Analysis of Ecological and Economic Benefits of Rural Land Integration in the Manas River Basin Oasis

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Abstract: Land consolidation is an effective means of promoting the regularization of fragmented arable land, optimizing the allocation of land resources and improving the environment in farming areas, as well as an important means of increasing the economic returns of farming households, and it is important to scientifically assess the ecological and economic benefits of agricultural land consolidation. In this study, participatory rural assessment (PRA) was used to investigate, in detail, the meaning, satisfaction and changes in farmland rehabilitation before and after implementation. The accuracy of the remote sensing data was verified through an experiment on the net cultivation coefficient. We used a sample of 447 farmers from nine villages in Manas County to study the differences in plot area, crop unit value, income and irrigation before and after the farmers’ integration. We found that, after the integration of farmland, the cultivated area increased significantly, the crop unit yield increased by at least 42.66%, the average income of farmers increased by a value of RMB 4324/ha and the water savings were all higher than 7.18 m³/ha. At the same time, after the integration of farmland, the number of plots was significantly reduced, the arable land became more regular and the microclimate of the farmland improved significantly. The government and individuals should follow the concept and construction requirements of the “community of life in mountain, water, forest, lake, grass and sand”, consider the economic and ecological benefits of land consolidation, ensure the quality of farmland ecosystems, actively explore new models of land consolidation and stimulate the economic vitality of rural areas.

Keywords: land integration; oasis; Manas County; Manas River Basin; ecological and economic benefits

1. Introduction

“Land consolidation” is the transformation, annexation and reuse of land resources based on existing scientific, technological and management tools within a certain geographical area and the multilevel design and combination of spatial and temporal scales of land use structure to promote the orderly, rational and scientific use of land to achieve the goal of maximizing economic, social and ecological benefits within a certain region [1,2]. Since 1998, land remediation has been encouraged and advocated in China from the policy-making and legal levels [3,4]. At present, research on land remediation in China focuses on how to effectively integrate land resources, increase the area of arable land [5,6], improve the efficiency and potential of land use, “eco-friendly” land management methods, and achieve large-scale agricultural operation, etc. [7–10]. The representative models are the Longzhou model [11], the Nanhai model [12], the Wenzhou model [13], the Chengdu
and the Shawan model [15]. In particular, Shawan is located in the Manas River Basin, where land consolidation was initiated successively in 2004, and to date, the second round of consolidation has been completed.

During the implementation of land consolidation work, the structure of land use types is bound to change, and its effect is reflected in the improvement of ecological and economic benefits and service function values of land systems (ecological service function refers to the natural ecosystem providing direct or indirect products and services for human beings through its own ecological functions) [16–19]. Iscan [20] showed that land consolidation changed the degree of land fragmentation and improved the farming level of farmland; Junge et al. [17] believe that farmland rehabilitation is important not only for environmental protection but also for landscaping aesthetics; Kangalawe et al. [21] proposed that land reclamation should be developed toward sustainability, intensification, and scale. Yang et al. [22] evaluated the benefits of land remediation projects using the fuzzy comprehensive evaluation method; Wang et al. [23] analyzed the remediation effects of hilly terraces; Guo et al. [24] estimated the value of agricultural land consolidation using the residual method, revenue reduction method, and net production value reduction method, separately. Throughout the existing studies, the research on the benefits of agricultural land consolidation is mostly concentrated in the relatively developed areas in the east and central parts of the country, and there are few reports on the scientific and quantitative assessment of the ecological and economic benefits of agricultural land consolidation in arid areas. Research on the Shawan model is even rarer, which is rather unfortunate for the publicity and promotion of the results of the Shawan model.

In our published article, “Analyzing Macro-Level Ecological Change and Micro-Level Farmer Behavior in the Manas River Basin”, we found that farmers were aware of their dependence on land resources for their livelihoods. However, in times of population pressure, land expansion and resource exploitation are undertaken to increase short-term production and to meet farmers’ basic needs. In this context, it is proposed that an active and steady land consolidation process, tailored to the local context, is a scientific model for the future expansion of the oasis, in order to further test the effectiveness of land consolidation in the oasis [25]. Using a sample of 447 farmers from nine villages in Manas County, we conducted a detailed survey of the connotation, satisfaction and pre- and post-implementation changes of farmland improvement among farmers using participatory rural assessment (PRA). The accuracy of the remote sensing data was verified through experiments on the net cultivation coefficient. With the help of ArcGIS10.3, FRAGSTATS 4.2 [26] and other tools, the ecological and economic benefits of land consolidation were analyzed in terms of field plots, crop production value, changes in farm household income, irrigation water quota, landscape index and farmland microclimate, aiming to provide typical cases and references for the orderly expansion of oases, improvement of farmland ecological environment and large-scale farmland management.

2. Materials and Methods

2.1. Study Area

This paper takes nine villages in Manas County as the research objects, specifically as follows: Dongwan, Zhengjiazhuang and Zhangjiazhuang villages in Letuyi township, Jiahezi village in Lanzhouwan township, Weigou and Weiba villages in Guangdongdi township, Damiao and Heshawo villages in Beiwucha township and Tugongying village in Liutoudi township (as shown in Figure 1). Since 2007, land integration has been carried out in nine villages, and the integration had basically been completed by 2017. The average operating land is about 2–3.5 h, of which the local land and reserved area occupy 40% and 60% of the operating area, respectively (reserved land is where some rural collective economic organizations reserve land in advance for possible future adjustments when contracting rural land). The main economic crops include cotton, corn, wheat, melons and other fruits and vegetables.
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Figure 1. Map showing the location of study area.

2.2. Research Methods and Data Sources

2.2.1. The Net Arable Land Coefficient Sampling Experiment

The essence of land consolidation is to transform fine ground objects, such as ditches, ridges, and forest belts, into cultivated land, that is, to increase the net area of farmland. The area of fine ground objects in farmland is generally small, and the resolution of TM, CBERS, SPOT and other images makes it difficult to meet accuracy requirements. Therefore, the data source used in this paper is the 0.3 m resolution LocaSpace Viewer (LSV) [27] remote sensing images of nine villages in 2007 (before integration) and 2017 (after integration). In order to verify whether the accuracy of LSV meets the requirements, the net arable land coefficient experiment was carried out by using a field sample combined with remote sensing feature interpretation. The details are as follows: A sample plot in each of the nine villages was selected, and then, a small sample subplot in each sample plot was selected. Through the visual interpretation of data and object-oriented classification method, the forest belt, grassland, road, ridge, ditch, cultivated land, residential area, unused land and other small features in each sample plot were classified. While processing the data, 13 field surveys and interviews with local farmers were carried out in the study area to verify the classification results. The sampling calculation formula for the arable land coefficient experiment is provided in the article by Pujia et al. [21].

\[ \eta = \frac{A_i}{A_m} \times 100\% = \frac{A_m - \sum_{f=1}^{n} A_f}{A_m} \times 100\% \]

\[ \eta_h = \frac{1}{n} \sum_{i=1}^{n} \eta_i \]

\[ S_i = \eta_h \times s_i \]
\[ S = \sum_{i=1}^{m} S_i \]

where \( \eta \) is the net arable land coefficient; \( A_m \) is the gross area of cultivated land in the sample plot; \( A_i \) is the net area of cultivated land in the sample plot; \( A_f \) is the area of the \( f \) small ground objects in the sample plot; \( n \) is the number of small ground objects in the sample plot. \( \eta_i \) is the net arable land coefficient within sample \( i \); \( \eta_h \) is the net arable land coefficient for sample \( h \); \( m \) is the sample number in each sample area. \( S_i \) is the net cultivated land area in plot \( i \); \( s_i \) is the gross cultivated land area in sample plot \( i \). \( S \) is the total area of net cultivated land in the study area.

2.2.2. Participatory Rural Appraisal

From July to September 2019, the author and members of the research team went deep into the project area and conducted more than 40 days of household research in nine villages in Manas County. Using participatory farm household assessment methods, in-depth interviews were conducted with village cadres to obtain basic information and socioeconomic statistics on the project areas, and random visits were made to farm households to conduct farmland integration surveys, with each farm household taking about 1.5–2 h. Interviews included the connotation of farmland improvement, satisfaction, changes in plot size, yield changes, changes in irrigation methods, and labor migration before and after implementation. The survey sample consisted of 464 people, including 6 county and township leaders, 11 village cadres, and 447 farmer representatives, with a total of 439 valid questionnaires.

2.2.3. Landscape Pattern

After the integration of agricultural land in the Manas River Basin, the area, shape, and quantity of cultivated land changed greatly. Based on the existing research results \[28,29\], this paper comprehensively considers the scale, distribution, area, and other factors of rural cultivated land, and describes and measures the degree of farmland fragmentation before and after farmland integration. In sum, nine villages in Manas River Basin were selected as the research objects. The number of patch (NP), edge density (ED), mean patch size (MPS), largest patch index (LPI), landscape shape index (LSI), and aggregation index (AI) were selected to reflect the degree of farmland fragmentation before and after farmland integration.

2.2.4. Farmland Microclimate

The integration of agricultural land and the adoption of efficient water-saving technologies produced large differences in the microclimate of farmland, mainly in terms of changes in salinity, biomass, water content, and ground temperature of arable land, and the relevant indicators were measured as follows \[30\].

(1) Salinity: The multilayer soil moisture and salinity monitoring system was used to monitor the soil in the cultivated layer at different locations in the nine villages before and after the improvement of water conservancy facilities to understand the salt content and water content of the cultivated land in the study area. It varies with the seasons, so samples were taken in the same season when the weather was clear. After drilling 30 soil samples from different locations before and after consolidation in each village, each sample was placed in an aluminum box after sampling to reduce moisture evaporation due to weather. The salt content was specifically determined by the dry residue method, and the water content was calculated by gravimetric analysis as follows:

\[
Y = 2.956 \times 10^{-4} EC - 0.0214 \left( r^2 = 0.98 \right) \\
X = \frac{W_1 - W_2}{W_2} \times 100\% 
\]
where $Y$ is the salt content of the soil sample, g/L, $EC$ is the conductivity value, $X$ is the soil moisture content, $W_1$ is the weight of the soil sample before integration, and $W_2$ is the weight of the soil sample after integration.

(2) Farmland biomass: A sample method was used with a sample size of $1 \times 1$ m. At least 10 sample plots were selected in each village, and the farmland sample plots were mostly chosen from the middle area of the field away from trees, settlements, ditches and field canals. Sampling was carried out before the crop was harvested after maturity, and whole plant bodies were collected from the above-ground parts of the sample plots [31]. In the laboratory, the crop plants were weighed for fresh weight and recorded, baked to a constant weight in an oven at $80^\circ$C, and the dry weight data recorded. The biomass of each village sample was averaged to obtain the biomass of the nine villages in m$^2$.

(3) Ground temperature: A handheld small weather meter was used to detect the ground temperature at different locations of the farmland in nine villages to study the impact of the improvement of irrigation methods on the farmland microclimate.

2.2.5. Other Data Sources

(1) Basic data of basin administrative boundary and map: from national basic geographic information center; (2) social and economic data: from Manas agriculture, land and other departments.

3. Results and Analysis

3.1. Calculation and Analysis of the Sample Arable Land Coefficient

Table 1 shows the net arable land coefficient measurements for the study area, from which it can be seen that the arable land coefficient of the remote sensing image obtained in the study area and the arable land coefficient obtained from the field survey are close to each other, mostly about 97%, which indicates that the data interpreted by remote sensing image are close to the real data. Therefore, the reliability of calculating the net cultivated land area by using an LSV remote sensing image with a resolution of 0.3 m is high. Compared with field investigation, the use of remote sensing images to obtain and calculate data can effectively reduce the workload of field investigation and improve work efficiency [31].

Table 1. Study area net arable land table.

| Name                  | Net Cultivated Land Coefficient of Remote Sensing Images in the Study Area | Field Survey Net Cultivated Land Coefficient |
|-----------------------|---------------------------------------------------------------------------|---------------------------------------------|
| Dongwan Village       | 0.7268                                                                    | 0.7132                                      |
| Zhengjiazhuang Village| 0.7327                                                                    | 0.7145                                      |
| Zhangjiazhuang Village| 0.7315                                                                    | 0.7201                                      |
| Weigou Village        | 0.7883                                                                    | 0.7647                                      |
| Weiba Village         | 0.7635                                                                    | 0.7406                                      |
| Jiahezi Village       | 0.7729                                                                    | 0.7497                                      |
| Damiao Village        | 0.7644                                                                    | 0.7414                                      |
| Heishawo Village      | 0.7843                                                                    | 0.7607                                      |
| Tupaoying Village     | 0.7536                                                                    | 0.7309                                      |

3.2. Analysis of Economic Benefits of Agricultural Land Integration

3.2.1. Analysis of Newly Added Cultivated Land Rate

In order to calculate the farmland integration rate of different villages in detail, according to the LSV image, the farmland integration situation of nine different villages was obtained (see Table 2). We found that the area of cultivated land in each village had increased to a greater or lesser extent in the categories of marginal land, forest land, ditches, field cans and fragmented land, and the rate of new cultivated land was greater than 3.35%. Among them, the village with the highest integration proportion was Jiahezi village, whose
cultivated land area increased from 1260.12 ha to 1348.18 ha, with the newly increased cultivated land rate reaching 6.99%; Damiao village was second, with a newly increased cultivated land rate of 6.50%; Zhongjiazhuang village and Zhangjiazhuang village had the lowest integration proportion, with newly increased cultivated land area of 47.00 ha and 37.43 ha, respectively. The new cultivated land rate was 3.98% and 3.35%, respectively.

| Name of Village         | Before Integration/ha | After Integration/ha | Change in Cultivated Land/ha | New Cultivated Land/% |
|-------------------------|-----------------------|----------------------|-------------------------------|-----------------------|
| Dongwan Village         | 752.70                | 789.50               | 10.25                         | 4.89%                 |
| Zhengjiazhuang Village  | 1180.52               | 1227.52              | 13.83                         | 3.98%                 |
| Zhangjiazhuang Village  | 1118.25               | 1155.68              | 10.81                         | 3.35%                 |
| Weigou Village          | 636.12                | 671.07               | 9.36                          | 5.49%                 |
| Weiba Village           | 1130.10               | 1196.42              | 19.33                         | 5.87%                 |
| Jiahezi Village         | 1260.12               | 1348.18              | 38.26                         | 6.99%                 |
| Damiao Village          | 1662.99               | 1771.08              | 35.19                         | 5.87%                 |
| Heishawo Village        | 972.61                | 1023.83              | 11.22                         | 6.50%                 |
| Tupaoying Village       | 787.61                | 834.28               | 12.33                         | 5.95%                 |

### Table 2. Status of land integration in the Manas River Basin.

#### 3.2.2. Comparative Analysis of Crop Yield and Income before and after Land Consolidation

For this study, cotton was the main crop grown in each village, and the volume and area of cotton planted in each of the nine villages increased after land consolidation [32]. Among them, the yield per unit area increased by more than 42.66%, and the planting area exceeded 5.44% (as shown in Table 3). However, there was a positive correlation between farmers' income and yield and planting area, which means that with the increase in yield and planting area, the income of cotton was also significantly improved. The average income increased by RMB 7.03 million, and increased by 146.69% before and after integration. Among the nine villages, Damiao village and Jiahezi village had the most obvious economic income growth, which was RMB 27.18 million and RMB 33.04 million, respectively. It was found that the economic value of land integration was most significantly affected by the per unit yield and new cultivated land. Through increasing the area of cultivated land, land integration improves the grain production capacity, improves the agricultural infrastructure, increases the economic income of farmers, improves the living conditions of farmers and has considerable economic benefits. In addition, the value of the land itself was enhanced after consolidation, for example, for the same plot of land, the cost of circulation before consolidation was roughly RMB 350–500, while after consolidation, the cost of circulation reached RMB 650–900.

#### 3.2.3. Comparative Analysis of Farmers' Income before and after Integration

A survey of the incomes of 447 farming households in nine villages found that after the integration of farmland, with the increase in the area of farm households and the increase in crop yields, the income of farmers generally showed a clear increasing trend (see Table 4). For example, before the integration, the farmers' operating area was at least 1.20 ha, and the annual income value was RMB 5163; after the integration, the operating arable land area was 1.26 ha, the newly added arable land reached 0.06 ha, the annual income value was RMB 5494, and the annual income value per hectare was RMB 286. Before the integration, the farmer household with the largest operating area (6.67 ha) had an annual income of RMB 28,687. After the integration, the operating area reached 7.13 ha, with an annual income value of RMB 30,691. The newly increased cultivated area was 0.46 ha, and the annual income added value was RMB 2003. After the integration, the more cultivated land area was added, the more farmers’ income would increase, and the average annual income increase was RMB 4324/ha.
Table 3. Crop yield and income.

| Village                  | Classification of Integration | Unit Yield (kg/ha) | Plant the Measure of Area/ha | Income/RMB 10,000 |
|-------------------------|-------------------------------|--------------------|------------------------------|------------------|
| Dongwan Village         | Before                        | 4591.36            | 752.70                       | 392.72           |
|                         | After                         | 6835.76            | 789.50                       | 1897.95          |
| Zhengjiazhuang Village  | Before                        | 4809.80            | 1180.52                      | 712.65           |
|                         | After                         | 6819.48            | 1227.52                      | 2938.65          |
| Zhangjiazhuang Village  | After                         | 6886.96            | 1155.68                      | 2793.31          |
| Weigou Village          | Before                        | 4589.52            | 636.12                       | 331.46           |
|                         | After                         | 4861.84            | 671.07                       | 1624.01          |
| Weiba Village           | Before                        | 4858.28            | 1130.10                      | 702.75           |
|                         | After                         | 6769.68            | 1196.42                      | 2827.56          |
| Jiahezi Village         | After                         | 7017.52            | 1348.18                      | 3391.71          |
| Daminiao Village        | After                         | 4983.40            | 1662.99                      | 1112.16          |
| Heishawo Village        | Before                        | 5026.48            | 972.61                       | 666.16           |
|                         | After                         | 6969.80            | 1023.83                      | 2545.67          |
| Tupaoying Village       | After                         | 7113.80            | 834.28                       | 2148.26          |
| Average value           | After                         | 6913.96            | 1113.06                      | 2729.31          |

Table 4. Income comparison before and after integration.

| Before Integration/ha | Income/RMB | After Integration/ha | Income/RMB |
|-----------------------|------------|----------------------|------------|
| 1.20                  | 5163       | 1.26                 | 5449       |
| 1.60                  | 6885       | 1.73                 | 7457       |
| 1.87                  | 8032       | 2.00                 | 8605       |
| 2.00                  | 8268       | 2.20                 | 9094       |
| 2.27                  | 9753       | 2.47                 | 10,612     |
| 2.67                  | 11,775     | 2.87                 | 12,656     |
| 2.93                  | 12,622     | 3.20                 | 13,768     |
| 3.33                  | 14,343     | 3.60                 | 15,489     |
| 3.47                  | 14,917     | 3.73                 | 16,062     |
| 3.80                  | 16,352     | 3.93                 | 16,923     |
| 3.93                  | 16,704     | 4.20                 | 17,834     |
| 4.20                  | 18,309     | 4.47                 | 19,469     |
| 4.53                  | 19,507     | 4.73                 | 20,365     |
| 4.80                  | 20,655     | 5.07                 | 21,799     |
| 5.07                  | 21,653     | 5.33                 | 22,790     |
| 5.67                  | 24,384     | 6.00                 | 25,815     |
| 5.93                  | 26,533     | 6.27                 | 28,020     |
| 6.20                  | 26,679     | 6.53                 | 28,110     |
| 6.47                  | 27,637     | 6.86                 | 29,342     |
| 6.67                  | 28,687     | 7.13                 | 30,691     |

3.2.4. Comparative Analysis of Irrigation Water Consumption before and after Integration

The arid zone in the northwest of the study area region is a temperate continental arid semi-arid climate with long sunshine hours and high evaporation; with annual precipitation in Manas County ranging from 109.3 mm to 321.8 mm during 2005–2017 (see Figure 2), it can be found to be low. Therefore, the efficiency of water-resource use should be further optimized, and the irrigation management of water resources should be further strengthened. The amount of water used in the study area after the land consolidation showed a clear downward trend, with each village saving more than 7.18 m$^3$/ha, with the
most obvious saving in Damiao village, where the amount of water saved was 21.32 m$^3$/ha (see Figure 3). After land consolidation, not only can each category be fully utilized, making the arable land area increase, but also, water conservancy facilities, such as ditches and drip irrigation, can be adjusted to ensure the effective use of irrigation water, saving of irrigation expenses, and reduction in farmers’ planting costs. This provides new ways and means to save water for the sustainable use of water resources in the basin [33].

![Figure 2. Precipitation map of Manas County.](image)

![Figure 3. Water-saving irrigation trends for the nine villages.](image)

3.3. Ecological Benefits

3.3.1. Comparative Analysis of Changes in the Number and Shape of Cultivated Land Plots before and after Integration

After the integration of farmland in nine villages, the farmland landscape changed significantly: first, unnecessary field paths and drains were removed, and some of the barren land and marginal land were integrated; second, the number of plots of cultivated land was significantly reduced, and the number of plots of other land types was also
reduced, and the degree of fragmentation was reduced; third, the shape of the strip fields was more regular, and the area of each strip field was significantly larger, making small plots of arable land larger, optimizing the allocation of arable land resources, promoting the concentration of farmland in a row, increasing the convenience of farming and also improving land utilization [5] (see Figure 4).

Figure 4. Comparison of field changes before and after land consolidation in nine.

3.3.2. Comparative Analysis of Landscape Pattern before and after Integration

The landscape patterns of the nine villages in the Manas River Basin have experienced significant changes over the past 10 years due to land consolidation (Figure 5). In terms of the number of patch (NP) of cultivated land, in each village, it showed a decreasing trend, indicating that the fragmentation of the cultivated landscape may be decreasing. The above judgment can be further proved by MPS. The average patch area of arable land in the nine villages from 2007 to 2017 increased, indicating that there are fewer and fewer arable land patches and more compact patches. This can also reflect that the aggregation index (AI) of cultivated land has increased and the degree of fragmentation has decreased. From the perspective of the marginal nature of cultivated land, the ED of cultivated land continued to decrease from 2007 to 2017, indicating that the length of the heterogeneous edge decreased, which also reflects the reduction in fragmentation in the study area. From the perspective of LPI of cultivated land, most of the villages showed an upward trend. Only Weigou village and Tupaoying village showed a decreasing trend. The increase in LPI indicates that the dominant landscape of cultivated land is gradually increasing, but in the study area the abundance will be reduced. LSI had a clear downward trend, indicating
that the overall morphology of farmland landscape patches tends to be simple. From an overall point of view, the concentration density of the study area increased, the degree of fragmentation of the cultivated land landscape decreased, the cultivated land tended to be regular, and the level of land intensive use increased, which is conducive to the promotion of largescale agricultural mechanization and irrigation technology and facilities, thereby improving agricultural infrastructure construction to improve the income levels of farmers.

![Figure 5. Nine village landscape index analysis.](image)

### 3.3.3. Impact on Farmland Microclimate after Integration

After the integration of the study area, the farmland water conservancy facilities were re-planned and adjusted to form a larger-scale drip irrigation belt under the film. This affected the farmland microclimate to a certain extent [34]. Through monitoring calculations, it was found that the large-scale coverage of mulch film increased the soil temperature. The average ground temperature of each village increased by more than 1.8 °C (see Figure 6). The highest temperature increase was 3.8 °C in Heishawo village. Due to the proximity to the desert edge, the ground cover is more extensive and warms up faster [35]; soil water evaporation was reduced, the average water content of crops in the nine villages increased by more than 3.43%, and the water content of Dongwan village was the highest at 26.35%. It is located in the piedmont alluvial fan, with abundant and concentrated water sources and increased biomass. The increase in the village was between 129.54 g·m$^{-2}$ and 249.22 g·m$^{-2}$, and the biomass in Damiao village was, at most, 1651.72 g·m$^{-2}$. The experiment showed that through drip irrigation under the mulch to grow cotton soil, the average salt content of the farming layer of each village decreased from 1.87 g/L to 0.53 g/L, and the villages on the edge of the desert had more serious salinization, such as Tupaoying. The decrease in salinity was also the most obvious, with a decrease of 1.55, indicating that the salinization of the soil was significantly improved [36–38]. To a certain extent, the development and utilization of surface water and groundwater were reduced, so as to achieve the purpose of water conservation.
Figure 6. Nine village farmland microclimate indicators.

4. Discussion

Rural land reclamation is a systematic process involving arable land, water resources, and transport. It not only taps into the potential of effective arable land, facilitates the promotion of large-scale agricultural mechanization and improves agricultural efficiency and productivity but also provides new ways and means of water conservation for the sustainable use of water resources in the watershed [39]. As the ultimate aim is to increase the size of the land and the area of effective arable land, rural areas are often subjected to extensive land leveling, and the hardening of ditches and field roads, but this practice is not fully compatible with the concept of ecosystem protection and sustainable development, resulting in a certain degree of damage to the existing ecological balance in rural areas [1,40,41]. Therefore, it is important to follow the concept and construction requirements of the “Mountains, Rivers, Forests, Field, Lakes and Grasses Form a Community of Life”; to consider the economic and ecological benefits of land remediation work; and to carry out corresponding ecological and environmental management work to ensure the quality of farmland ecosystems [42]. Second, the government and individuals in the process of land remediation speed up the construction of modern land resource management systems, under the conditions that the environmental carrying capacity allows, according to the development of local conditions, not blindly pursuing the big opening and digging for ecological harmony and the formation of an environmentally sound agricultural ecological environment. This could be achieved, for example, through the new construction and transformation of concentrated areas of farmland, efficient water-saving irrigation, interception and drainage systems, film and other measures to improve the production environment and water environment. Alternatively, adjusting, rectifying and developing underutilized land, i.e., the internal expansion of arable land, by merging fields instead of external expansion, on the premise of reducing the damage to the ecological environment, and increasing the effective arable land area, taking engineering technology, biological restoration and other measures to improve the quality of land, is another approach. The use of the land should be improved by taking measures such as adopting engineering techniques and biological restoration. Finally, rural land remediation should be fully integrated with rural tourism, industrial integration, beautiful countryside construction, and cultural construction, actively exploring new models of land remediation, increasing employment opportunities for farmers who have transferred their land, realizing the transfer of surplus rural labor to secondary and tertiary industries, stimulating the economic vitality of rural
areas, improving people's living standards and promoting high-quality regional economic development [12,14,43,44].

5. Conclusions

Optimizing the development of rural land management can effectively promote the economic development and environmental improvement of the study area, and has a positive effect on enhancing its economic and ecological benefits.

(1) The integration of agricultural land resulted in a significant increase in the area of arable land. The village with the highest percentage of integration is Jiahezi, where the rate of new arable land reached 6.99%. The increase in arable land fundamentally increased food yields, with all villages increasing their yields by 42.66% and increasing the average annual income of farmers by around RMB 4324/ha, raising farmers’ incomes and improving their quality of life; the readjustment of water conservancy facilities, such as ditches and drip irrigation, in the process of land consolidation saved more than 7.18 m$^3$/ha of water in each village, with Damiao village saving the most significant amount of water. The water saving was 21.32 m$^3$/ha, which ensured the effective use of irrigation water, saving irrigation costs and reducing farmers’ planting costs.

(2) The number of arable plots was significantly reduced by converting field paths, drains, sandwiched wastelands and marginal lands into arable and motorized land. Overall, before and after integration, the aggregation of arable land in the study area increased from an overall perspective, the fragmentation of the arable landscape decreased and the arable land tended to be regularized.

(3) The integration of the study area resulted in the formation of a large-scale under-membrane drip irrigation belt, which influenced the microclimate of the farmland to some extent. Large-scale mulching increased the soil temperature, with the average ground temperature in all the villages rising by more than 1.8 °C. The evaporation of soil moisture was reduced, with the average crop water content in all nine villages increasing by more than 3.43%, allowing the crop roots to exist in a more reasonable soil moisture environment, increasing the biomass, with the increase in all villages ranging from 129.54 g·m$^{-2}$ to 249.22 g·m$^{-2}$. The salinity of the soil significantly improved, decreasing from 1.87 g/L to 0.53 g/L. To a certain extent, the exploitation of surface water and groundwater was reduced, thus achieving the purpose of concealing water and strongly protecting the fragile ecological environment of the arid zone.

Author Contributions: Conceptualization, N.L. and X.G.; methodology, Y.W.; software, X.G. and N.L.; validation, N.L. and X.G.; formal analysis, H.X.; investigation, Z.F.; resources, Y.W.; data curation, N.L. and X.G.; writing—original draft preparation, N.L.; writing—review and editing, Y.W.; visualization, X.G.; supervision, Y.W.; project administration, Y.W.; funding acquisition, Y.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Foundation of China (Project Number: U1803244), Key Technologies Research and Development Program (Project Number: 2017YFC0404303), and the Shihezi University (Project Numbers: RCZK2018C41 and RCZK2018C22).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

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

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