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Monitoring and Evaluation of Benefits of Project of Returning Farmland to Forests in Henan Province

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Abstract The project of returning farmland to forest has been implemented and consolidated in Henan Province for 20 years. At present, it is in a critical transition period when the previous round of project of returning farmland to forests has completed and a new round of project of returning farmland to forests has started. Henan Province took counties (cities) with different representations as sample counties for monitoring the benefits of project of returning farmland to forests (key monitoring areas in Henan Province), and monitored social and ecological benefits every year, and has obtained real and scientific monitoring data.

Key words Returning farmland to forests, Project benefits, Monitoring and evaluation

1 Introduction

In March 2000, China included four counties (cities) of Shanxian County (now Shanzhou District of Sanmenxia City), Xin'an County, Jiyuan City and Lingbao City in Henan Province into the pilot areas of returning farmland to forests, and the project was fully implemented in 2002. On December 28, 2016, the General Office of the People's Government of Henan Province distributed the *Notice on Issuing Henan Province's 13th Five-Year Plan for Agricultural and Rural Economic Development* (Yu Zheng Ban [2016] No. 227), decided to return farmland to forests for "slope farmland of more than 25 degrees, severely desertified farmland, 15–25 degree slope farmland of important water source areas, and seriously polluted farmland" in Henan Province. By the end of 2019, Henan Province had completed a total of 1.099 million ha of returning farmland to forests, of which 0.25 million ha farmland had been returned to forests, 0.711 million ha of barren hills and wasteland completed afforestation, and 0.131 million ha had been closed for afforestation. The project of returning farmland to forests in the entire Henan Province involved 18 provincial municipalities and 136 counties (cities and districts), including more than 1.2 million farmers returning farmland. By the end of 2019, it had invested more than 10 billion yuan.

2 General situation

2.1 Implementation of the project of returning farmland to forests in Henan Province In 2000–2019, Henan Province had completed a total of 1.099 million ha of returning farmland to

forests, of which 0.25 million ha farmland had been returned to forests, 0.711 million ha of barren hills and wasteland completed afforestation, and 0.131 million ha had been closed for afforestation. After the state verification and provincial re-examination, the conservation rate of the farmland returning to forests reached 100%, and the forest forming rate was greater than 75%.

2.2 Scope of farmland returning to forests In Henan Province, the implementation objects of returning farmland to forests are mainly farmland with large slope, serious soil erosion, serious desertification, and farmland with important ecological status but low and unstable grain yield. In the process of project implementation, priority would be given to incorporating the steep slope farmland at the sources and both sides of rivers, and the farmland around the lakes and reservoirs into the scope of returning farmland to forests. We performed a statistical analysis on the slope grades of the 12 counties under monitoring for returning farmland to forests. The main slopes of returning farmland to forests in these 12 counties were 6°–15° and 16°–25° (Fig. 1), the area of farmland returned to forests was 41 500 and 43 000 ha respectively, accounting for 42.7% and 44.3% of the total area of farmland returned to forests. The area of the mountain area with slope greater than 25° returned to forests was 11 000 ha, accounting for 11% of the entire area of farmland returned to forests, and the conservation rate was 96%. The area of the mountain area with slope not greater than 5° returned to forests was 1 500 ha, accounting for 1.5% of the entire area of farmland returned to forests.

2.3 Implementation of project of returning farmland to forests In terms of institutional organization, Henan Province established a leading group for the protection of natural forests in the upper reaches of the Yellow River in Henan Province and the project of returning farmland to forests in 2000. The leading group was headed by the vice governor responsible for daily work and set an office under the Henan Provincial Forestry Department. In 2002, Henan Provincial Forestry Department established Henan Provincial Management Center for Returning Farmland to Forest

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Project and Natural Forest Protection Project responsible for the full-time management of returning farmland to forests in the province, so that the project of returning farmland to forests is truly managed at every level, managed at every level, and the work responsibility system is effectively implemented, which provides an organizational guarantee for the forestry department to perform its duties of returning farmland to forests.

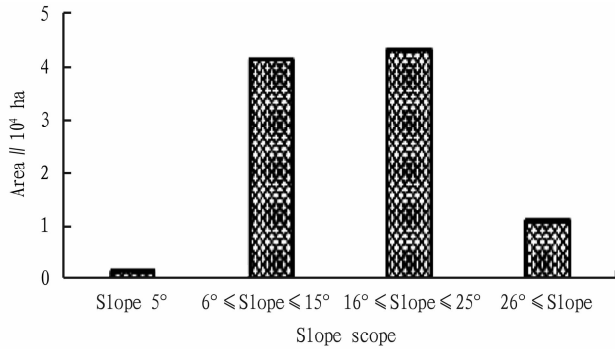


Fig. 1 Slope distribution of returning farmland to forest in counties under monitoring

3 Evaluation of ecological benefits of returning farmland to forests in Henan Province

Since the implementation of the project of returning farmland to forests for 20 years, through the monitoring of 12 sample counties for 19 consecutive years, compared with 2001, the 12 sample counties realized increase of 891 400 ha of forest land, 766 100 ha of closed forest land, and 1 105 000 m³ of forest stock volume (Fig. 2). The project of returning farmland to forests has played a great role in water conservation, soil conservation, carbon fixation and oxygen release, tree nutrient accumulation, biodiversity protection, atmospheric environment purification and forest protection.

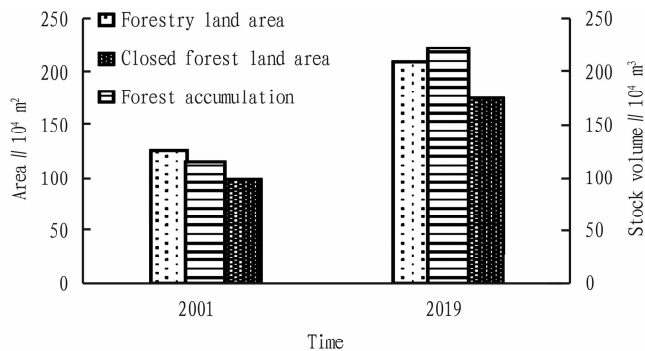


Fig. 2 Comparison of forestry resources in monitored counties between 2001 and 2019

In compliance with the principles of forest zoning in *Henan Forests*^[1], combined with the Henan Forestry Development Zoning Plan^[2], and according to the ecological importance of each ecological zone, the diversity of ecosystems and other factors^[3], Henan Province built 10 ecological monitoring stations for returning farmland to forests in the province. The ecological data in this study were reported by 10 ecological monitoring stations for re-

turning farmland to forests, and d the distributed measurement algorithm^[4] to evaluate the ecological benefits. The comparison of ecological indicators was shown in Fig. 3.

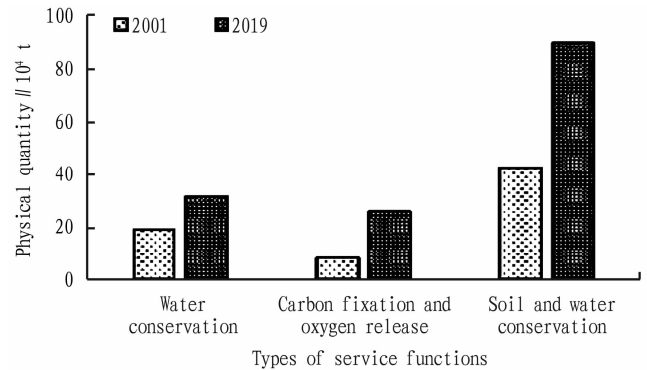


Fig. 3 Comparison of relevant ecological indicators in monitoring counties between 2001 and 2019

3.1 Function of water conservation In 2019, in monitored counties in Henan Province, 384.264 million m³ of farmland were returned to forests for water conservation, including 121.992 million m³ of farmland returned to forests, 186.134 million m³ of barren hills and wasteland suitable for forestry, and 76.138 million m³ of closed mountains for forest cultivation.

3.2 Function of soil conservation In 2019, 7 655 310 t of soil were conserved in the monitored counties of Henan Province, including 7 476 120 t of soil fixation, 51 930 t of nitrogen fixation, 1 910 000 t of phosphorus fixation, 8 170 000 t of potassium fixation, and 117 180 t of inherent organic matter.

3.3 Function of carbon fixation and oxygen release In this study, we selected two indicators, carbon sequestration and oxygen release, were selected to reflect the function of forest carbon fixation and oxygen release. According to the chemical reaction of photosynthesis, forest vegetation can absorb 1.63 g of CO₂ and release 1.19 g of O₂ for every 1.00 g of dry matter accumulated in forest vegetation. The specific monitoring data were as follows: in 2019, the monitored counties returned farmland to forests for carbon fixation of 593 000 t and oxygen release of 496 800 t. Among them, returning farmland to forests fixed 156 900 t of carbon and released 169 600 t of oxygen; barren hills and wasteland suitable for forests fixed 369 000 t of carbon and released 274 400 t of oxygen.

3.4 Function of purifying the atmospheric environment Harmful substances in the atmosphere mainly include sulfur dioxide (SO₂), fluoride, nitrogen oxides and other harmful gases and dust. In this study, we selected three indicators, namely, negative ion provision, pollutants absorption and dust retention, to reflect the ability of forests to purify the atmospheric environment. The specific monitoring data were as follows: In 2019, in the 12 monitored counties (cities) of Henan Province, the project of returning farmland to forest provided 10.774 9 × 10²² negative ions, absorbed 32.36 million t of pollutants, retained 379 595 t of dust, retained 303 677 t of total suspended particulate (TSP) matter, and retained 511 586 t of PM_{2.5}.

3.5 Function of forest protection The combined action of the ground and the underground can reduce the wind strength and sand

carrying capacity, and reduce the soil loss and sand damage caused by wind erosion. The specific monitoring data were as follows: In 2019, the project of returning farmland to forests in Henan Province achieved windbreak and sand fixation of 226 986 t, including 72 120 t from farmland returned to forests, 146 934 t from barren hills and wasteland suitable for forestry, and 79 320 t from closing hillsides to facilitate afforestation.

4 Evaluation of social and economic benefits of project of returning farmland to forests

Since the implementation of project of returning farmland to forests for 20 years, Henan Province achieved the reduction of soil erosion, and the improvement of the ecological environment. In addition, through monitoring the economic and social income of 12 sample counties (cities) and 120 sample households for 19 consecutive years, it was found that the project of returning farmland to forests also brought social and economic benefits such as the improvement in farmers' living standards and the coordinated development of the local economy.

4.1 Economic benefits

4.1.1 Impact on local economic development. (i) The monitoring results show that the GDP of the monitored counties in 2019 was 510.2 billion yuan, which was 5.8 times that of 2001. Specifically, the GDP of the primary industry was 21.8 billion yuan, an increase of 4.2 times compared with that in 2001, the GDP of the secondary industry was 331.2 billion yuan, an increase of 5.9 times compared with 2001, and the GDP of the tertiary industry was 1 572 yuan, an increase of 5.9 times compared with 2001. (ii) The monitoring results also indicate that in 2019, the primary industry of the monitored counties was 21.8 billion yuan, accounting for 4.41% of the GDP, which was 1.8 percentage points lower than that in 2001; the secondary industry was 331.2 billion yuan, accounting for 68% of the GDP, an increase of 2.1 percentage points over 2001; the tertiary industry was 157.2 billion yuan, accounting for 28.66% of the GDP, an increase of 2.11 percentage points over 2001, which make farmers obtain the benefits of the policy of returning farmland to forests.

4.1.2 Impact on grain unit area yield and grain security. After returning farmland to forests, monitoring counties strengthened efforts to build farmland for grain ratio. By the end of 2019, although the area of farmland has been reduced by returning farmland to forests, the grain yield has increased year by year, indicating that the increase in grain unit area yield has resulted in a steady increase in the total grain yield of the entire project area. In 2019, the total grain yield of the monitored counties was 2.255 million t, an increase of 19.6% over 2001, which demonstrates that after the implementation of the project of returning farmland to forests, the grain security capacity of the counties where the project was implemented has not been weakened, but has increased.

4.1.3 Impact on per capita income of farmers. The monitoring results show that after the implementation of the project of returning farmland to forests, the per capita net income of residents in the monitored counties has increased steadily and substantially, which was higher than the average level in the whole Henan Province. In 2019, the per capita net income of rural residents in the monitored counties of returning farmland to forests in Henan Prov-

ince was 18 604 yuan, which was 6.23 times that of 2001. The added value and growth rate of per capita net income of rural residents in the monitored counties were higher than the provincial average level.

4.1.4 Gradual improvement in rural social security. The monitoring results show that in 2019, the monitored counties received a total of 92.323 million yuan of financial subsidies, including 52.009 2 million yuan in living allowances, 26.209 4 million yuan in management and maintenance expenses, and 14.104 4 million yuan in special funds for later consolidation. By 2019, farmers received a total of 323.954 3 million yuan in financial subsidies.

4.2 Social benefits of project of returning farmland to forests

4.2.1 Adjustment of the employment structure of farmers. Since the implementation of the project of returning farmland to forests for many years, the planting structure of remote rural areas has been changed, and a large number of rural laborers have been released from the cultivation of sloping farmland with extensive cultivation and but meager harvest, and transferred to other industries or migrant workers. The number of migrant workers in 120 sample villages in the monitored counties has reached 1 256, and the implementation of the project has expanded the channels for farmers to increase their employment and income.

4.2.2 Enhancement of rural ecological awareness. Since the implementation of the project of returning farmland to forests, the rural ecological environment has been significantly improved. The phenomenon of deforestation, slash-and-burn cultivation, and destruction of ecological development and economic development in the past has basically disappeared. The return of farmland to forests makes the farmers obtain the state economic subsidy and a comfortable living environment of the blue mountains and green waters, blue sky and white clouds. People's love for forestry ecological construction becomes unprecedentedly high, creating a positive atmosphere of ecological protection and forest protection in the whole society.

5 Conclusions

5.1 Significant ecological benefits of project of returning farmland to forests In 2019, the total value of the ecological benefits of returning farmland to forests in the 12 sample counties reached 20.131 billion yuan, which was higher than the total investment by the central government in the project of returning farmland to forests in the above-mentioned 12 counties in Henan Province from 2000 to 2019. Since the implementation of the project of returning farmland to forests for nearly 20 years, the biomass has been stable, and its comprehensive ecological benefits such as soil and water conservation, water conservation, soil improvement, carbon fixation and oxygen release are very significant.

5.2 Positive effect of the project of returning farmland to forests on national grain security In 2019, the grain per unit area yield of the sample counties was 5 287 kg/ha, and the grain per unit area yield of the sample households was 8 865 kg/ha, an increase of 49.14% and 27.61% over 2001, respectively. The total grain yield in the monitored counties was 2.255 4 million t, an increase of 19.7% over 2001. The total grain yield is continuously increasing, which has a positive effect on national grain security.

5.3 Positive effect of the project of returning farmland to forests on rural social and economic development

The implementation of the project of returning farmland to forests has increased the opportunities for rural labor to go out to work and accelerated the transfer of rural surplus labor. Farmers' income has increased, their economic conditions have improved, and their living standards have improved. Moreover, enthusiasm of farmers to love forests and protect forests has strengthened, and their ecological awareness has been significantly enhanced.

6 Development recommendations and prospects

6.1 Strengthening later management The forest management formed by the project of returning farmland to forests is relatively extensive, and the economic benefits produced are still far from the expected value of the masses. It is recommended to strengthen the management of returning farmland to forests and forests, and increase the special management and protection costs to ensure the quality and efficiency of forest stands. It is recommended that grass-roots forestry departments increase the promotion and training of forest and fruit management technology, and improve the management technology level of farmers who return farmland to forests.

6.2 Raising the subsidy standard The subsidy standard for returning farmland to forest is still very low, the enthusiasm of the masses cannot be mobilized, and it is still difficult to consolidate the achievements. It is recommended to raise the subsidy standard, include the returning ecological forest that has expired and

meet the ecological location into the forest ecological benefit compensation, and appropriately extend the subsidy period for economic forest to consolidate the achievements of returning farmland to forests.

6.3 Increasing the monitoring investment Monitoring personnel and equipment still need to be enriched and strengthened. In the monitoring stations, there are problems such as lack of monitoring personnel, low cultural and scientific literacy of personnel, insufficient observation facilities and experimental equipment, and inability to keep up with equipment maintenance and upgrade. It is recommended to increase project investment, introduce technical personnel, and improve observation conditions, so as to ensure the normal operation of the monitoring stations for returning farmland to forests, provide scientific and accurate data, and better serve the forestry ecological construction.

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on further Strengthening the Construction of Scientific Research Integrity was printed and issued. Emphasis is placed on the education of scientific research integrity and scientific research code of conduct, so that researchers can establish a clear sense of scientific research integrity and morality from the inside. Scientific research managers also need to understand the relevant systems of scientific ethics and style of study. They should scrupulously abide by academic ethics, and pursue the spirit of seeking truth and pragmatism while constantly improving their scientific research management level, to prevent the occurrence of misconduct such as achievements hitchhiking, and paper naming.

4.2 Learning relevant professional knowledge while improving business ability The scientific research managers may face more than one discipline. In the tree research institute, there are not only fruits, such as apples, pears, peaches, grapes, cherries, but also dried fruits, such as chestnuts and walnuts, involving cultivation, breeding and plant protection. If managers just know it and don't know why, there will be confusion.

4.3 Scientific research management being both a science and an art Scientific research management workers should not only achieve professional, refined and scientific management, but also have enthusiastic service. Whether it is for the project or the project host, they should adhere to the combination of strict rules and regulations with enthusiasm, and adhere to people-oriented.

Regardless of the target is the division level leaders, section level cadres or front-line scientific and technological personnel, they can treat people and things equally, and can not treat them differently.

4.4 Improving the management level of science and technology innovation managers in the new era with "new four focuses" In May of 2021, the general secretary pointed out at the 20th Academician Meeting of the Chinese Academy of Sciences that it should focus on science and technology management according to the positioning of "grasping strategy", "grasping reform", "grasping planning" and "grasping service". It should deeply understand the important assertion of "scientific and technological innovation and institutional innovation" by the general secretary, understand its essence, apply what we have learned, and strengthen the sense of serving scientific and technological innovation. Talents are the root of innovation, and it should create a training mechanism conducive to the growth of talents.

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