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*Review*

# Mountainous Areas: Alleviating the Shortage of Cultivated Land Caused by Changing Dietary Structure in China

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**Abstract:** Achieving food security and improving nutrition is one of the United Nations Sustainable Development Goals. With rapid socioeconomic development, the dietary structure of the Chinese population has changed significantly, leading to increased demand for cultivated land. At the same time, rapid urbanization has continuously reduced the amount of cultivated land in China, and there is an urgent necessity for the nation to alleviate the shortage of cultivated land to meet the population's evolving dietary consumption needs. A review of the literature indicates that the use of mountainous areas to produce agricultural products for the population can effectively reduce the use of cultivated land on the plains and mitigate the shortage of cultivated land to meet dietary consumption needs. According to the different natural and socioeconomic conditions of mountainous areas, this study concludes that the adoption of mountain hillside, mountain understory, and mountainous limited cultivated land use patterns to develop agricultural production in mountainous areas is an effective approach to address the shortage of cultivated land caused by changes in the Chinese dietary structure.

**Keywords:** mountain agriculture; dietary structure; cultivated land shortage; China



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## 1. Introduction

The rapid growth of the world's population has led to the occurrence of a shortage of food supply and a shortage of cultivated land resources. Global food demand has increased approximately twofold in the past 50 years [1], and the demand for cultivated land has increased accordingly. However, due to the rapid process of urbanization and industrialization, illegal land use, and over-exploitation of cultivated land [2–5], the world's cultivated land is gradually decreasing [6]. By 2030, 3.7% of the world's farmland will disappear, especially in developing countries. Cultivated land shortages and food crises continue to worsen in many parts of the world, and global food insecurity is becoming increasingly evident. China has a population of more than 1.4 billion. According to the FAO, the per capita cultivated land in China is about 0.08 ha [7], and the average cultivated land per household in China is only 0.38 ha [8], which is much lower than the global average. The shortage of cultivable land in China is very serious due to the huge demand for food from the huge population and the very tight cultivable land resources.

On top of the increasing demand for food, the changing structure of China's national food consumption has placed new demands on cultivated land. In recent years, China's food consumption patterns have rapidly shifted from the predominant use of grains and vegetables to a greater variety and diversity of animal products [9,10]. According to Figure 1, the per capita consumption of staple foods in rural areas of China showed a significant decrease and a small increase in the per capita consumption of vegetables and edible mushrooms, while a significant increase in animal products (meat, aquatic products, eggs, and milk) was observed. However, existing studies have shown that more land resources are required to provide animal-based food than plant-based food [11,12].

The production of animal food requires land for feed production in addition to land for feeding. Shepon's study showed that per unit of cultivated land produced, plant-based nutritious food can reach 2–20 times more in volume than animal-based nutritious food [13]. Smil's research shows that the land needed to produce meat protein is three to ten times greater than vegetable protein [14]. The increased demand for animal food will inevitably require more cultivated land [15]. Some studies have predicted that if China relies solely on domestic cultivated land resources, by 2035, it will be difficult to feed its population under seven dietary consumption structures, even with the strictest farmland protection regime maintaining cultivated land at around 124.3 Mha [16]. The increase in demand for animal-based food has exacerbated the strain on China's cultivated land, posing a greater challenge to the country's food production land and food security.

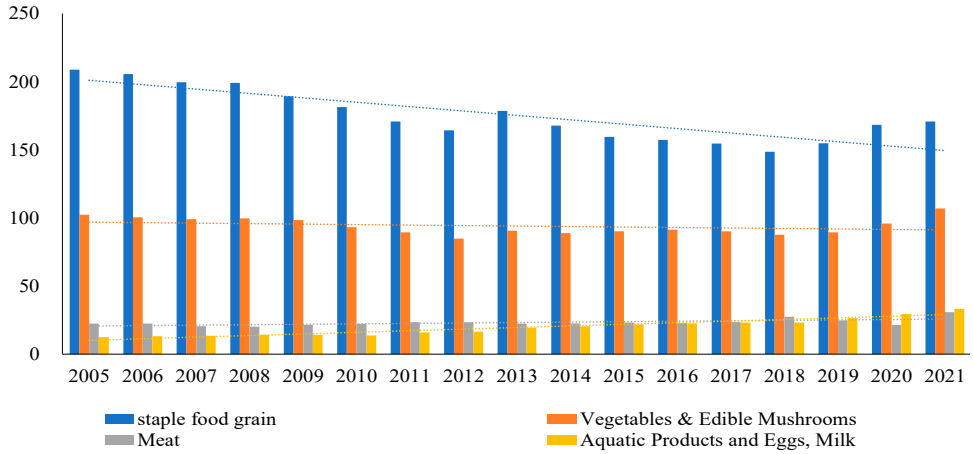


**Figure 1.** Rural residents' per capita consumption of major foodstuffs. Between 2005 and 2021, per capita consumption of staple food grain in rural areas decreased from 208.85 kg to 170.8 kg; per capita consumption of vegetables and edible mushrooms increased slightly from 102.28 kg to 107 kg; per capita consumption of meat increased from 22.42 kg to 30.9 kg; per capita consumption of aquatic products and total consumption of eggs and milk increased from 12.15 kg to 33.2 kg (data from the China Statistical Yearbook 2005–2021). The dashed line in the figure shows the trend in per capita consumption of each of the major foodstuffs.

In the face of tightly cultivated land resources, some scholars advocate the reduction in food loss and food waste (FLW) to alleviate the shortage of cultivated land. Approximately one-third of global food production is lost or wasted in the food supply chain [17]. The unsustainable and wasteful use of resources throughout the supply chain is detrimental to society: FLW leads to reduced food access and availability [18] and undermines food security [19,20]. The loss and waste of food reused for animal feed or other non-food purposes may reduce the uptake of cultivated land resources. However, we found that there are very fewer studies advocating the use of mountains to satisfy dietary structure needs. Research on issues related to land for food production in mountainous areas has focused on the quantity and quality of cultivated land. Although some researchers have noted that there is a large amount of wasteland in mountainous areas that has been left unused for a long time [21,22], there is no clear answer on how to use these mountainous land resources to support the development and optimization of agriculture.

China is a mountainous country, with mountainous areas covering 2/3 of the country's area [23]. These mountainous areas are dotted with extensive land resources such as cultivated and forested land [24]. However, there is obvious room for improving the utilization of these lands. The results of a survey conducted in a sample of mountain counties across the country show that abandonment is widespread in China's mountainous regions, with a rate of 14.32% as of 2014 [25]. There is a large amount of unused land in the

mountains. The full exploitation of this land can contribute to the effective alleviation of China's cultivated land shortage.

This study explores possible approaches to alleviating the land resources shortage arising from the changing dietary structure of the Chinese population and the feasibility of using mountain land as a crucial resource for addressing China's food security problem. We contend that the use of mountain land in rational models, such as hillside, understory, and limited cultivated land in mountain areas, can improve agricultural development and convert mountain land into land for food production, which could be an effective way to alleviate the shortage of land due to evolving national dietary structure.

## 2. Background and Methods of Analysis

With the rapid socioeconomic development and the continuous growth of the population's consumption power, China's demand for food is growing and diversifying. The evolution of the per capita diet is characterized by two notable features. (1) A gradual decrease in the proportion of plant-based food and a significant increase in the proportion of animal-based food [26]. (2) Differences between urban and rural residents' diet structures are narrowing [27]. Overall, dietary choices are shifting from a predominantly grain-based diet to a nutritionally diverse mix of meat, fruit, and vegetables [10], with urgent consumer demand [28].

According to some previous studies, more forage and livestock pasture land resources are required to provide animal-based food than plant-based food intake [29]. The expected increase in animal products will further intensify global land pressure [30,31]. The per capita demand for land for food production in capital cities and small cities will increase to 15.33 million $m^2$ and 12.55 million $m^2$ under the livestock-based food model of urbanization in China, far exceeding the land demand for vegetable-based diets (8.5 million $m^2$), respectively, by 2030 [32]. Changing dietary patterns have put unprecedented pressure on the sustainable use of cultivated land resources. Limited cultivated land resources are unable to meet the demand of the agricultural market. Cultivated land faces encroachment by urban development and is reaching peak productivity in addition to the need to ensure basic regional food security, which poses a huge challenge to already insufficient cultivated land resources [33]. In addition, changes in the farming structure caused by changes in dietary structure require long lead times and considerable expenditure, while it is difficult to foster a farming structure that meets market demand in a short period of time due to the farmers' production habits.

The shortage of agricultural land due to changes in dietary structure has become a matter of widespread concern. Increasing the area of cultivated land and productivity to boost food supply are among the most frequently cited approaches, and research has demonstrated that this could be effective for achieving the sustainable use of arable resources. However, these two options have almost reached maximum utility, particularly in China. Meeting the needs of the population's changed dietary structure requires that China maintain approximately 135.5 million hectares of land for food production in peak population years [34,35], but there are currently challenges to China's adherence to the 120 million hectares red line of cultivated land [36]. Notably, increased levels of mechanization, pesticides, fertilizers, and agricultural labor are all seen as influential factors in improving productivity [37]. As production rises, intensification becomes increasingly difficult, the overuse of cultivated land reduces its productive capacity, and production will eventually approach its maximum potential [38]. Our research does not focus on options with low marginal benefits; instead, we examine the increased use of all land for food production, including cultivated land, through better use of potential natural resources, focusing on mountainous areas.

Mountainous areas refer to mountain-based regions where people and nature interact, which are potential areas for modernization [39]. China is a mountainous country with a mountainous area of about 622.39 $\times$ 104 $km^2$, accounting for about 64.89% of the nation's land space. China's mountains can be generally divided into five different mountain types

(the five different types of mountains in China are very high mountains, high mountains, middle mountains, low mountains, and hills). Of these, low hilly areas account for approximately 25.90% of the total land area, concentrated in the large mountainous regions of the northeast, southeast, and southwest. Zhongshan accounts for about 11.23% of the area, primarily in the northern and southwestern mountainous regions, and the area of middle and high mountains comprises about 8.48%, primarily in the eastern and northern edges of the mountainous region of the Tibetan Plateau and in the Tian Shan mountain system of the northwestern mountainous region. The high mountain area reaches about 15.09%, and that of very high mountains makes up about 4.19%, both of which are predominantly distributed in the mountainous region of the Tibetan Plateau. These mountain systems can be significantly leveraged as areas of natural resource storage and containment and biodiversity aggregation through the rational use of mountain space for cultivation to meet the diversified demand for agricultural products resulting from changes in dietary structure. Therefore, our investigation is expected to provide practical insights for China's policymakers and agricultural stakeholders as well as inspiration for land managers and food production sectors in other parts of the world.

The main objective of this study is to explore the use of mountain areas for alleviating the shortage of cultivated land due to societal changes in dietary structure. We take an overall research approach and analyze three typical cases in China. This method allows for a detailed presentation of the various steps we use in the study to draw common patterns, increasing the rigor of the research. The method also allows for the selection of cases from different regions. The cases in this study are selected from three typical mountainous regions in northern, central, and southern China to examine the applicability of the cases in China more comprehensively and offer more realistic conclusions, improving the accuracy of the study. Our research steps are fourfold:

Step 1: Identify the problem. This study endeavors to answer the following two questions by exploring the three adopted approaches to mountain use and analyzing the data collected. (1) How has the dietary structure of the Chinese population changed? (2) What mountain land use practices have been adopted in China to produce agricultural products in response to changes in the land use structure for food production based on the demand for dietary structure changes? (3) How do these approaches alleviate cultivated land constraints?

Step 2: Case selection. The case study method was chosen to answer the research questions because it allows for an in-depth examination of social phenomena through a limited number of observations. Natural conditions vary greatly across China, and agricultural practices vary somewhat from region to region. The selected cases should be representative of the types of agricultural production in China and, at the same time, be geographically representative of the natural conditions and vegetation types in different regions of China, in addition to using different kinds of utilization patterns as much as possible to improve the efficiency of land use in mountainous areas. Based on the above conditions, we investigate three representative cases, including (1) mountain hillside land use patterns using a stereoscopic cultivation model in the mountainous areas of Zigui County, (2) understory land use patterns in the mountains of Yichun City, and (3) a limited cultivated land using the "rice-fish-duck" integrated farming model in the Hani terraces.

Step 3: Data collection. The data for this study were obtained from government reports, statistical yearbooks, literature reviews, official government websites, and research conducted by the author in related fields. Research data on the stereoscopic cultivation model in the mountainous areas of Zigui County were primarily obtained from available literature, statistical yearbooks, government websites, and government reports [10,40–53]. Data on understory farming models in the mountains of Yichun City were obtained from official government websites, government reports, and available literature [54–65]. Research data on the rice-fish-duck integrated farming model in the Hani terraces were based on existing literature [42,66–75].

Step 4: Case studies. We first provide an analysis of the notable elements of the three mountain use models based on research data and context, including mountain conditions, use patterns, food production effects, and mitigation effects on the shortage of cultivated land resources. Second, the conclusions of the study are summarized, and the effects of the cases are evaluated based on the available research data, analyzing the effects of each model on mitigating the shortage of cultivated land, the ecological and economic benefits of each model, and the objective basis for replication. In addition, similar case studies from other parts of the world, including both developed and developing countries, are selected to show that mountain agricultural development can alleviate the shortage of cultivated land caused by dietary changes, demonstrating the feasibility and development potential of the models examined through a comparison of similar cases in other parts of the world.

## 3. Case Analyses

### *3.1. Using Elevation Difference in Hillside Land: Stereoscopic Cultivation in the Hills of Zigui County, Hubei Province*

Increased demand for fruit, vegetables, and nuts is a distinctive feature of the changing dietary structure of the Chinese population [10]. From 1980 to 2021, the annual per capita consumption of fruit in China increased from 5.9 kg to 180 kg, the annual per capita consumption of vegetables increased from 48.7 kg to 463.5 kg, and the annual per capita consumption of nuts increased from 1.3 kg to 7.1 kg [40]. Per capita consumption of vegetables, fruits, and nuts has all significantly increased [41], and the area of agricultural land required for the rising consumption of these foods shows a clear upward trend [42].

Zigui County is located in Yichang City, Hubei Province [43], in the Three Gorges reservoir area. As shown in Figure 2, the county covers an area of 2274 km$^2$, and the mountainous area above 500 m is 1930.6 km$^2$, accounting for 84.9% of the total area. The total land area of Zigui County is 227,400 hectares, including 28,300 hectares of cultivated land, accounting for 12.4% of the total land area, and 151,600 hectares of forest land, accounting for 66.67% of the total land area. The county has less land per capita and even less cultivated land, and agricultural land is tight [44]. To meet the market demand for richer food, expand agricultural land, and alleviate the problem of insufficient land for expanding agricultural production [45], Zigui County adopted the development method of building a "mountainous area 'three layered' green industry" to address the combination of more people, less land [46], high mountains, steep slopes, and considerable differences in vertical altitude.

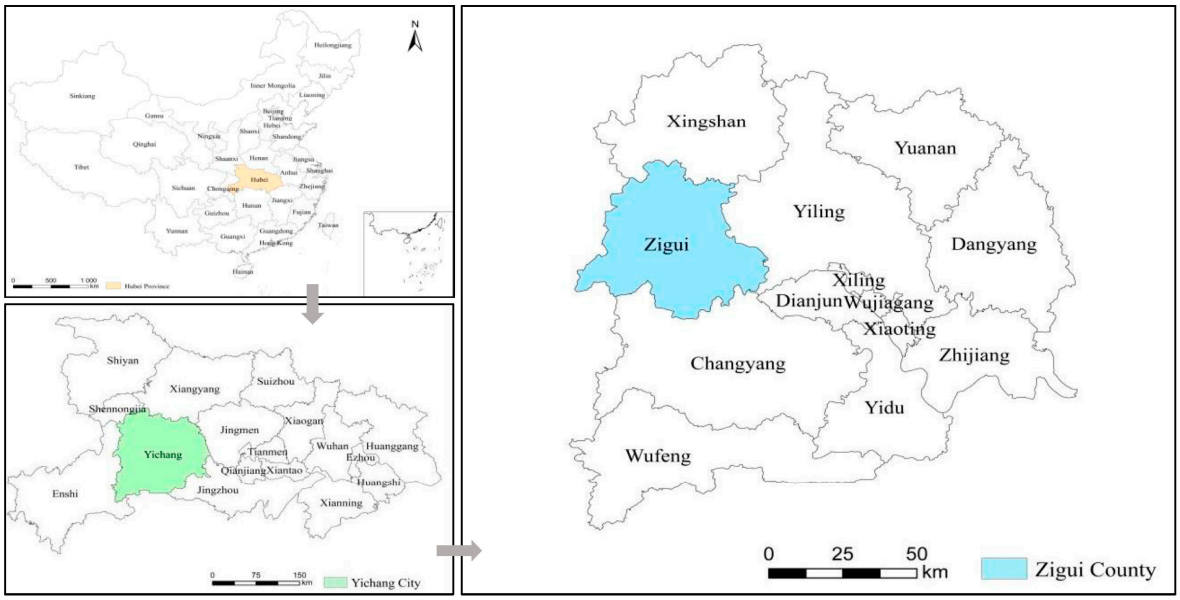


**Figure 2.** Study area: Zigui County, Hubei Province.

The three-layered green industry in the mountainous area refers to the economic structure of forests according to altitude gradient, forming a low mountain navel orange belt, medium mountain tea and chestnut belt, and high mountain walnut and Chinese herbal medicine belt (Figure 3a). The model returns farmland to the forest while planting cash crops, expands forest coverage, rationalizes the use of land resources, promotes industrial development, taps deeply into the potential of existing land, and generates comprehensive benefits from limited land resources. Zigui County takes advantage of the geographical conditions of large vertical altitude differences to plant traditional advantageous crops, including citrus and navel oranges in the low mountain belt with high temperature and good heat conditions below 500 m above sea level (Figure 3b); tea, chestnuts, walnuts, and other woody grain and cash crops with low temperature requirements in the middle mountain area between 500 and 800 m (Figure 3c); and vegetables, walnut and Chinese herbs medicine in the high mountain area above 800 m (Figure 3d). Through the stereoscopic use of natural conditions in different areas of the mountain, the ecological economic forestry development model of multi-productivity and rational use of one mountain is achieved. By 2021, the county developed an ecological economic forest area of 66,666.7 hectares, and full coverage of forest fruit and leaves has been reached below 700 m above sea level, and the forest coverage rate has reached 77.56% [47], realizing the organic combination of ecological management and development of special industries. In 2021, Zigui County citrus output was 757,720 t, an increase of 210% over 2011; edible nuts (walnuts, chestnuts) output was 7100 t, up 71% from 2011; and tea output was 7982 t, up 240% from 2011 [48].

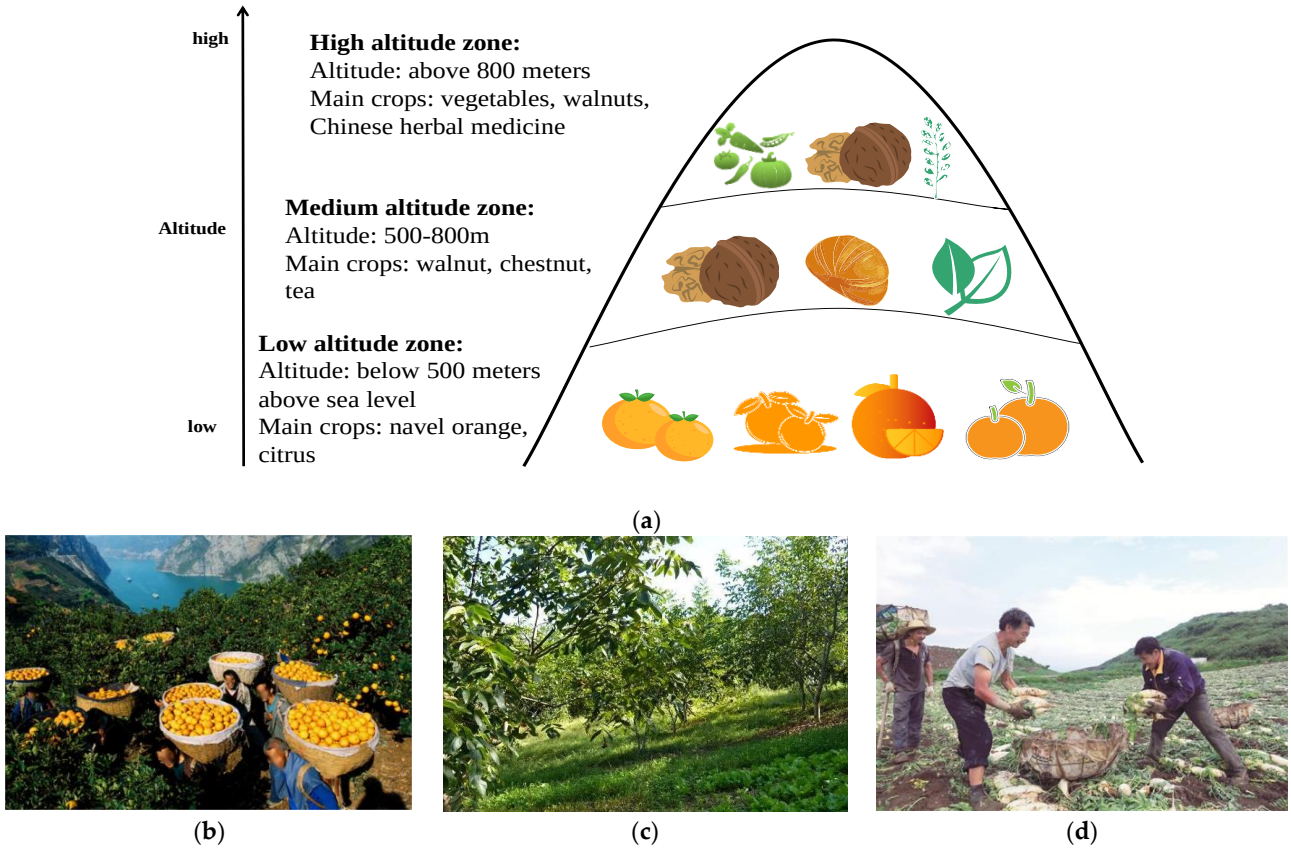


**Figure 3.** Example of Stereoscopic cultivation in Zigui County, Hubei Province, China. (**a**) Zigui County mountainous area's three layers of green industry, according to the altitude economic gradient layout of forests, forming a low mountain navel orange belt; a medium mountain tea, walnut, chestnut belt; and a high mountain vegetable, walnut, and Chinese herbal medicine belt. (**b**) In the low-altitude zone, Zigui County planted oranges and navel oranges in the low mountain belt below 500 m above

sea level, where the temperature and heat are amenable to cultivation (http://www.yichang.gov.cn/content-62936-1038659-1.html (accessed on 13 March 2023)). (**c**) The medium-altitude zone shows walnuts grown on sloping land (http://zigui.cjyun.org/p/29685.html (accessed on 13 March 2023)). (**d**) The high-altitude zone shows alpine vegetables grown in the mountains above 800 m (http://www.yichang.gov.cn/html/zhengwuyizhantong/zhengwuzixun/tupianxinwen/2017/0731/984741.html (accessed on 13 March 2023)). These photographs are from the author's drawings and the Yichang Municipal Government website.

This study asserts that the integrated vertical use of mountainous areas is crucial for alleviating cultivated land tension, enriching crop species, protecting the ecological environment, and improving incomes. Without competing for existing cultivated land resources, the vertically integrated use model for mountainous areas produces a wider variety of crops from limited land and meets the population's growing demand for a wider variety of food. In addition, compared with the previous excessive logging mountain forest development mode in Zigui County, the construction of an ecological economic forest effectively cuts about 87% of the phosphorus pollution load and about 50% of the nitrogen pollution load [49], reduces soil erosion by about 30% [50], and provides a protective role for local areas. In 2022, Zigui County built a 55,333-hectare multi-forestry base, including 26,666.7 hectares of navel oranges, 14,666.7 hectares of walnuts, 10,000 hectares of tea, 2000 hectares of chestnuts, 2000 hectares of small fruits, and 0.15 hectares of full-caliber per capita economic forest, resulting in a per capita income of more than 13,000 CNY [51]. Extensive hills and mountains in south-central China and the three-layered green industry in the mountainous areas of Zigui County provide a reasonable and effective solution for adapting to the Chinese population's changing dietary structure and alleviating the tension of cultivated land resource limitation.

Despite the enormous ecological and economic benefits of the transformation of mountain agriculture in Zigui County, it still faces a problem: the reclamation and preparation of hillside land require huge construction costs. The three-dimensional cultivation in Zigui County relies on the support of the national policy of returning farmland to forest and the financial support given by the local government to realize the industrial plan, with the government sharing the costs for the mountain development [52]. In other areas is the practice process, huge construction and maintenance costs are difficult to avoid. However, the policy of returning farmland to forest is nationwide, and the Chinese government encourages and continues to pay financial subsidies. According to the Regulations on the Return of Cropland to Forests [53], the corresponding subsidy standards are set in different regions according to the actual economic development. The amount of subsidies may vary from place to place depending on the economic development status, but all of them can reduce the cost of barren mountain development to a certain extent.

### *3.2. Using Mountainous Forest Understory Land: Raising Pigs in Forests in Xiaoxinganling Mountains, Yichun City, Heilongjiang Province*

In recent years, the Chinese population's demand for meat has continuously increased [54]. Pork, in particular, accounts for 60% of meat consumption in China [55]. In 2022, China's per capita meat consumption reached 34.6 kg, representing a 5.0% rise from the previous year; 699.95 million pigs were slaughtered throughout the year, up 4.3%, pork production was 55.41 million t, up 4.6%, and Chinese residents' per capita pork consumption reached 26.9 kg, up 6.7% [56]. Growing demand for meat means that farming must be expanded [57], and limited cultivated land resources are driving the search for new solutions to alleviate the shortage of land for pig farming.

As shown in Figure 4, the Yichun state-owned forest area, located in the Xiaoxinganling Mountains in the northeastern part of Heilongjiang Province, is the largest state-owned forest area in China, with an administrative area of 32,800.29 $km^2$, including 2.88 million $hm^2$ of woodland, and an 87.2% forest coverage rate. In 2014, the natural forest area of Yichun ceased commercial logging completely, facing industrial turnover and an urgent need for economic transformation [58]. Relying on the rich mountain forests of the Xiaoxinganling,

Yichun City actively developed the under-forest pig industry, adopted a reasonable breeding model, formed a scientific breeding management system, and created a green ecological brand, providing high-quality pork products for the Chinese population.

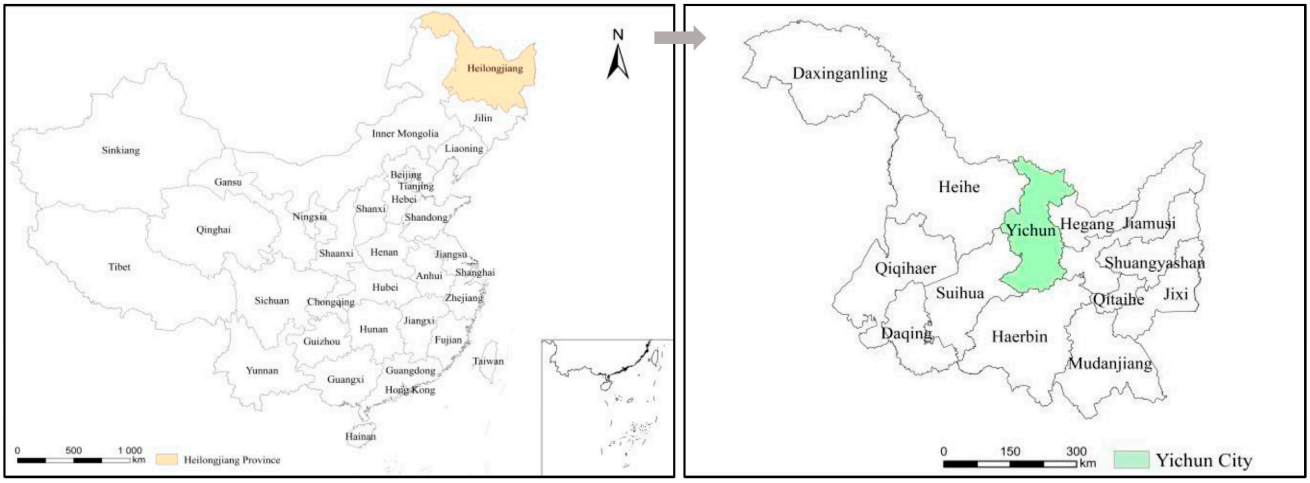


**Figure 4.** Study area: Xiaoxinganling Mountains, Yichun City, Heilongjiang Province.

Using a differentiated breeding model of in-house breeding, rearing in the forest, and rotational grazing production, Yichun forest pigs are produced and nursed in pens, and weaned piglets are released into the forest for free feeding, using the forest understory land as the feeding ground (Figure 5a). Forest pigs drink mineral-rich spring water in the mountains (Figure 5b) and consume the abundant wild fruit, grasses, vegetables, and herbs (Figure 5c,d), ensuring sufficient nutrition, and farmers do not need to use hormones to stimulate pigs' weight gain. The healthy environment, wide space for activity, and sufficient activity make the physical quality of forest pigs far better than that of captive pigs, the survival rate is as high as 99%, and the flavor and taste of forest pork are significantly better than captive pigs. About 250,000 forest pigs were raised in 2016 [59], and in 2020, the forest pig breeding base in Yichun reached an area of more than 70,000 square meters, with 100,000 pigs slaughtered, more than 79,000 forest pigs in stock, and sales reaching 30 million CNY. The Yichun Forest Pig industry has passed many certifications, such as the ISO 9001 quality system [60], green food grade A product designation, and food safety management system certification and has become a geographical landmark brand in Yichun.

This study concludes that the forest pig farming model in Yichun City fully leverages the natural conditions of the mountainous area, takes advantage of unused forest understory land space, and provides the Chinese population with green and healthy pork without occupying cultivated land resources, which meets the demand for sustainable agriculture and pork amid the changing dietary structure of China. In terms of policy support, the central government has introduced the "The 14th Five-Year Plan of Action for Ecological Protection and Economic Transformation of Daxiaoxinganling Forest Area" [61] to promote the rapid development of the forest economy. Heilongjiang Province issued the "2023 implementation plan for the development of the province's forest economy", with forest farming as a prominent development industry [62], through agricultural cooperatives, from financial services, farming technology, sales channels, and other aspects of forest pig farming to provide various support. From a cost–benefit perspective, forest pig farming remains economically viable. The rearing period of each forest pig in the Daxinganling area is about 12 months, the rearing cost is about 2500 CNY, the sales price is more than 4000 CNY, and the profit per pig is about 1500 CNY [63]. The mountainous areas of the three northeastern provinces of China cover an area of 423,800 square kilometers, with forest land accounting for 45.34% of the total area of the region [64]. Making full use of forest space for forest farming can help meet the food-consumption needs of the population

while taking into account animal welfare and protecting cultivated land. In addition, the model has also driven employment opportunities for local residents who were laid off from previous means of income due to the ban on commercial logging. According to incomplete statistics, in the past 10 years, a total of more than 2000 laid-off workers and 1980 migrant workers have been placed, driving more than 1200 farmers [65]. Understory pig farming has supported the positive development of the economy and employment.

**Figure 5.** Example of raising pigs under forests in Xiaoxinganling Mountains, Yichun City, Heilongjiang Province, China. (**a**) In Yichun, pigs are free-ranging in the forest with plenty of space to move around (https://yichun.dbw.cn/system/2009/12/21/052273439.shtml (accessed on 13 March 2023)). (**b**–**d**) Pigs free-ranging in the forest (https://heilongjiang.dbw.cn/system/2017/08/31/057765807.shtml (accessed on 13 March 2023); https://www.yc.gov.cn/xwzx/ycyw/2018/12/105940.html (accessed on 13 March 2023); http://nynct.gxzf.gov.cn/xxgk/ztjj/lsxztgd/gxhy/yqygypp/qzs/t2053503.shtml (accessed on 13 March 2023)). Figure 5a,b are from official government news sites; Figure 5c,d are from government websites.

However, the process of implementing the forest farming program needs to consider the ecological carrying capacity, and the number of animals stocked per unit area needs to be determined by scientific research and study based on local conditions. If overstocking is performed for economic purposes, it will be against the concept of sustainable development.

### *3.3. Using Limited Cultivated Land in Mountainous Areas: The Rice–Fish–Duck Integrated Farming Model in Hani Terraces*

China's dietary structure is diversified, and animal consumption (meat, eggs, milk, and aquatic products) is rapidly increasing [66]. The proportion of cultivated land required for animal food production rose from 27% in 1986 to 40% in 2006 and 46% in 2016 [42]. Per capita animal consumption in China was 63.1 kg in 2013, increasing to 87 kg in 2021, representing a 37% growth rate. The rapid increase in meat-based consumption demand

means the expanded occupation of cultivated land, and cultivated land resources are narrowing [67].

As shown in Figure 6, the Hani Terraces are located in the southern part of the Ailao Mountains in Yuanyang County, Honghe Prefecture, Yunnan Province, with a minimum elevation of 144 m and a maximum elevation of 2939.6 m [68], with dramatic undulations that include a low-latitude, high-altitude area.

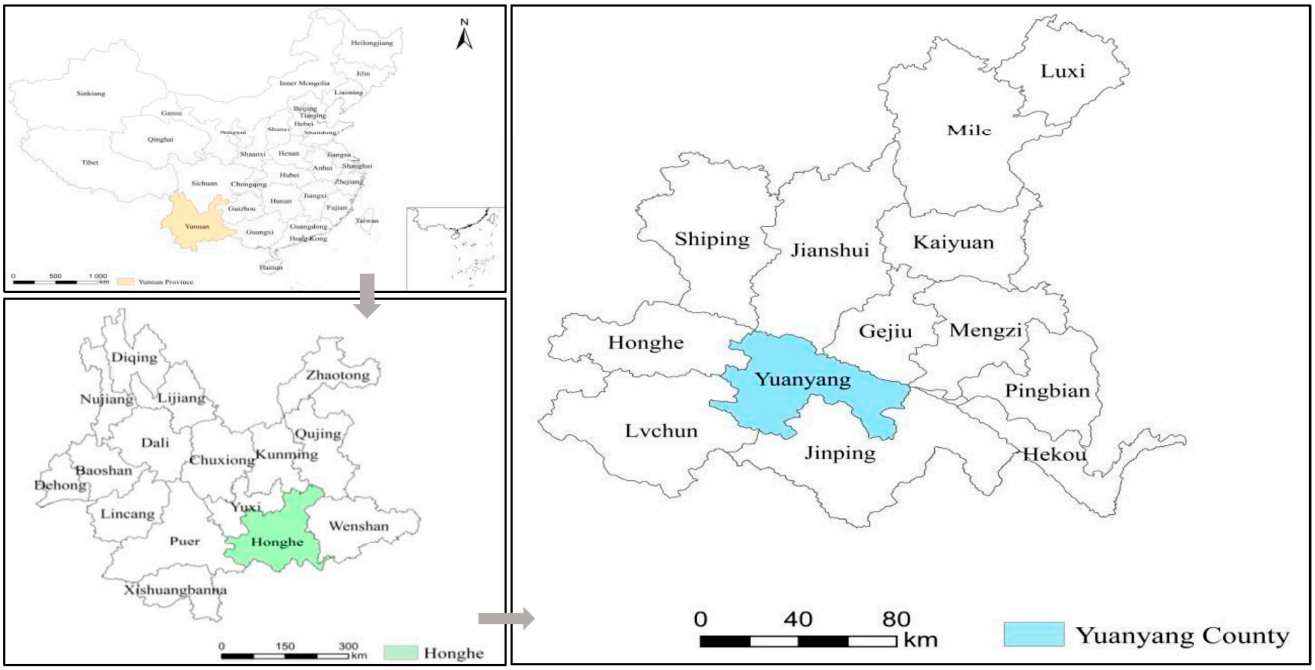


**Figure 6.** Study area: Hani Terraces, Yuanyang County, Honghe Autonomous Prefecture, Yunnan Province.

Local flat cultivated land is extremely limited, so terraces are being reclaimed to expand the cultivated area (Figure 7a). Historically, the Hani terraces have employed an integrated, rice–fish–duck farming model [69] to meet the demand for food as the local population expanded. Among the terraces, rice is the most dominant crop, while fish, ducks, loaches, snails, and other aquatic products are stocked in the water (Figure 7b–d). Ducks in the rice fields can loosen the soil and remove insects. Fish and loaches swim in the water and loosen the soil, while their manure is used as fertilizer to increase soil fertility [70]. In this model, the terraces were changed to growing only rice, and the yields of rice, fish, and ducks were outstanding. The average yield of red rice was 5370 kg/hm$^2$; the average yield of fish (carp) products was 750 kg/hm$^2$, with 150 male and 225 female ducks per hectare; and the duck egg production was 21,600 eggs/hm$^2$ [71]. In addition, the rice–fish–duck integrated farming model not only provides a variety of high-quality products to improve farmers' living conditions but also contributes to local ecological conservation. The swimming, feeding, and waste excretion of fish and ducks contributes to the weeding, fertilizing, and cultivation of rice, with the three processes being mutually beneficial and symbiotic. Organic fertilizers have been applied to inhibit the growth of weeds and loosen the soil structure, reducing the usage of chemical fertilizers and pesticides and thereby reducing environmental pollution. This has resulted in the formation of a virtuous ecological cycle with very significant ecological benefits [71–74].

**Figure 7.** Example of the rice–fish–duck integrated farming model in Hani terraces, Honghe Autonomous Prefecture, Yunnan Province, China. (**a**) The Hani have restructured the hills into layers of terraces to expand the area under cultivation (https://difang.gmw.cn/yn/2019-09/20/content_33175447.htm (accessed on 13 March 2023)). (**b–d**) In the terraces, ducks are stocked on the water and underwater, and fish fry are placed in the rice fields, where fish, ducks, and rice are cultivated together (https://baijiahao.baidu.com/s?id=1744836957018380136&wfr=spider&for=pc (accessed on 13 March 2023); http://www.jiangsu.gov.cn/art/2019/7/4/art_64753_8607835.html (accessed on 13 March 2023); http://www.moa.gov.cn/ztzl/zywhycsl/dypzgzywhyc/201305/t20130531_3480248.htm (accessed on 13 March 2023)). Figure 7a is from a newspaper report; Figure 7b is from Xinhua report; Figure 7c is from the People's Government of Jiangsu Province; and Figure 7d is from the Ministry of Agriculture and Rural Affairs of the People's Republic of China.

This study concludes that in the rice–fish–duck integrated farming model, farmers can grow rice and harvest other animal agricultural products simultaneously, which increases the variety of agricultural products, improves the yield per unit of farmland, and establishes the potential to meet the increased demand for animal products in the Chinese population's dietary structure. This model uses existing cultivated land to increase the variety of agricultural products supplied, adopting a stereoscopic agricultural approach to improve land use efficiency, thereby meeting the increasingly diverse dietary needs of the population. The rice–fish–duck integrated farming model relies on the existing terraces, which does not require significant additional construction costs, while making effective use of terrace resources, increasing the output rate of Hani terraces, and increasing the economic income of farmers. After deducting the costs of seeds, labor, fertilizer (manure), and feeding

materials, the average profit was 35,850 CNY/hm$^2$ [71]. According to the second national land survey, the scale of terraces in China is about 18.66 million hectares, accounting for 13.7% of the total cultivated land [75]. The rice–fish–duck integrated farming stereoscopic agriculture system has profound implications for making full use of terraced rice fields, increasing animal product supplies, and satisfying the public demand for animal products.

## 4. Results: How Mountain Areas Can Alleviate the Shortage of Agricultural Land due to Changing Dietary Structure

Mountain land is an important supplementary resource for alleviating China's cultivated land constraints [76]. The increasing level of urbanization in China and the growing integration of primary, secondary, and tertiary industries means that a large amount of cultivated land will be occupied [77–79]. In particular, the policy of encouraging rural residents to move to small towns to protect cultivated land during urbanization could actually accelerate the occupation of cultivated land [80]. Therefore, considering the need to strictly observe the cultivated land red line and the growing demand for food, making full use of available natural resources and using mountainous land for sustainable planting and farming activities can simultaneously achieve the dual objectives of saving cultivated land resources and improving the agricultural products demanded by the changing dietary structure. Faced with the reality of dwindling cultivated land, the use of land in mountainous areas is an important approach for guaranteeing China's food security.

The use of land in mountainous areas objectively provides space for production to meet the demand for food resulting from changes in public dietary structure and alleviates the diminishing nature of cultivated land. All three forms of mountain agricultural use cited in this study significantly avoid using existing cultivated land resources while producing products that meet the nation's changing demands. First, agricultural production in mountainous areas fully leverages a mountainous area of limited land to avoid using cultivated land in plains. Second, these cases produce viable and increasingly demanded agricultural products in mountainous areas, aligning with the population's evolving food consumption needs and serving as an alternative to using the limited cultivated land on the plains. Finally, the projects described in this study have increased the yield of agricultural products per unit of land in mountainous areas, with the case of the Hani terraces also expanding the variety of agricultural products and improving the efficiency of land production.

The schemes described in this study provide both ecological and economic benefits while alleviating the shortage of cultivated land. China is currently undergoing rapid urbanization, and diverse land use demands have led to frequent conflicts between various land use types, exacerbating the conflict between the economic, ecological, and social benefits of land use [81]. Agricultural development is currently facing challenges of sustainable development due to narrowing cultivated land resources, damage to the ecological environment, and the relatively low economic efficiency of agriculture. As shown in Table 1, the projects described in this study (stereoscopic cultivation, raising pigs under forests, and rice–fish–duck integrated farming) can produce many of the agricultural products demanded by the population while also maintaining the local ecological environment, avoiding the destruction of vegetation, increasing the production and quality of agricultural products, raising farmers' incomes, and promoting sustainable agricultural development.

It should be noted that the use of mountainous areas to alleviate the shortage of land for agriculture requires sufficient mountainous areas. China's mountainous areas are widely distributed and vast. There are 1284 mountainous counties (mountainous areas) in mainland China, accounting for 74.9% of the nation's total area, particularly in the central and western regions, where 73.8% of the territory is covered by mountains [82]. Large tracts of cultivated land have been abandoned in China's mountains [83–85]. In 2015, more than 30% of cultivated land was abandoned and not used for mountain farming [86]. The vast mountainous areas provide a reserve of land for the development of mountain agriculture and production space for dietary structure and food consumption changes. Faced with the

shortage of cultivated land, the Chinese government has introduced a series of policies to encourage the development of mountain agriculture, providing necessary financial, technical, and human resources policy support to its development.

**Table 1.** Ecological and economic values of the three case studies of mountain use.

| | **Stereoscopic Cultivation on Hillside Land in Zigui County** | | **Understory Forest Pig Farming in Yichun City** | | **Rice-Fish-Duck Integrated Farming in Hani Terraces** | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| Ecological environment | Soil pollution | Reduction of about 87% of the phosphorus pollution load and about 50% of the nitrogen pollution load [49] | Primeval forest | Within the ecological carrying capacity of the forest, no ecological damage occurred | Carbon emissions | 1–2% reduction in greenhouse gas emissions [87] |
| | Serious erosion of water and soil | Reduced soil erosion by approximately 30% | Forested woodland, no pesticide application | No additives or hormones; no heavy metal and drug residues [65] | Weed growth | Effective suppression of weed growth [88] |
| | | | | | Use of chemical fertilizers and pesticides | Reduced application of chemical fertilizers and pesticides [89] |
| Financial income | National-level poverty-stricken counties | Per capita income increased by more than 13,000 CNY; comprehensive output value of Zigui navel oranges reached 10 billion CNY [90] | Understory land unused, no income | 120,000 CNY earned from raising 300 forest pigs [65] | Income from rice production only | A significant increase in income from the sale of animal products such as fish, duck, and duck eggs [71] |
| | | | | | Feed inputs for rearing ducks and fish | Reduced feed use [87] |

## 5. Discussion

### *5.1. Similarities and Differences between the Case Studies Examined and Similar Projects around the World*

Other parts of the world face a similar conflict between the lack of cultivated land and the demand for food. This is especially true in countries with large populations but limited cultivated land resources. Clearly, there are differences in the natural and economic circumstances of different countries and regions, and dietary structure needs vary; thus, understanding the dietary structure needs of different regions is an important prerequisite for the development of mountain agriculture.

In Japan, for example, 76% of the country's total land area is mountainous [91], with only 0.21 acres (about 850 square meters) of cultivated land per person [92]. To meet domestic food and to cater to the changing dietary structure, Japan has cultivated hilly and mountainous areas into terraced fields to grow food [93]. The shift in crops in mountainous areas to produce, such as fruit and organic vegetables [94,95], has objectively contributed to a change in the dietary structure. Korea also faces the dilemma of having too many people and too little cultivated land, with mountains covering 64% of the country's land area. Korean mountain farming is primarily aimed at increasing food production. Relying on the rich forest resources in mountainous areas, combined with short-term high-efficiency planting varieties, Korea has adopted forest planting of camphor, ginseng, mountain saxifrage, aralia buds, and other mountain herbal medicines, in addition to livestock grazing in mountain grasslands [96]. Domestic food consumption needs are safeguarded as far as possible and adapted to the dietary structure of the population.

The diet of the Hindu Kush in the South Asian Himalayas has changed in recent years as a result of socioeconomic development [97]. In response to changes in market demand, fruit is grown on mountain marginal and sloping land [98], and the area under mountain vegetable cultivation is increasing. Although the motivation for expanding fruit and vegetable cultivation in the Hindu Kush mountains is to increase economic income, the production of fruit and vegetable products meets the food consumption needs of the population at the supply level [99]. This study demonstrates that mountains can provide productive space for changes in dietary demand. Norway is located on the Scandinavian peninsula in northern Europe. Mountains make up at least 50% of Norway's total area [100]. Due to its high latitude and mountainous terrain, Norway's farming conditions are unfavorable, and animal husbandry is its primary agricultural industry, with cattle, sheep, and reindeer being the predominant meat products [101]. Norwegian farmers use the vast mountainous terrain to herd cattle, sheep, and reindeer and to forage among the leaves, shrubs, and grasses of the forests. The Scandinavian mountains provide the Norwegian diet with abundant meat to meet the country's food consumption needs; however, Norwegian mountain forests are at risk of ecological degradation due to grazing over-exploitation [102], and the rationalization of grazing in the future is an important issue for the country.

### *5.2. Study Limitations and Future Research Needs*

This study highlights the use of mountainous areas for agricultural production to alleviate the shortage of cultivated land due to dietary structure changes. While all three cases described in this study show that mountainous areas can alleviate the problem of cultivated land shortage, preliminary cost–benefit data were collected and analyzed for our studied cases. However, we must admit that there is a certain lack of data in terms of comprehensive costs and benefits, which include construction costs, maintenance costs, and ecological costs. At present, there are insufficient data to carry out a common cost–benefit analysis. Collecting these data will be a priority for future research as they will help to further confirm the economic viability and sustainability of our three cases.

In addition to this, there is a lack of a monitoring system for the construction costs, maintenance costs, and ecological impacts of case implementation. Long-term monitoring and evaluation of the case study area will enable all ecological risks to be identified, ensuring that environmental health is safeguarded and that the project will continue to provide benefits in the future. This monitoring should be implemented through the development of institutions that will continue long after the original research project has ended. We suggest that a testing system should be constructed using three elements: program operators; government; and third-party organizations, such as research institutes. First, program operators will fully consider the costs, benefits, and profitability cycle of a project before it is implemented [103]. The project construction company will make preliminary judgment forecasts and long-term monitoring of the project's costs and benefits and demonstrate the feasibility of the project implementation plan. Second, the government should set strict ecological and construction standards in order to minimize the negative impact on the ecological environment. At the same time, the natural environment is continuously monitored by the environmental protection department in order to determine the ecological benefits and ecological risks of project implementation. Finally, the research unit or a third-party institution conducts an objective analysis and evaluation of the effects of the project implementation through field research, observations, and interviews.

## 6. Conclusions

China's cultivated land resources are in very short supply, with less than half of the world's cultivated land per capita. Rapid urbanization and industrialization have led to a steady decline in cultivated land. At the same time, the increasing demand for food and the change in the dietary structure of the population to a greater proportion of animal foods, fruits, and vegetables have all contributed to the tightening of China's cultivated land.

China has a growing shortage of cultivated land. Therefore, there is an urgent need for China to find a solution to meet the population's food consumption needs while alleviating the shortage of cultivated land due to the changing dietary structure. China's mountainous areas are vast, and there is a great deal of under-utilized land in them. The rational use of this land for agricultural production will be able to meet the changing needs of the population's dietary structure while alleviating cultivated land constraints. Therefore, we propose to make full use of hillside, understory, and limited cultivated land to produce the agricultural products required by the dietary structure and to meet food consumption needs without taking away from existing cultivated land resources. The results of the study show the feasibility of using mountain land to alleviate the shortage of cultivated land due to changing dietary patterns. The results of the study show the feasibility of using mountain land to alleviate the shortage of cultivated land due to dietary changes. First, the use of land in mountainous areas objectively provides space for production to meet the demand for food resulting from the changing structure of the diet and alleviates the tightness of cultivated land. Second, there are certain economic and ecological benefits in the mountains in terms of alleviating the shortage of cultivated land. Finally, China has enough mountainous land to provide a sufficient reserve of mountainous land to alleviate the shortage of cultivated land through mountains.

The shortcoming of this study is that there is a real lack of data on the combined costs and benefits, and the collection of such data will be a priority for future research. Long-term monitoring and evaluation of the case study area should also be undertaken to ensure that all construction costs, maintenance costs, ecological risks, and benefit effects are identified; that environmental health is safeguarded; and that the project will continue to provide benefits in the future.

Despite these drawbacks, the solutions described in this paper may provide inspiration for improving the shortage of cultivated land elsewhere in the world. It is not only China—most countries in the world are facing a shortage of cultivated land resources and food security issues. We hope that these Chinese case experiences will help others around the world who are facing the same dilemma. However, this potential can only be achieved if planners identify the factors required for the success of each method, whether those factors are present in a given project area, and if not, whether alternative solutions must be found.

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## References

1. Bodirsky, B.L.; Rolinski, S.; Biewald, A.; Weindl, I.; Popp, A.; Lotze-Campen, H. Global food demand scenarios for the 21st century. *PLoS ONE* **2015**, *10*, e0139201. [CrossRef] [PubMed]
2. Lichtenberg, E.; Ding, C. Assessing farmland protection policy in China. *Land Use Policy* **2008**, *25*, 59–68. [CrossRef]
3. Abass, K.; Adanu, S.K.; Agyemang, S. Peri-urbanization and loss of arable land in Kumasi Metropolis in three decades: Evidence from remote sensing image analysis. *Land Use Policy* **2018**, *72*, 470–479. [CrossRef]

4. Gorgan, M.; Hartvigsen, M. Development of agricultural land markets in countries in Eastern Europe and Central Asia. *Land Use Policy* **2022**, *120*, 106257. [CrossRef]
5. Berihun, M.L.; Tsunekawa, A.; Haregeweyn, N.; Meshesha, D.T.; Adgo, E.; Tsubo, M.; Masunaga, T.; Fenta, A.A.; Sultan, D.; Yibeltal, M. Exploring land use/land cover changes, drivers and their implications in contrasting agro-ecological environments of Ethiopia. *Land Use Policy* **2019**, *87*, 104052. [CrossRef]
6. Pribadi, D.O.; Pauleit, S. The dynamics of peri-urban agriculture during rapid urbanization of Jabodetabek Metropolitan Area. *Land Use Policy* **2015**, *48*, 13–24. [CrossRef]
7. Yan, D.; Wu, S.; Tang, Y.; Zhu, J.; Zhou, S.; Xu, Z. Arable land and water footprints for food consumption in China: From the perspective of urban and rural dietary change. *Sci. Total Environ.* **2022**, *838*, 155749. [CrossRef]
8. Alexandratos, N.; Bruinsma, J.; Boedeker, G.; Schmidhuber, J.; Broca, S.; Shetty, P.; Ottaviani, M. *World Agriculture: Towards 2030/2050. Interim Report. Prospects for Food, Nutrition, Agriculture and Major Commodity Groups*; FAO: Rome, Italy, 2006; Available online: http://www.fao.org/es/esd/AT2050web.pdf (accessed on 26 June 2023).
9. Bu, T.; Tang, D.; Liu, Y.; Chen, D. Trends in dietary patterns and diet-related behaviors in China. *Am. J. Health Behav.* **2021**, *45*, 371–383. [CrossRef]
10. Yuan, M.; Seale, J.L., Jr.; Wahl, T.; Bai, J. The changing dietary patterns and health issues in China. *China Agric. Econ. Rev.* **2019**, *11*, 143–159. [CrossRef]
11. Sun, Z.; Scherer, L.; Tukker, A.; Spawn-Lee, S.A.; Bruckner, M.; Gibbs, H.K.; Behrens, P. Dietary change in high-income nations alone can lead to substantial double climate dividend. *Nat. Food* **2022**, *3*, 29–37. [CrossRef] [PubMed]
12. Zhu, Z.; Zhang, X.; Dong, H.; Wang, S.; Reis, S.; Li, Y.; Gu, B. Integrated livestock sector nitrogen pollution abatement measures could generate net benefits for human and ecosystem health in China. *Nat. Food* **2022**, *3*, 161–168. [CrossRef]
13. Shepon, A.; Eshel, G.; Noor, E.; Milo, R. The opportunity cost of animal based diets exceeds all food losses. *Proc. Natl. Acad. Sci. USA* **2018**, *115*, 3804–3809. [CrossRef]
14. Smil, V. Nitrogen and food production: Proteins for human diets. *Ambio* **2002**, *31*, 126–131. [CrossRef] [PubMed]
15. Liu, J.; Savenije, H.H. Food consumption patterns and their effect on water requirement in China. *Hydrol. Earth Syst. Sci.* **2008**, *12*, 887–898. [CrossRef]
16. Zhu, Y.; Wang, Z.; Zhu, X. New reflections on food security and land use strategies based on the evolution of Chinese dietary patterns. *Land Use Policy* **2023**, *126*, 106520. [CrossRef]
17. do Canto, N.R.; Grunert, K.G.; De Barcellos, M.D. Circular Food Behaviors: A Literature Review. *Sustainability* **2021**, *13*, 1872. [CrossRef]
18. Corrado, S.; Caldeira, C.; Eriksson, M.; Hanssen, O.J.; Hauser, H.E.; van Holsteijn, F.; Liu, G.; Östergren, K.; Parry, A.; Secondi, L.; et al. Food waste accounting methodologies: Challenges, opportunities, and further advancements. *Glob. Food Secur.* **2019**, *20*, 93–100. [CrossRef]
19. Santeramo, F.G. On the composite indicators for food security: Decisions matter! *Food Rev. Int.* **2015**, *31*, 63–73. [CrossRef]
20. Santeramo, F.G. Food security composite indices: Implications for policy and practice. *Dev. Pract.* **2015**, *25*, 594–600. [CrossRef]
21. Ma, L.; Tao, T.; Yao, Y.; Li, Y. Renovation Potential Evaluation and Type Identification of Rural Idle Residential Land: A Case Study of Yuzhong County, Longzhong Loess Hilly Region, China. *Land* **2023**, *12*, 163. [CrossRef]
22. Tao, Z.; Guanghui, J.; Wenqiu, M.; Guangyong, L.; Yanbo, Q.; Yingying, T.; Qinglei, Z.; Yaya, T. Dying villages to prosperous villages: A perspective from revitalization of idle rural residential land (IRRL). *J. Rural Stud.* **2021**, *84*, 45–54. [CrossRef]
23. Central People's Government of the People's Republic of China. Terrain. Available online: https://www.gov.cn/guoqing/2005-09/13/content_2582624.htm (accessed on 26 June 2023).
24. Zhang, B.; Sun, P.; Jiang, G.; Zhang, R.; Gao, J. Rural land use transition of mountainous areas and policy implications for land consolidation in China. *J. Geogr. Sci.* **2019**, *29*, 1713–1730. [CrossRef]
25. Li, S.; Li, X.; Xin, L.; Tan, M.; Wang, X.; Wang, R.; Jiang, M.; Wang, Y. Extent and distribution of cropland abandonment in Chinese mountainous areas. *Resour. Sci.* **2017**, *39*, 1801–1811. [CrossRef]
26. Challinor, A.J.; Adger, W.N.; Benton, T.G.; Conway, D.; Joshi, M.; Frame, D. Transmission of climate risks across sectors and borders. *Philos. Trans. R. Soc. A Math. Phys. Eng. Sci.* **2018**, *376*, 20170301. [CrossRef]
27. Renard, D.; Tilman, D. National food production stabilized by crop diversity. *Nature* **2019**, *571*, 257–260. [CrossRef]
28. Deng, X.; Yue, T.; Liu, Y.; Dong, J.; Sun, Z.; Chen, M.; Shi, W.; Zhang, X.; Zhao, Z.; Yu, Z. Changes in China's Food Self-Sufficiency Rate in the Context of a Changing Dietary Structure. *J. Glob. Inf. Manag.* **2021**, *30*, 1–19. [CrossRef]
29. Day, L. Proteins from land plants–potential resources for human nutrition and food security. *TRENDS FOOD SCI TECH* **2013**, *32*, 25–42. [CrossRef]
30. Haberl, H.; Mbow, C.; Deng, X.; Irwin, E.G.; Kerr, S.; Kuemmerle, T.; Mertz, O.; Meyfroidt, P.; Turner, B.L. Finite land resources and competition. *Rethink. Glob. Land Use Urban Era* **2014**, *14*, 35–69.
31. van Zanten, H.H.; Mollenhorst, H.; Klootwijk, C.W.; van Middelaar, C.E.; de Boer, I.J. Global food supply: Land use efficiency of livestock systems. *Int. J. Life Cycle Assess.* **2016**, *21*, 747–758. [CrossRef]
32. Jiang, L.; Seto, K.C.; Bai, J. Urban economic development, changes in food consumption patterns and land requirements for food production in China. *China Agric. Econ. Rev.* **2015**, *7*, 240–261. [CrossRef]
33. Zhan, S. Riding on self-sufficiency: Grain policy and the rise of agrarian capital in China. *J. Rural Stud.* **2017**, *54*, 151–161. [CrossRef]

34. Yang, M. Analysis and prediction of chinese medium and long term total demand of grain and economic structure. *Adv. J. Food Sci. Technol.* **2015**, *9*, 322–325. [CrossRef]
35. Yu, H.; Du, P.F. lmpact of Urban and Rural Dietary Pattern Changes on Cultivated Land: Based on Foodtion Data of Urban and Rural Residents in China from 1981 to 2019. *China Land Sci.* **2022**, *36*, 98–108. [CrossRef]
36. Wang, J.; Li, Y.; Huang, J.; Yan, T.; Sun, T. Growing water scarcity, food security and government responses in China. *Glob. Food Secur.* **2017**, *14*, 9–17. [CrossRef]
37. Springmann, M.; Clark, M.; Mason-D'Croz, D.; Wiebe, K.; Bodirsky, B.L.; Lassaletta, L.; de Vries, W.; Vermeulen, S.J.; Herrero, M.; Carlson, K.M.; et al. Options for keeping the food system within environmental limits. *Nature* **2018**, *562*, 519–525. [CrossRef]
38. Zhang, J.; He, C.; Chen, L.; Cao, S. Improving food security in China by taking advantage of marginal and degraded lands. *J. Clean Prod.* **2018**, *171*, 1020–1030. [CrossRef]
39. Zhou, J.; Li, C.; Chu, X.; Luo, C. Is Cultivated Land Increased by Land Consolidation Sustainably Used in Mountainous Areas? *Land* **2022**, *11*, 2236. [CrossRef]
40. Hou, M.H.; Bai, J.R.; Li, X.G.; Chen, H.Y.; Zhang, X.F.; Cal, S.L.; Wu, R.N.; Xu, H.Q. Analysis of Change Tendency of Chinese Residents' Food Consumption Structurefrom 1980 to 2021 and Optimization Suggestion. *Food Nutr. China* **2023**, *29*, 36–40. [CrossRef]
41. Tilman, D.; Clark, M. Global diets link environmental sustainability and human health. *Nature* **2014**, *515*, 518–522. [CrossRef] [PubMed]
42. He, G.; Zhao, Y.; Wang, L.; Jiang, S.; Zhu, Y. China's food security challenge: Effects of food habit changes on requirements for arable land and water. *J. Clean Prod.* **2019**, *229*, 739–750. [CrossRef]
43. Ding, X.; Han, X.; Kang, B.; Zhai, A. Spatial-temporal variation of permanganate index under accident conditions during different water periods in Zigui drinking water source area, Three Gorges reservoir area. *China. Ecol. Indic.* **2019**, *101*, 647–660. [CrossRef]
44. The People's Government of Zigui County. Natural Resources. Available online: http://www.hbzg.gov.cn/list-42-1.html (accessed on 13 March 2023).
45. Fitton, N.; Alexander, P.; Arnell, N.; Bajzelj, B.; Calvin, K.; Doelman, J.; Gerber, J.S.; Havlik, P.; Hasegawa, T.; Herrero, M.; et al. The vulnerabilities of agricultural land and food production to future water scarcity. *Glob. Environ. Change* **2019**, *58*, 101944. [CrossRef]
46. Xiang, J.; Song, X.; Li, J. Cropland use transitions and their driving factors in poverty-stricken counties of western Hubei Province, China. *Sustainability* **2019**, *11*, 1997. [CrossRef]
47. The People's Government of Yichang City. Zigui County Focuses on Ecological Protection to Guard the Last Ecological Barrier in the Three Gorges Reservoir Area. Available online: http://www.yichang.gov.cn/content-62751-1034986-1.html (accessed on 13 March 2023).
48. China Economic Social Big Data Research Platform. Yichang Statistical Yearbook. Available online: https://data.cnki.net/yearBook/single?id=N2013010030 (accessed on 13 March 2023).
49. Chen, M.; Zeng, L.; Huang, Z.; Lei, L.; Shen, Y.; Xiao, W. Evaluating suitability of land for forest landscape restoration: A case study of Three Gorges Reservoir, China. *Ecol. Indic.* **2021**, *127*, 107765. [CrossRef]
50. China Environment Website. The Most Is Orange "Forest" Green, Hubei Zigui Ecological Restoration and Characteristic Industry Combination, Realize the Scenery Beauty People Rich. Available online: https://www.cenews.com.cn/news.html?aid=1007723 (accessed on 13 March 2023).
51. The People's Government of Yichang City. The Typical Case of Ecological Transformation of Zigui—Deepening the Practice of "Two Mountains" Theory and Accelerating the Rise of Green Ecology. Available online: http://lyj.yichang.gov.cn/content-63247-976628-1.html (accessed on 13 March 2023).
52. National Forestry and Grassland Administration. Returning Farmland to Forestry to Weave Three Major Industrial Zones for Hubei Zigui. Available online: http://www.forestry.gov.cn/main/102/20230116/092626584424492.html (accessed on 26 June 2023).
53. The People's Republic of China. Regulations on the Return of Cropland to Forests. Available online: https://www.gov.cn/hudong/2016-04/28/5068873/files/0ea78ed1e1d34c76bc733e0fbd447f07.pdf (accessed on 26 June 2023).
54. Wang, H.H. The perspective of meat and meat-alternative consumption in China. *Meat Sci.* **2022**, *194*, 108982. [CrossRef]
55. He, Y.; Yang, X.; Xia, J.; Zhao, L.; Yang, Y. Consumption of meat and dairy products in China: A review. *Proc. Nutr. Soc.* **2016**, *75*, 385–391. [CrossRef]
56. National Bureau of Statistics. Fang Xiaodan: Residents' Income and Economic Growth Are Basically Synchronized, and the Real Growth Rate of Consumer Spending Has Fallen Slightly. Available online: http://www.stats.gov.cn/xxgk/jd/sjjd2020/202301/t20230118_1892287.html (accessed on 13 March 2023).
57. Alexander, P.; Rounsevell, M.D.; Dislich, C.; Dodson, J.R.; Engström, K.; Moran, D. Drivers for global agricultural land use change: The nexus of diet, population, yield and bioenergy. *Glob. Environ. Change* **2015**, *35*, 138–147. [CrossRef]
58. Ruan, F.; Yan, L.; Wang, D. Policy effects on the sustainable development of resource-based cities in China: A case study of Yichun City. *Resour. Policy* **2021**, *72*, 102145. [CrossRef]
59. Huang, C.; Shen, L.; Liu, Q.; Zhang, Y.; Wang, H. Study on the Influence of the Construction of Traceability System in Yichun City on the Forest Ecological Food Industry. *Ekoloji* **2019**, *28*, 1141–1146.

60. ISO 9001 and Related Standards. Available online: https://www.iso.org/iso-9001-quality-management.html (accessed on 13 March 2023).
61. National Forestry and Grassland Administration. The 14th Five-Year Plan of Action for Ecological Protection and Economic Transformation of Daxiaoxinganling Forest Area Was Issued. Available online: http://www.forestry.gov.cn/search/6721 (accessed on 26 June 2023).
62. National Forestry and Grassland Administration. Heilongjiang Promotes High-Quality Development of Forest Economy. Available online: http://www.forestry.gov.cn/main/4102/20230323/110412248557897.html (accessed on 26 June 2023).
63. Ministry of Agriculture and Rural Affairs of the People's Republic of China. Relying on the Advantages of Forest Resources, the Daxinganling Area Has Made a Big Effort to Strengthen the Forest Pig Industry. Available online: http://www.moa.gov.cn/xw/qg/201901/t20190117_6169133.htm (accessed on 26 June 2023).
64. Tian, J.; Wang, B.; Zhang, C.; Li, W.; Wang, S. Mechanism of regional land use transition in underdeveloped areas of China: A case study of northeast China. *Land Use Policy* **2020**, *94*, 104538. [CrossRef]
65. National Forestry and Grassland Administration. Typical Cases of Forest Economy Development. Available online: http://www.forestry.gov.cn/html/main/main_5461/20211224164139275849745/file/20211224164220127155731.pdf (accessed on 13 March 2023).
66. Huang, L.; Wang, Z.; Wang, H.; Zhao, L.; Jiang, H.; Zhang, B.; Ding, G. Nutrition transition and related health challenges over decades in China. *Eur. J. Clin. Nutr.* **2021**, *75*, 247–252. [CrossRef] [PubMed]
67. Lam, H.M.; Remais, J.; Fung, M.C.; Xu, L.; Sun, S.S.M. Food supply and food safety issues in China. *Lancet* **2013**, *381*, 2044–2053. [CrossRef] [PubMed]
68. Zhang, Y.; Min, Q.; Zhang, C.; He, L.; Zhang, S.; Yang, L.; Tian, M.; Xiong, Y. Traditional culture as an important power for maintaining agricultural landscapes in cultural heritage sites: A case study of the Hani terraces. *J. Cult. Herit.* **2017**, *25*, 170–179. [CrossRef]
69. Zhang, Y.; Guan, C.; Li, Z.; Luo, J.; Ren, B.; Chen, C.; Xu, Y.; Ding, J.; Huang, H. Review of Rice-Fish-Duck Symbiosis System in China: One of the Globally Important Ingenious Agricultural Heritage Systems (GIAHS). *Sustainability* **2023**, *15*, 1910. [CrossRef]
70. Sapcota, D.; Begum, K. Integrated duck farming. In *Duck Production and Management Strategies*; Springer: Singapore, 2022; pp. 247–264. [CrossRef]
71. Yuan, Y.; Xu, G.; Shen, N.; Nie, Z.; Li, H.; Zhang, L.; Zhu, J.; Duan, J.; Xu, P. Valuation of Ecosystem Services for the Sustainable Development of Hani Terraces: A Rice–Fish–Duck Integrated Farming Model. *Int. J. Environ. Res. Public Health* **2022**, *19*, 8549. [CrossRef]
72. Wilson, M.A.; Troy, A.; Costanza, R. The economic geography of ecosystem goods and services: Revealing the monetary value of landscapes through transfer methods and geographic information systems. In *Cultural Landscapes and Land Use: The Nature Conservation_Society Interface*; Springer: Berlin/Heidelberg, Germany, 2004; pp. 69–94. [CrossRef]
73. Cressey, D. Future fish. *Nature* **2009**, *458*, 398–400. [CrossRef]
74. Li, F.; Gao, J.; Xu, Y.; Nie, Z.; Fang, J.; Zhou, Q.; Xu, G.; Shao, N.; Xu, D.; Xu, P.; et al. Biodiversity and sustainability of the integrated rice-fish system in Hani terraces, Yunnan province, China. *Aquac. Rep.* **2021**, *20*, 100763. [CrossRef]
75. Wei, W.; Chen, D.; Wang, L.; Daryanto, S.; Chen, L.; Yu, Y.; Lu, Y.; Sun, G.; Feng, T. Global synthesis of the classifications, distributions, benefits and issues of terracing. *Earth-Sci. Rev.* **2016**, *159*, 388–403. [CrossRef]
76. Liang, X.; Jin, X.; Yang, X.; Xu, W.; Lin, J.; Zhou, Y. Exploring cultivated land evolution in mountainous areas of Southwest China, an empirical study of developments since the 1980s. *Land Degrad. Dev.* **2021**, *32*, 546–558. [CrossRef]
77. Deng, J.S.; Wang, K.; Hong, Y.; Qi, J.G. Spatio-temporal dynamics and evolution of land use change and landscape pattern in response to rapid urbanization. *Landsc. Urban Plan* **2009**, *92*, 187–198. [CrossRef]
78. Fei, R.; Lin, Z.; Chunga, J. How land transfer affects agricultural land use efficiency: Evidence from China's agricultural sector. *Land Use Policy* **2021**, *103*, 105300. [CrossRef]
79. Liu, Y.; Fang, F.; Li, Y. Key issues of land use in China and implications for policy making. *Land Use Policy* **2014**, *40*, 6–12. [CrossRef]
80. Deng, X.; Huang, J.; Rozelle, S.; Zhang, J.; Li, Z. Impact of urbanization on cultivated land changes in China. *Land Use Policy* **2015**, *45*, 1–7. [CrossRef]
81. Zuo, Q.; Zhou, Y.; Wang, L.; Li, Q.; Liu, J. Impacts of future land use changes on land use conflicts based on multiple scenarios in the central mountain region. *China. Ecol. Indic.* **2022**, *137*, 108743. [CrossRef]
82. Fang, Y.P.; Ying, B. Spatial distribution of mountainous regions and classifications of economic development in China. *J. Mt. Sci.* **2016**, *13*, 1120–1138. [CrossRef]
83. Shi, T.; Li, X.; Xin, L.; Xu, X. Analysis of farmland abandonment at parcel level: A case study in the mountainous area of China. *Sustainability* **2016**, *8*, 988. [CrossRef]
84. Hou, D.; Meng, F.; Prishchepov, A.V. How is urbanization shaping agricultural land-use? Unraveling the nexus between farmland abandonment and urbanization in China. *Landsc. Urban Plan* **2021**, *214*, 104170. [CrossRef]
85. Hua, X.; Yan, J.; Li, H.; He, W.; Li, X. Wildlife damage and cultivated land abandonment: Findings from the mountainous areas of Chongqing, China. *Crop. Prot.* **2016**, *84*, 141–149. [CrossRef]
86. Li, W.; Li, X.; Tan, M.; Wang, Y. Influences of population pressure change on vegetation greenness in China's mountainous areas. *Ecol. Evol.* **2017**, *7*, 9041–9053. [CrossRef]

87. Long, P.; Huang, H.; Liao, X.; Fu, Z.; Zheng, H.; Chen, A.; Chen, C. Mechanism and capacities of reducing ecological cost through rice–duck cultivation. *J. Sci. Food Agric.* **2013**, *93*, 2881–2891. [CrossRef] [PubMed]
88. Nayak, P.K.; Panda, B.B.; Das, S.K.; Rao, K.R.; Kumar, U.; Kumar, A.; Munda, S.; Satapathy, B.; Nayak, A. Weed control efficiency and productivity in rice-fish-duck integrated farming system. *Indian J. Fish* **2020**, *67*, 62–71. [CrossRef]
89. Hu, L.; Zhang, J.; Ren, W.; Guo, L.; Cheng, Y.; Li, J.; Li, K.; Zhu, Z.; Zhang, J.; Luo, S.; et al. Can the co-cultivation of rice and fish help sustain rice production? *Sci. Rep.* **2016**, *6*, 28728. [CrossRef] [PubMed]
90. The People's Government of Yichang City. Zigui Navel Orange Brand Value Reached 6.018 Billion Yuan, Another Record High. Available online: http://www.hbzg.gov.cn/content-10-92152-1.html (accessed on 13 March 2023).
91. Fukamachi, K. Sustainability of terraced paddy fields in traditional satoyama landscapes of Japan. *J. Environ. Manag.* **2017**, *202*, 543–549. [CrossRef]
92. Sato, K. Development and conservation of agricultural land in steep mountainous areas in Japan. *J. Irrig. Eng. Rural. Plan.* **1983**, *1983*, 23–32. [CrossRef]
93. Iiyama, N.A.O.K.I.; Nehira, K.U.N.I.T.O.; Nakagoshi, N.O.B.U.K.A.Z.U. Landscape change of terraced paddies in rural Japan. *Acta Univ. Carol. Environ.* **1999**, *13*, 69–76.
94. Kako, T. Sharp decline in the food self-sufficiency ratio in Japan and its future prospects. In Proceedings of the International Association of Agricultural Economists (IAAE), Beijing, China, 16–22 August 2009.
95. Ito, K.; Dyck, J.H. *Fruit Policies in Japan*; No. 1494-2016-130580; United States Department of Agriculture (USDA): Washington, DC, USA, 2010. [CrossRef]
96. Park, K.; Zhang, Y.; Wan, Q.; Chun, K.; Kim, S.; Jung, S.; Yoon, S.; Moon, K.; Moon, K. General situation and type of agroforestry in Korea. *World For. Res.* **2012**, *25*, 58–62.
97. Rasul, G.; Hussain, A.; Mahapatra, B.; Dangol, N. Food and nutrition security in the Hindu Kush Himalayan region. *J. Sci. Food Agric.* **2018**, *98*, 429–438. [CrossRef]
98. Hussain, A.; Mahapatra, B.; Rasul, G. Adaptation in Mountain Agriculture: Food Security in the Hindu-Kush Himalayan (HKH) Region. In *Status of Climate Change Adaptation in Asia and the Pacific*; Springer: Cham, Switzerland, 2019; pp. 211–236. [CrossRef]
99. Rasul, G.; Saboor, A.; Tiwari, P.C.; Hussain, A.; Ghosh, N.; Chettri, G.B. Food and nutrition security in the Hindu Kush Himalaya: Unique challenges and niche opportunities. In *The Hindu Kush Himalaya Assessment: Mountains, Climate Change, Sustainability and People*; Springer: Cham, Switzerland, 2019; pp. 301–338. [CrossRef]
100. Skjeggedal, T.; Overvåg, K.; Riseth, J.Å. Land-use planning in Norwegian mountain areas: Local development or nature protection? *Eur. Plan. Stud.* **2016**, *24*, 344–363. [CrossRef]
101. Wehn, S.; Pedersen, B.; Hanssen, S.K. A comparison of influences of cattle, goat, sheep and reindeer on vegetation changes in mountain cultural landscapes in Norway. *Landsc. Urban Plan* **2011**, *102*, 177–187. [CrossRef]
102. Benjaminsen, T.A.; Svarstad, H.; Benjaminsen, T.A.; Svarstad, H. Pastoralists and the State. In *Political Ecology: A Critical Engagement with Global Environmental Issues*; Springer: Cham, Switzerland, 2021; pp. 155–182. [CrossRef]
103. Bansal, A.K. Feasibility analysis and business plan. In *Basic Biotechniques for Bioprocess and Bioentrepreneurship*; Springer: Cham, Switzerland, 2023; pp. 427–440. [CrossRef]