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Investigation and Exploration of the Current Situation and Feasible Paths of Agricultural Waste Resource Utilization Development under the "Dual Carbon" Strategy: Taking Wuhe, Anhui as an Example

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ABSTRACT

With the continuous development of rural social economy in China, the quality of life and agricultural production level of farmers have significantly improved. The lifestyle of farmers has changed significantly, and some traditional agricultural production links have been broken, resulting in a sharp increase in the quantity and variety of agricultural waste. The resource utilization of agricultural waste can not only improve the efficiency of rural resource utilization, but also reduce agricultural waste pollution and protect the rural environment. This article takes the agricultural waste resource utilization in Wuhe County, Anhui Province as an example for investigation and analysis. The main conclusions are as follows: the significance of agricultural waste resource utilization is significant, and resource utilization treatment is very necessary; Agricultural waste has a wide range of sources, and strengthening classification and integration is particularly important; Group cognition needs to be improved, and guiding education is imperative; The subjective willingness of villagers is good, and policy implementation is expected to be popularized; The four types of factors have a significant impact, and targeted measures are taken. Based on the results of the practical investigation, this article mainly proposes the following feasible path suggestions for agricultural waste resource utilization: publicity and education, improving the awareness of villagers; Government guidance and increased regulatory support; Facing market pain points and enhancing industrial vitality; Strengthen classification integration and promote technological innovation; Strengthen scientific layout and promote benefit sharing.

KEYWORDS

Resource utilization of agricultural waste; Development status; Feasible path.

1. INTRODUCTION

When agricultural waste is properly utilized, it can transform from an environmental pollution source into a renewable resource. With the rapid development of the social economy and the advancement of urbanization, the development of agriculture is clearly constrained by the environment and resources. Therefore, accelerating the utilization of agricultural waste resources and achieving sustainable development of agriculture is an urgent practical problem that needs to be solved[1]. The contradiction between the lag in agricultural waste treatment technology and the demand for agricultural waste resource utilization is becoming increasingly prominent, becoming one of the important factors restricting the sustainable development of rural ecology. The resource utilization of

agricultural waste is an important way to achieve sustainable development and establish an environmentally friendly society[2]. At present, China has successively issued multiple plans and guidance opinions to promote the efficient utilization of agricultural waste resources. The "Zhejiang Province Agricultural Waste Treatment and Utilization Promotion Measures" passed by the Zhejiang Provincial Government in 2010 was the first local regulation in China to define agricultural waste. In February 2023, the No. 1 central document guiding the work of "agriculture, rural areas and farmers" pointed out that it is necessary to accelerate the popularization and application of the technology of reducing agricultural inputs and increasing efficiency, promote the integration of water and fertilizer, and establish and improve the collection, utilization and treatment system of agricultural waste such as straw, agricultural film, pesticide packaging waste, livestock and poultry manure.

2. LITERATURE REVIEW

Agricultural waste exists as a special type of agricultural resource, specifically referring to the material energy loss caused by the utilization of agricultural resources and the energy and material difference between resource input and output in agricultural production and reproduction processes[3]. The characteristics of agricultural waste are diverse and mainly come from four channels, namely rural living sources, agricultural by-product processing sources, animal sources, and plant sources. Li Heand others (2022) pointed out that there are many types of waste that can be generated in agricultural production activities, and often in large quantities. If agricultural waste such as crop straw and edible mushroom residue cannot be effectively utilized as resources, then sustainable agricultural development cannot be achieved[4]. Hu Zikun and Zhang Hao (2022) constructed a tripartite evolutionary game model of government, enterprises, and farmers in the utilization of agricultural waste resources from the perspective of organizational behavior, and analyzed the asymptotic stability conditions of each subject[5]. Hu Jianjun (2023) pointed out that in order to achieve the collection and utilization of agricultural waste in China, it is necessary to achieve the same goals, gather resources, adhere to innovation, effectively mobilize the enthusiasm of all parties, and improve comprehensive utilization efficiency[6]. Di Jiaying (2022) explores research on standardization technology, proposes the construction of a scientific and reasonable standard system, strengthens data monitoring and evaluation management scope, and increases innovation and application[7]. Yang Wenhui (2021) pointed out that in the treatment of agricultural waste, it is necessary to actively adopt high-tech technology for treatment, introduce market mechanism management, and do a good job in publicity and management to ensure the effective treatment of agricultural waste[8].

With the development of social economy, the problem of agricultural waste is increasingly troubling various countries. From the literature of existing scholars, it can be seen that they have conducted extensive research on agricultural waste and its resource utilization. The researchers first start with the current situation of agricultural waste and the reasons for this problem, then clarify the importance of agricultural waste resource utilization, and finally propose a series of measures to promote agricultural waste resource utilization. Based on the existing research, this paper takes Wuhe County, Bengbu City, Anhui Province, as an example, and based on the practical research data, analyzes the development status and feasible path of agricultural waste recycling in Wuhe County.

3. CURRENT DEVELOPMENT STATUS OF AGRICULTURAL WASTE RESOURCE UTILIZATION AT HOME AND ABROAD

3.1. Analysis of the current development status of agricultural waste resource utilization in foreign countries

The problem of agricultural waste has always plagued various countries, and developed countries in Western Europe and America have conducted early research on the technology of agricultural waste resource utilization, with relatively mature development. In European and American countries, agricultural cultivation is generally based on scale and standardization, while agricultural production is mainly mechanized, which is conducive to the collection of agricultural waste and lays a good operational foundation for the industrial system of agricultural waste resource utilization. At the same time, agricultural waste collection technology can promote sustainable economic development. Some large-scale breeding and straw industrial power generation manufacturers will sign relevant supply agreements with farmers based on their own demand. Farmers will collect, stack and store straw in a centralized manner during the straw harvesting season, and then transport it to the manufacturers. In addition, the collection and storage equipment technology combines agricultural waste collection with agricultural equipment and related information equipment, continuously improving the professional supporting system and improving the efficiency and reliability of operations.In the 1970s, Japan began to develop ecological agriculture, with a focus on achieving the transformation and utilization of agricultural waste and reducing agricultural three-dimensional pollution.Since 1970, the Netherlands has strengthened legislation to regulate the discharge and treatment of livestock and poultry manure. In 1990, the Soil Protection Law was promulgated to restrict the use of fertilizers. At the same time, the Netherlands has also established a special fund for the source treatment of agricultural waste materials, encouraging and supporting talents to carry out technological innovation and continuously promoting the resource utilization of agricultural waste. In Germany, the breeding industry is mainly focused on Mainly based on family farms, breeding control is carried out according to the carrying capacity of the land. Cows and pigs mainly adopt a deep storage pool model, storing animal manure in the storage pool under the livestock shed. After about 6-9 months, the manure is fermented and directly used in farmland, achieving a utilization model of breeding and ecological balance.

3.2. Analysis of the current development status of domestic agricultural waste resource utilization

The utilization of agricultural waste in China has a long history, from composting and biogas technology to the current circular economy and the establishment of comprehensive treatment bases for agricultural waste, all of which prove that China is constantly exploring better ways of utilizing agricultural waste. In 2020, the comprehensive utilization rate of crop straw in China was 81.68%, of which the fertilizer utilization rate of straw was 47.20%, the feed utilization rate was 17.99%, the fuel utilization rate was 11.79%, the base material utilization rate was 2.23%, and the raw material utilization rate was 2.47%. Although the development of agricultural waste resource utilization in China has made continuous progress and achieved significant results in many aspects, for a long time, agricultural waste has been mainly treated through three methods: landfill, composting, and direct incineration, which not only damages the rural ecological environment but also causes waste of resources. In recent years, the attention and investment of Chinese governments at all levels in the resource utilization of agricultural waste have significantly increased compared to the past. However, the relevant technological level and infrastructure have not met the standardization requirements. The contradiction between the lag in agricultural waste treatment technology and the demand for agricultural waste resource utilization is more prominent, which has become one of the important factors restricting the sustainable development of rural ecology.

3.3. Analysis of the current development status of agricultural waste resource utilization in Wuhe County

In 2021, Wuhe County was successfully approved to establish a national rural comprehensive reform pilot project area, actively expanding the comprehensive utilization of crops, and vigorously promoting straw silage, yellow storage, ammonification, and microbial fermentation technologies in combination with modern animal husbandry and dairy production enterprises. At the same time, the contracted projects of the Provincial Straw Expo were implemented in Wuhe County. In 2021, Wuhe County applied for and obtained the pilot project of comprehensive utilization of crops from the central government, promoting the straw industry to enrich the people and strengthen the county. Through the pilot program of comprehensive utilization of straw, the area of crop straw leaving the field in Wuhe County exceeded 1.5 million mu in 2021, and the comprehensive utilization rate of straw in the county has reached 97%, effectively promoting the development of green and circular agriculture in the county. In 2022, Wuhe County actively promotes the pilot demonstration of green planting and breeding circular agriculture and the action of reducing and increasing the efficiency of fertilizers and pesticides. It implements a five-year action plan to improve the resource utilization of straw and livestock and poultry waste, establishes a demonstration base for green planting and breeding circular agriculture in all aspects, covering an area of 100000 acres, achieving a green prevention and control coverage rate of 53.5% for diseases and pests, a comprehensive utilization rate of 97.01% for straw, and a resource utilization rate of 99.3% for livestock and poultry manure. In addition, we will promote standardized agricultural production, implement a quality and safety traceability management system for agricultural products based on the commitment certificate and QR code traceability of edible agricultural products, deepen the construction of the "Anhui American Agricultural Products" brand, and currently add 8 green food certifications, 1 influential "Anhui American Agricultural Products" regional public brand, 1 enterprise brand, and 4 product brands.

4. ON SITE INVESTIGATION AND RESULT ANALYSIS IN WUHE COUNTY

4.1. The significance of agricultural waste resource utilization is significant, and resource utilization treatment is essential

At present, there are still many problems in the resource utilization of agricultural waste, such as weak awareness among villagers, incomplete market industry operation mechanisms, and lack of financial and technical support. Proper utilization of agricultural waste can transform from a "pollution source" into a "renewable resource". Its resource utilization is beneficial for improving the rural ecological environment, bridging the internal resource circulation chain of agricultural production, promoting rural production development, prosperous living, and ecological livability. There are still many problems in the resource utilization of agricultural waste in China,about 86.55% (560/647) of respondents believe that the development of agricultural waste resource utilization is necessary or more necessary, and agricultural waste urgently needs resource treatment.

4.2. Agricultural waste is generated from a wide range of sources, and strengthening classification and integration is particularly important

Based on factor analysis and SEM models, this study explores the influencing factors of villagers' willingness to accept agricultural waste resource utilization. From the contribution rate of common factor variables, the effect of external factor factors is greater than that of agricultural waste factors, and the latter is greater than the effect of personal cognitive understanding. Agricultural waste has a significant positive impact on cognitive understanding, with a path coefficient of 0.88; In agricultural waste, the path coefficient of agricultural waste components is 1, the path coefficient of agricultural

waste scale is 0.821, and the path coefficient of agricultural waste types is 0.824. Agricultural waste is mainly generated through four channels: rural life, processing of agricultural and sideline products, and sources of animal and plant origin. It has the characteristics of large quantity, variety, wide distribution, and dispersion. Villagers have various ways to handle agricultural waste. The classification and integration of agricultural waste plays an important role in reducing the cost of agricultural waste recycling and improving recycling efficiency. Therefore, it is necessary to change our thinking and build a multi-level research system for agricultural waste resource utilization technology based on agricultural waste classification, continuously strengthen classification integration, and promote efficient utilization of agricultural waste.

4.3. Group cognition needs to be improved, and guiding education is imperative

Through descriptive and cross correlation analysis of gender, age, income, and awareness of agricultural waste resource utilization, it was found that the above factors are significantly correlated with the tendency towards agricultural waste resource utilization. The cognitive level of males is generally higher than that of females, and males are generally more interested in engineering related rational things; And the awareness of the 20-39 age group is relatively high, which is consistent with the current positioning of young people as the main body of agricultural waste resource utilization promotion. Young people are easy to accept new knowledge; Compared to low-income groups, the group with an annual income of over 100000 yuan has a better understanding, which is consistent with the fact that high-income individuals are relatively more concerned about resource utilization. Among the 647 valid survey respondents, nearly 70% of them have general or no understanding of agricultural waste resource utilization. It is necessary to strengthen the awareness of villagers about agricultural waste resource utilization. We conducted cluster analysis on 647 valid survey subjects and classified them into four groups based on cognitive characteristics: A, B, C, and D. The A-class group has a great understanding and importance of agricultural waste resource utilization, and belongs to the active participation type, but the proportion is relatively small; The B-type group is neutral and has a better understanding and attention to it. They are actively involved in the utilization of agricultural waste resources; The C-type group is optimistic, with the highest proportion. If policy and methods are properly guided to encourage the participation of this group, it can effectively promote the development of agricultural waste resource utilization; The D group is passive receptive and has poor enthusiasm. Overall, the four types of group cognition have significant characteristics, and group cognition needs to be improved. Guiding education is imperative.

4.4. The subjective willingness of villagers is good, and policy implementation is expected to be popularized

Based on Python sentiment analysis, the willingness of villagers to support agricultural waste resource utilization was analyzed. Positive and negative emotions were classified and trained using the existing SnowNLP library, and positive emotions accounted for 62%. Among the 647 valid survey respondents, over 70% of them are more willing or willing to accept and promote agricultural waste resource utilization, and nearly 90% of the survey respondents believe that agricultural waste resource utilization has great and promising prospects. If the issues related to agricultural waste resource utilization can be resolved, only 3.25% of the survey respondents expressed a reluctance to participate in the process of agricultural waste resource utilization. Under the strategic policy of continuing to promote rural revitalization in poverty-stricken areas and comprehensive utilization of agricultural waste, the majority of villagers have a high willingness to accept agricultural waste resource utilization. The prospect of comprehensively promoting agricultural waste resource utilization is broad, and relevant policies are expected to be popularized.

4.5. The four types of factors have a significant impact, and targeted measures are taken to address them

Through factor analysis, it was found that the effect of external factors is greater than that of agricultural waste factors, and the latter is greater than the effect of personal cognitive understanding. This article divides the influencing factors of the willingness of villagers in Wuhe County to promote agricultural waste resource utilization into eight major factors: implementation effectiveness, cost and expenses. Based on the Apriori association rule, an analysis of the correlation between the influencing factors of promotion willingness indicators is conducted, and it is found that cost and subsidy rebates are the focal points that users will always pay close attention to in the entire promotion of agricultural waste resource utilization. Based on the C4.5 decision tree model, a preference study on the promotion form of agricultural waste resource utilization was conducted. It was found that among villagers who preferred the new media push form of agricultural waste resource utilization information, the implementation effect and subsidy rebate were divided into nodes in order. This indicates that the promotion index of most villagers in terms of implementation effect and subsidy rebate is higher than the average level. To explore the degree of influence of various influencing factors on the development of agricultural waste resource utilization in Wuhe County, this article is based on logistic regression analysis, exploring the degree and path of influence from the perspectives of village factors, village committees and government factors, agricultural waste factors, and market economy factors. The coefficient of average annual household income level is 2.124, the coefficient of village awareness is 1.521, and the coefficient of village willingness is 1.420. There are significant relationships between the four types of factors, various indicators, and the established model to varying degrees. Among them, the subjective norms of villagers have a relatively large impact. In the later stage, the top-level design and supporting measures for agricultural waste resource utilization will be targeted and targeted.

5. EXPLORING FEASIBLE PATHS FOR AGRICULTURAL WASTE RESOURCE UTILIZATION

5.1. Propaganda and education to enhance the awareness of villagers

The problem of agricultural waste resource utilization is fundamentally a human problem. Farmers are the producers of agricultural waste, and they directly choose to dispose of agricultural waste. Before agricultural waste enters the recycling mechanism, such as agricultural waste classification, it plays an important role. Agricultural waste is not entirely useless. From another perspective, agricultural waste is a misplaced treasure. Many villagers have a weak awareness of the resource utilization of agricultural waste, which not only leads to ineffective utilization of many resources, but also causes environmental pollution caused by improper handling behavior. Therefore, strengthening publicity and guidance, and improving the awareness of villagers are of great significance. We should adopt diverse forms of publicity and education activities to promote the benefits and significance of agricultural waste resource utilization to farmers, introduce some basic theoretical knowledge, and strengthen the awareness of villagers towards agricultural waste resource utilization; At the same time, introduce some simple and effective ways of agricultural waste resource utilization to farmers, so that they are willing to support the path of agricultural waste resource utilization from the bottom of their hearts, mobilize their enthusiasm to participate in agricultural waste resource utilization, stimulate their endogenous motivation, and take practical actions for agricultural waste resource utilization. Classify agricultural waste and choose the correct way of agricultural waste resource utilization.

5.2. Government guidance and increased regulatory support

Agricultural waste can only be processed into usable energy through a series of procedures. In addition to the cost of agricultural waste itself, all intermediate processing steps require the consumption of labor, equipment, processing and other costs. Modern large-scale agricultural production has been gradually promoted, but nowadays, most agricultural production still relies on decentralized management by farmers, making it difficult to form a systematic and standardized system for the application of agricultural waste technology. Due to the large investment, high cost, low added value, and long recycling cycle, agricultural waste resource utilization projects have limited social capital and require government policy support or the promotion of research and technology projects. The subsidy income provided by the government for agricultural waste disposal is an important channel for the profitability of the agricultural waste industry today. Relying on government preferential policies to develop a group of cutting-edge enterprises that efficiently utilize resources is the necessary way to recycle agricultural waste.

At present, the legal and regulatory system related to agricultural waste resource utilization in China needs to be improved. In the implementation process, the standardization and professionalism of agricultural waste resource utilization cannot meet the standard requirements. Relevant parties may seize loopholes and take the opportunity to reduce investment, resulting in secondary environmental pollution during the transformation and utilization process. Therefore, it is necessary to improve the relevant legal and regulatory system, strengthen supervision and constraints on the behavior of agricultural waste resource utilization entities, and promote more standardized and effective utilization of agricultural waste resources. In addition, the utilization of agricultural waste resources currently has no significant advantage in the market, and the enthusiasm of the main body in practical operation is not high. In certain aspects, mandatory legal and regulatory constraints are required for implementation. The resource utilization of agricultural waste has externalities and incomplete non competitiveness and non exclusivity in consumption. The government plays an important role in the process of agricultural waste resource utilization. The government supports the resource utilization of agricultural waste from aspects such as funding and technology, invests funds in practical applications, improves the infrastructure related to agricultural waste resource utilization, strengthens research and development of related technologies, or introduces advanced agricultural waste resource treatment technologies to create a solid material and technological foundation for agricultural waste resource utilization. In addition, special subsidy funds can be set up to formulate preferential policies to encourage the resource utilization of agricultural waste, and to play the role of funding and policy incentives.

5.3. Facing market pain points and enhancing industrial vitality

Due to the fragmentation of traditional governance models, it is difficult to effectively solve the problem of agricultural waste resource utilization. The subsidy income provided by the government for agricultural waste resource utilization is an important channel for the profit of the current agricultural waste resource utilization industry. However, during the operation stage, there is still significant development space for other income generated from the secondary utilization of agricultural waste, such as power generation income, and investment. By improving the model of agricultural waste resource utilization, introducing dynamic social capital and market forces, it can develop towards marketization and industrialization, forming a complete industrial chain, such as building comprehensive treatment bases for agricultural waste, developing agricultural circular economy and ecological agriculture. The utilization of agricultural waste resources faces pain points such as irregular market order, unclear recycling information, and difficulty in identifying the identity of scavengers. The operational mechanism of the agricultural waste resource utilization market industry needs to be improved. We need to face these market pain points directly, continuously improve the relevant market management system, establish a specialized recycling network,

standardize the market order of agricultural waste resource utilization, and improve the efficiency of agricultural waste resource allocation. At the same time, it facilitates communication between providers and processors of agricultural waste, promotes timely transmission of market information such as demand and prices, efficiently matches the needs of both buyers and sellers, and strengthens the identification of scavengers.

5.4. Strengthen technological innovation and realizing the transformation of waste into treasure

Agricultural waste mainly comes from four sources: rural living sources, agricultural by-product processing sources, animal sources, and plant sources. If it can be well treated and utilized as a resource, it can be converted into secondary energy for reuse. It can not only produce clean energy such as biogas and biological natural gas, but also make compost, liquid fermentation manure, and commercial organic fertilizer produced by factories. The key to the resource utilization of agricultural waste lies in technological breakthroughs, which require strengthening technological innovation and promoting the realization of turning waste into treasure. Agricultural waste, as a special type of agricultural resource, exists in large quantities, diverse types, complex forms, complex components, and high levels of harmful components; It is necessary to build a multi-level research system for agricultural waste resource utilization technology, and based on the classification of agricultural waste, choose different agricultural waste treatment methods and agricultural waste resource utilization paths. Intensify the cultivation of talents in the field of agricultural waste resource utilization, and provide a solid talent guarantee for the utilization of agricultural waste resources. In addition, we will strengthen the innovative research and development of agricultural waste resource utilization technologies, such as straw ensiling, yellow storage, ammonification, microbial fermentation, and other technologies. In addition to direct return to the field, we will also focus on fertilizer utilization technologies such as fermentation return and organic compound fertilizer production, as well as energy utilization technologies such as biogas production.

5.5. Strengthen Scientific Layout and Promoting Benefit Sharing

Promoting the resource utilization of agricultural waste involves multiple stakeholders, and in this process, production factors such as land, labor, capital, and technology must flow. The resource utilization of agricultural waste is a common result of multi-party cooperation, with the government, villagers, and enterprises playing important roles. Government leadership, market operation, enterprise operation, and public participation are important principles for the resource utilization of agricultural waste. Firstly, it should be clarified that in the process of agricultural waste resource utilization, the government should leverage its leading advantages and participate in the process through policies, funding, technology, and other advantages. Secondly, the government should guide the villagers to participate in it, mobilize the enthusiasm of the villagers to participate in the recycling of agricultural waste, and enhance the villagers' awareness of agricultural waste recycling. Finally, enterprises should also be actively welcomed to participate, utilizing the effectiveness of the market in resource allocation. While ensuring the service of agricultural production activities, by leveraging the power and policy effects of enterprises, reasonable planning and coordination should be achieved, so that enterprises can have income and operate sustainably. The development of production, livability of ecology, and prosperity of life are an organic whole, and villagers can also benefit from this process. Strengthening scientific layout, tripartite coordination and cooperation, and promoting benefit sharing are the necessary paths for the resource utilization of agricultural waste.

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