the existing rapeseed cultivation locations (Figure S5) in various suitability areas. The results indicate a significant spatial overlap between rapeseed cultivation areas from 2017 to 2021 and the optimum area, suitable area, and medium suitable area. On average, each year, approximately 86.84% of the cultivation areas were located within these three areas (Figure S6a). Considering the cultivation frequency, approximately 93.94% of the areas cultivated annually fell within these three areas (Figure S6b). Consequently, these environmental suitability assessment results demonstrate a high level of reliability.

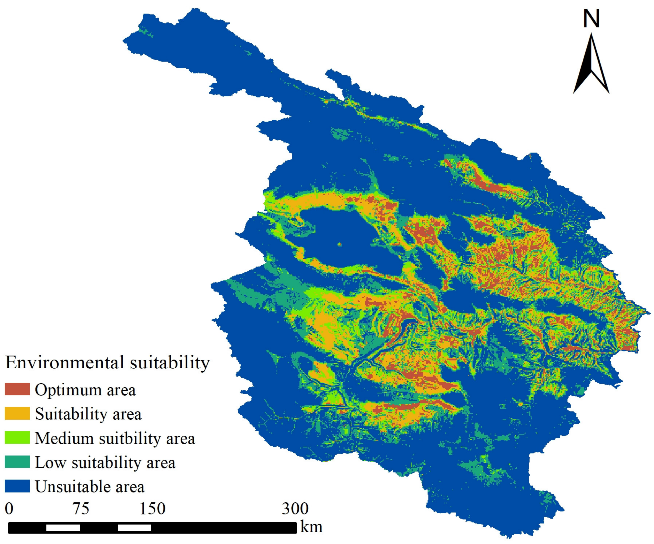

Figure 5. Environmental suitability of rapeseed cultivation.

Table 3. Environmental suitability zoning criteria and the areas of rapeseed cultivation.

Environmental Suitability Zone Type	*p*-Values Range	Proportion of Study Area	Proportion of Farmland in the Study Area
Optimum area	$0.52 \leq p < 1$	5.38%	26.52%
Suitable area	$0.36 \leq p < 0.52$	9.49%	33.13%
Medium suitable area	$0.20 \leq p < 0.36$	8.72%	19.27%
Low suitable area	$0.05 \leq p < 0.20$	15.28%	14.68%
Unsuitable area	$0 \leq p < 0.05$	61.13%	6.40%

3.3. Landscape Accessibility Characterized by Visibility

This study defined landscape accessibility in terms of the viewshed distance between popular tourist destinations and the main road network (Figure 6). Under the assumption of a constant tourist observation height, the viewshed distance is mainly determined by the geomorphological conditions in the study area. The results indicated that the terrain around Qinghai Lake was relatively flat and possessed long viewshed distances (Figure 6a). In contrast, the central region and the eastern river valley had more rugged terrain and shorter viewshed distances, mostly within 5 km. Tourists might observe viewsheds along the road, as represented in Figure 6b,c. At this short distance, tourists could view farmland, while in the far distance, they could see snow-capped mountains. By overlaying the distribution of farmland and the results of landscape visibility assessment, we found that approximately 73.40% of the farmland is within the visible range (Figure S7). Specifically, the farmland located in nearby regions (1 km < D ≤ 3 km) covers around 2015 square kilometers, accounting for 27.38% of the total farmland area. The proportions of farmland in the proximity area (3 km < D ≤ 5 km), farther area (5 km < D ≤ 10 km), and remote area (10 km ≤ D) are 22%, 10.7%, and 13.32%, respectively. Farmland located more than 10 km away accounts for approximately 26.60% of the total farmland area in the study area.

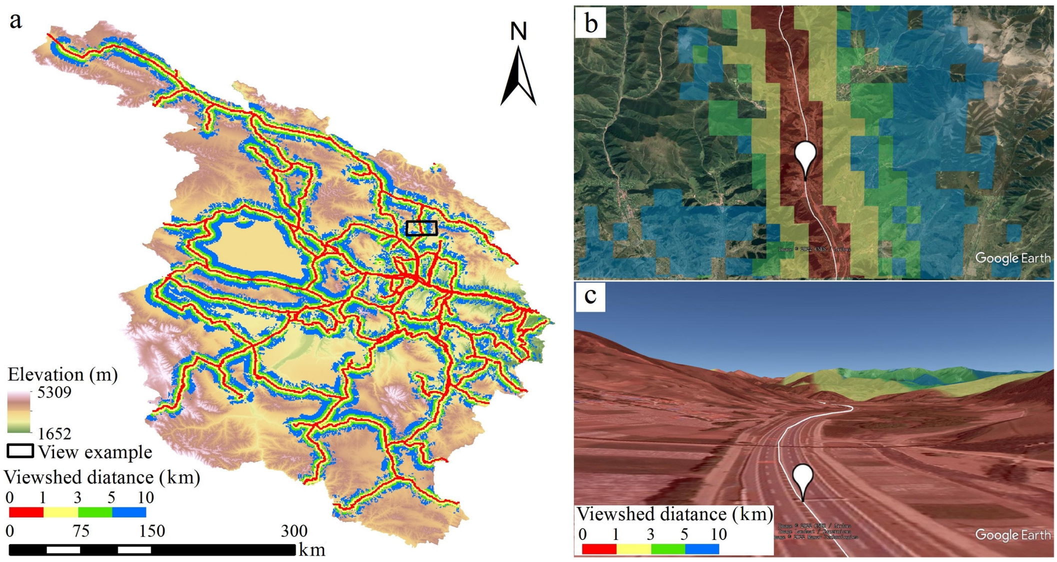

Figure 6. Landscape visibility and view example. (**a**) is the result of visibility distance analysis at main roads and scenic spots. Coordinates of the white points in (**b**,**c**): N37°05′42.36″, E101°47′53.28″. The viewing height of (**b**) is 25 km. The black frame of the view example in (**a**) is the boundary of (**b**).

3.4. Comprehensive Suitability for Integrating Agricultural and Ecotourism Development

Based on the results of the environmental suitability zoning and the results of the accessibility analysis, we obtained a comprehensive suitability zoning for rapeseed cultivation that integrates agricultural development and ecotourism. Figure 7 presents the comprehensive suitability of rapeseed cultivation, linking agricultural development and ecotourism development. The farmland divided into optimum and suitable zones was mainly located in the Xining, Haidong, and Menyuan areas of Haibei. The comprehensive suitability of some farmland around Qinghai Lake was also high. The optimum zone accounted for 12.63%, the suitable zone made up 29.00%, the medium suitable zone encompassed 24.10%, the low suitable zone covered 27.88%, and the unsuitable zone comprised 6.40% of the total farmland area.

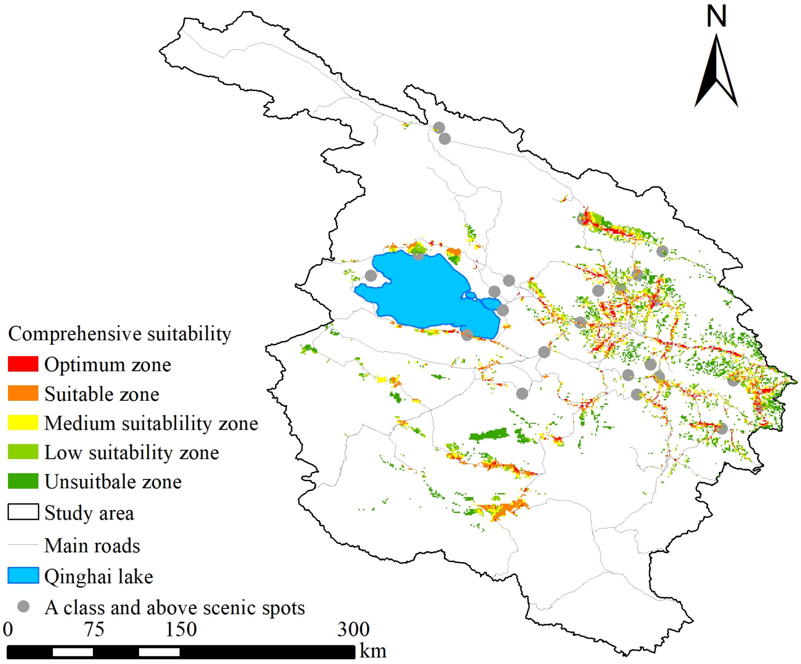

Figure 7. Comprehensive suitability zones of rapeseed cultivation for integrating agricultural and ecotourism development.

4. Discussion

4.1. Crop Cultivation Planning for Integrating Agricultural and Ecotourism Development

This study aimed to integrate agriculture and ecotourism development based on the environmental suitability–farmland accessibility-tourists' landscape preferences framework, using rapeseed cultivation in Qinghai Province as a case study. We obtained a comprehensive suitability zoning evaluation for rapeseed cultivation by assessing its environmental suitability and landscape accessibility. This was similar to the methods in other related studies that provided references for suitable areas for rapeseed cultivation to enhance the crop yield [24–26,57]. However, we also considered the accessibility of tourists to rapeseed fields in our cultivation planning, which offered guidance for ecotourism development and planning. It should be noted that the comprehensive suitability zoning method does not imply that farmland with high suitability should grow only rapeseed or that it is unsuitable for other crops. We focused on providing a planning reference in a spatial layout, and farmland with high comprehensive suitability had a higher potential for ensuring rapeseed production and promoting tourism development. If rapeseed were grown on all highly suitable farmland, it would lead to a reduction in farmland diversity, which was detrimental to farmland biodiversity conservation and stable income generation for farmers [58–60]. To effectively implement the agricultural planting and tourism development plans, we need to take the actual situation into account. Moreover, our questionnaire survey results supported the hypothesis that rapeseed fields attract tourists, which partly justified our proposed crop planting framework.

The integration of agriculture and ecotourism is a trend in regards to the development of agriculture and rural areas that can satisfy the consumption needs of urban tourists [18]. By developing integrated industries, such as rural tourism and agricultural experience tours, the unique features and advantages of agricultural and rural ecology and folk culture can be leveraged to drive increased income for farmers, as well as agricultural upgrading. A study in rural Spain also demonstrated that improving the visual quality of olive groves had a positive impact on the rural economy, as landscape improvements increase tourists' willingness to visit the area [61]. To create a complete industry chain that facilitates high-quality regional development, it was necessary to promote the integration of agriculture and ecotourism into crop planting planning, to develop a variety of tourism projects, and to establish supporting commercial projects.

4.2. Landscape Preferences of Tourists and Their Contribution to Farmland Accessibility Analysis

The questionnaire included a landscape preference module with seven questions concerning tourists' landscape preferences for rapeseed fields and their willingness to buy rapeseed products. Each question had five options based on the Likert scale: strongly disagree, disagree, neutral, agree, and strongly agree (Figure 8). The results of the questionnaire survey showed that rapeseed flower fields have great potential to promote ecotourism. They are the basis for the proposed environmental suitability—farmland accessibility—tourist' landscape preference framework.

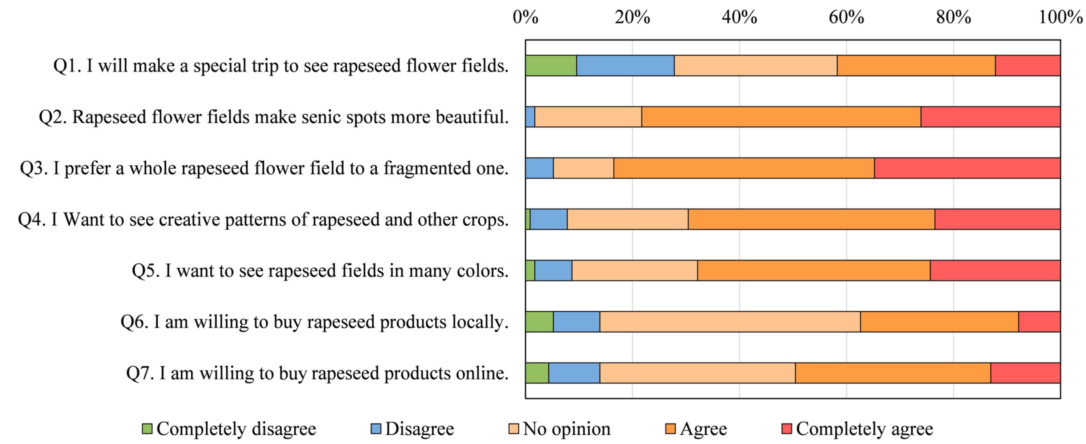

Figure 8. Tourists' landscape preference statistics regarding rapeseed flower fields.

The results suggest that rapeseed flowers have a high aesthetic value. The high appreciation of rapeseed fields by tourists highlighted the great potential of these fields to promote the development of ecotourism. A total of 78.26% of the tourists believed that rapeseed flower fields enhanced the beauty of natural scenic spots (26.09% completely agreed, 52.17% agreed), 20.00% of the tourists had no definite agreement, and only 1.74% disagreed. In addition, more than 40% of the visitors were willing to make a special journey to observe the rapeseed fields. Hence, improving the spatial arrangement of rapeseed farming not only improves the visitor experience, but also promotes their consumption. Regarding the spatial pattern of rapeseed flower fields, 83.49% of tourists preferred a continuous rapeseed flower field over a fragmented one (34.78% completely agreed, 48.70% agreed). At the same time, 69.56% of the tourists liked the creative patterns in the rapeseed fields (26.09% completely agree, 52.17% agree). Colorful flowers influence the ornamental value of many flowering plants. Currently, tourists are attracted mainly by yellow rapeseed flowers. It has been recently reported that rapeseed flowers are available in other colors, such as pale white, orange, pink, and purple [62,63]. In the future, it may be possible to plant rapeseed flowers of various colors to improve their ornamental value. The results of our questionnaire indicated that 67.83% of tourists expressed an interest in seeing multi-colored rapeseed flower fields (24.35% completely agreed, 43.48% agreed). We also compared visitors' willingness to purchase rapeseed products and found that tourists preferred online purchasing options. Based on the survey of tourists' landscape preferences, the spatial planning strategies of rapeseed fields can be formulated according to the tourists' preferences to enhance their attraction.

4.3. Recommendations for Agricultural and Ecotourism Development Considering Tourists' Landscape Preferences

In our study, the agricultural area of Qinghai Province was selected as a case study to implement our proposed crop cultivation planning framework. Qinghai Province is an important region for building an ecological society in China. In recent years, Qinghai Province has been practicing green development and promoting environmentally friendly tourism, with a tourism revenue of CNY 56.1 billion in 2019 [64]. According to the recently released 14th Five-Year Tourism Development Plan of Qinghai Province, the target for total tourism revenue is CNY 80 billion by 2025, with an average annual growth rate of more than 20% [65]. Therefore, ecotourism is regarded as an important engine for future economic growth in this region. Certainly, the development of the tourism business in Qinghai Province is based on the distinctive and diversified natural sceneries found on the plateau, including grasslands, lakes, canyons, snow mountains, and salt lakes. Rapeseed flower fields with yellow flowers can also offer unforgettable aesthetic experiences for tourists. The open plateau terrain allows tourists to enjoy more scenery while driving and riding. Qinghai Province has taken measures to increase the number of drivable camping sites, improve the transportation network, and establish a convenient car rental system to promote regional tourism and provide tourists with more opportunities to appreciate the scenery within the province. Qinghai Province is an ideal test area for integrating agricultural development and ecological tourism, and we believe that our conceptual framework is also applicable in other locations. Particularly in rural areas near cities, urban tourists have access more convenient transportation conditions, with sufficient time to visit.

Before making recommendations, it is necessary to analyze the factors influencing tourists' landscape preferences. Landscape attributes such as landscape type, landscape configuration, and landscape diversity are important factors that influence landscape preferences [66,67]. In addition, demographic characteristics, such as gender, age, education level, and travel behavior, are also important in generating differences in landscape preferences [68–70]. Exploring the relationship between demographic characteristics and landscape preferences can provide valuable information for planners and managers. The Mann-Whitney U test analysis revealed that there was no significant difference in respondents' preference for rapeseed fields across gender and marital status. Furthermore, we analyzed potential factors influencing landscape preference by calculating the Spearman correlation coefficient between other visitors' demographic characteristics and landscape preferences. We found no significant relationship between age and rapeseed-related landscape preferences (Figure 9). Education level and income showed significant positive correlations, while both showed insignificant negative correlations with landscape preferences. This is similar to the results of other studies. For instance, in a study of tourists' preferences in urban parks, Gan et al. found a negative correlation between tourists' education level and landscape preference scores [71]. Similar findings were obtained in Wang and Zhao's study on differences in visual preferences for urban green spaces in regards to different demographic characteristics [72]. In terms of tourism behavior, the results showed that tourists' willingness to purchase rapeseed agricultural products decreased as the length of tourism increased. Also, tourists' tour frequency and spending showed a significant negative correlation with landscape preferences for rapeseed. Considering people's varying perceptions and preferences would make the landscape design more valuable.

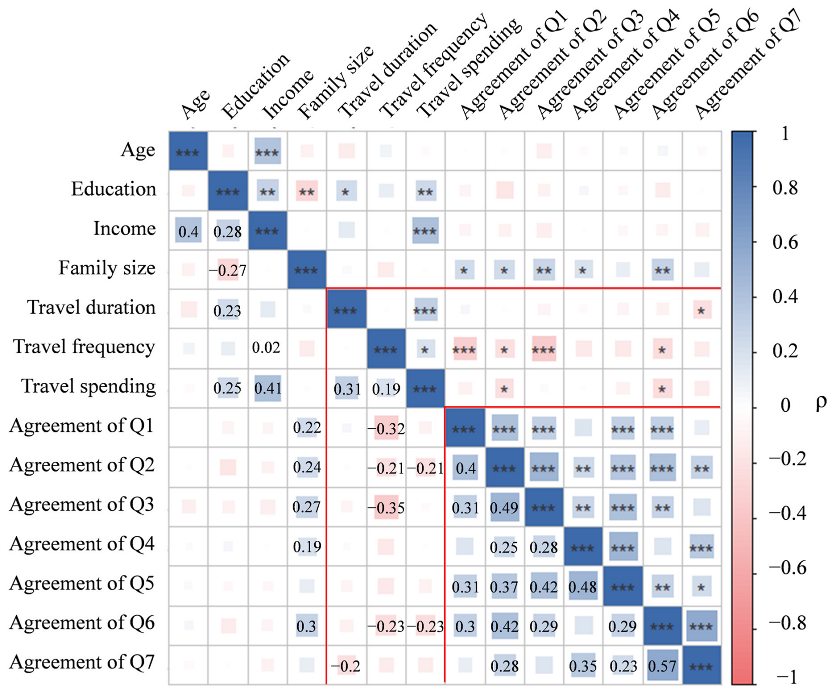

Figure 9. Spearman's correlation coefficients between questionnaire answers. ρ represents Spearman's correlation coefficient. Q1 represents, "I will make a special trip to see the rapeseed fields"; Q2, "Rapeseed flower fields make scenic spots more beautiful"; Q3, "I prefer a whole rapeseed flower field to a fragmented one"; Q4, "I want to see creative patterns of rapeseed and other crops"; Q5, "I want to see rapeseed fields in many colors"; Q6, "I am willing to buy rapeseed products locally"; Q7, "I am willing to buy rapeseed products online". *, **, and *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.

Based on the comprehensive zoning results and tourists' landscape aesthetic preferences, as well as the feedback from the tourists interviewed during the questionnaire survey, we suggest the following tourism development strategies: (1) increasing the ornamental diversity of rapeseed fields, (2) designing landscape paths in alignment with rapeseed cultivation layout, (3) strengthening the communication and coordination between government departments and farmers regarding rapeseed cultivation planning, (4) diversifying income sources for farmers through visitor tickets and rapeseed products, and (5) improving the rapeseed cultivation industry, marketing rapeseed agricultural products, and enhancing the economic benefits of rapeseed cultivation. Based on the results of landscape preference driver analysis, developing economical tourism routes and rapeseed agricultural products is more beneficial to promote tourists' consumption.

4.4. Limitations and Perspectives

There were some limitations in this study. Firstly, our study primarily focused on leveraging remote sensing technology and geographical knowledge to provide policy makers with spatial references for rapeseed cultivation. This spatial perspective was aimed at facilitating the integration of agricultural development and ecotourism. However, we have not extensively delved into the livelihood changes of farmers, the preferences of policy-makers, and the investment intentions of businesses. In future research, it will be essential to further refine the logical framework for the synergistic development of agriculture and ecotourism from economic and societal perspectives. Secondly, as higher precision data were difficult to obtain, we used spatial data with a resolution of 1 km to identify the environmental suitability of rapeseed and farmland accessibility, providing a reference for the comprehensive zoning of rapeseed cultivation. In planning for project implementation or suitability evaluation in a smaller study area, data with higher precision would be required. Thirdly, for the questionnaire survey, we only obtained 128 results. We would like to ensure that the answers we obtain are more representative of those who have traveled to Qinghai Province and viewed the rapeseed flower in the fields. This would avoid any bias in the results that might be caused by descriptions or photographs. In addition, as shown by the results of the study, there was an increased awareness of the crisis among tourists due to the COVID-19 epidemic, making tourism interview acceptability [73]. They also refused to scan the QR code to complete the survey online due to personal information leakage. This made it considerably more difficult to obtain questionnaires from tourists. In future studies, we will explore ways to make the questionnaire more accessible to tourists in order to increase the number of questionnaires and thus obtain more informative results. Finally, our study only discussed rapeseed, as it is a significant crop within the study area. In other study areas, plants such as sunflowers or lavender, which possess high landscape value, can be considered as subjects of study to plan their cultivation layouts, thereby enhancing tourists' aesthetic experiences.

5. Conclusions

This study proposed an environmental suitability–farmland accessibility–tourists' aesthetic preference crop cultivation planning framework. The agricultural area of Qinghai Province was selected as a case study to identify suitable areas for rapeseed cultivation, in order to promote the synergistic development of tourism and agriculture through the rational planning of the spatial layout of crops. Taking rapeseed as an example, we identified the integrated suitability of rapeseed cultivation based on both environmental suitability and farmland accessibility. The basis for integrating agriculture and tourism was garnered from a tourist landscape preference questionnaire survey. This offered a foundation for categorizing the accessibility analysis of farmland in terms of visibility of naturally beautiful areas and access from major roads, which only verified the huge potential of rapeseed fields for tourism growth. The results showed that the optimum zone accounted for 12.63%, the suitable zone made up 29.00%, the medium suitable zone encompassed 24.10%, the low suitable zone covered 27.88%, and the unsuitable zone comprised 6.40% of the total farmland area.

In contrast to the methods of other research, this study not only determined the environmental suitability of crops, but also their contribution to the growth of the tourism industry and the integration of agriculture and ecotourism into crop planning. There were still some shortcomings in our study, such as the lack of an in-depth study of the livelihoods of farmers, limitations in the number of questionnaires, and the consideration of only one crop, rapeseed. Future research could address these shortcomings in depth and refine the logical chain of integrating agricultural development and ecotourism through crop planning.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/rs15194685/s1, Figure S1: Spatial distribution of potential environmental factors affecting rapeseed cultivation; Figure S2: Jackknife test results of regularized gain of rapeseed (a), test gain of rapeseed (b) and AUC (c) for variable importance; Figure S3: Receiver operating characteristic (ROC) curves for the training and test sets of rapeseeds; Figure S4: Effect of environmental variables on Maxent's prediction results; Figure S5: Areas of rapeseed cultivation from 2017 to 2021 (a to e) and frequency (f) of cultivation over the five-year period; Figure S6: Area (a) and frequency area (b) statistics of rapeseed cultivation in different environmental suitability areas from 2017 to 2021; Figure S7: Landscape visibility of farmland in study area; Table S1: VIF values for eight variables entered the Maxent model; Table S1: VIF values for eight variables entered the Maxent model; Table S2: Catalogue of state class scenic spots of study area; Table S3: Estimates of relative contributions of the environmental variables to the Maxent model; Supplementary Questionnaire: survey of tourists' landscape preferences and travel behavior.

Author Contributions: H.W.: conceptualization, methodology, formal analysis, writing—original draft; J.Z.: writing—review and editing, resources, supervision; C.W.: data curation, formal analysis, writing—original draft; O.A.B. conceptualization, writing—review and editing; M.A.K.; writing—review and editing; W.L.: methodology, writing—review and editing; X.C.: formal analysis, writing—review and editing; Y.T.: methodology, writing—review and editing; H.L.: investigation, writing—review and editing; Z.Y.: investigation, writing—review and editing; C.B.: investigation, writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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Conflicts of Interest: The authors declare no conflict of interest.

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