Technology-Led Innovation, Industry-Assisted Poverty Alleviation: Effectiveness and Implications of the Hybrid Paper Mulberry Poverty Alleviation Project in Heze, Shandong (Post-print)

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Abstract

National strategic demands and socio-economic development constitute the direction and impetus for scientific and technological innovation, which in turn fosters economic growth and social advancement. Scientific and technological innovation serves as a novel driving force in securing a decisive victory in poverty alleviation. Addressing the current status of crude protein feed raw material imports and the development landscape of animal husbandry in China, the Institute of Botany, Chinese Academy of Sciences has developed a fast-growing, high-yield, and superior-quality new hybrid variety of paper mulberry (Broussonetia papyrifera) designated as “Kegou 101”, and introduced an industrial development model of “substituting trees for grain and integrating crop cultivation with livestock breeding cycles”, which effectively resolves the feed requirements of farming households in impoverished regions and promotes the advancement of animal husbandry in these areas. This article analyzes the progress of paper mulberry industry-driven poverty alleviation efforts in Heze, Shandong Province, and examines the opportunities, challenges, and corresponding strategies confronting the paper mulberry industry in poverty alleviation initiatives.

Full Text

Science and Technology Lead Innovation, Industry Promote Poverty Alleviation — Effect and Enlightenment of Poverty Alleviation Project of Hybrid Paper Mulberry in Heze City, Shandong Province

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Abstract

National major demands and socioeconomic development constitute the direction and driving force of scientific and technological innovation, which in turn promotes economic development and social progress. Such innovation serves as a new impetus for securing victory in poverty alleviation. In response to China's current reliance on imported crude protein feedstock and the development needs of its animal husbandry sector, the Institute of Botany, Chinese Academy of Sciences has bred a new hybrid paper mulberry variety "KeGou 101" characterized by rapid growth, high yield, and superior quality. The institute has proposed an industrial development model of "replacing grain with trees, cultivation-feeding circulation" that effectively addresses feed demands in impoverished regions and promotes the development of animal husbandry there. This paper analyzes the progress of paper mulberry poverty alleviation work in Heze City, Shandong Province, and discusses the opportunities, challenges, and countermeasures facing the paper mulberry industry in poverty alleviation efforts.

Keywords: scientific and technological innovation, production transforming, targeted poverty alleviation, poverty alleviation project of paper mulberry, cattle fed with paper mulberry

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1. Introduction

The value of scientific and technological innovation manifests not only in technological progress and economic development but also in social advancement, livelihood improvement, cultural prosperity, and national security. The 18th National Congress of the Communist Party of China proposed the goal of building a moderately prosperous society in all respects, while the 19th National Congress report set the target of eliminating poverty completely by 2020. Science and technology have always been integral to China's poverty alleviation and development strategy, with innovation and transformation serving as new drivers for securing victory in this campaign. Technology-driven poverty al-

leviation provides strong support for impoverished areas, and the transformation of scientific and technological achievements is key to its success. Through technology-based poverty alleviation, we can achieve both "aspiration support" and "intelligence support," enhancing the entrepreneurial and innovative skills of the labor force in poor areas, increasing incomes, and realizing sustainable rural economic development [1,2].

As China's socioeconomic development has progressed, residents' dietary structure has undergone tremendous changes, with consumption of meat, eggs, and milk increasing exponentially, reflecting a shift from "eating enough" to "eating well." Although China is a major global producer of animal products, it faces a severe shortage of feed raw materials and heavy reliance on imports, particularly soybeans, which have become a bargaining chip in China-U.S. trade disputes. Rising feed costs have significantly impacted China's breeding industry. Over the past decade, China's imports of feed raw materials, beef and mutton, liquid milk, and milk powder have increased year by year [3]. President Xi Jinping has emphasized food security, stating: "The Chinese people's rice bowl must be firmly held in our own hands at all times, and it should be filled mainly with Chinese grain." Ensuring national food security, in a sense, means guaranteeing sufficient and high-quality feed supply. How to break the bottleneck of protein source scarcity is an urgent priority for the healthy and stable development of China's animal husbandry and for ensuring food security.

Twenty years ago, recognizing the large protein feed gap and heavy import dependence, as well as the limited suitable areas for alfalfa cultivation that prevent nationwide promotion, Shen Shihua proposed the innovative concept of "replacing grain (feed grain) with trees." This approach leverages the broad adaptability of perennial woody paper mulberry, which can be cultivated in most provinces, autonomous regions, and municipalities across China. Unlike traditional herbaceous crops or cash crops, paper mulberry can significantly reduce annual cultivation time, labor, and material input costs. Based on the collection and evaluation of wild paper mulberry germplasm resources native to China, Shen Shihua's team at the Institute of Botany, Chinese Academy of Sciences (hereafter "Institute of Botany") developed the first high-protein woody feed variety in China—hybrid paper mulberry "KeGou 101"—through interspecific hybridization and space mutation breeding. The team proposed the vision of "replacing grain with trees, cultivation-feeding circulation" and established an integrated "forest-feed-livestock" ecological agriculture and animal husbandry technology system. This system has been piloted and demonstrated in over 20 provinces, autonomous regions, and municipalities nationwide, achieving "planting in the current year, benefiting in the same year; one-time planting, multi-year harvesting." It effectively addresses feed demands of farmers in poor areas and promotes the development of animal husbandry. Planting hybrid paper mulberry extensively on marginal land, secondary farmland, and idle farmland in China can yield crude protein feed raw materials, resolve conflicts between agriculture and animal husbandry for land use, help farmers escape poverty, and improve ecological environments in poor areas. This represents a national

project that unifies economic, ecological, and social benefits.

Although paper mulberry is a plant resource with significant potential value, it had not undergone systematic domestication and breeding historically. Wild paper mulberry suffers from high lignin content and inability to mechanize leaf harvesting, limiting its industrialization and large-scale development as feedstock. Shen Shihua's team systematically collected wild paper mulberry resources across most regions of China, spanning multiple climate zones from temperate to tropical, and conducted genetic evaluation of germplasm traits to identify superior breeding resources for biomass yield, stress resistance, lignocellulose content, and crude protein content. In the breeding process, the team employed both traditional interspecific hybridization techniques for woody plants and modern breeding technologies such as space mutation and molecular markers [4] to accelerate the integration of superior traits and ultimately obtain the new high-protein woody feed variety of hybrid paper mulberry.

2. Germplasm Innovation and Industrial Technology System Construction of Hybrid Paper Mulberry

2.1 Germplasm Innovation and Breeding (1) The new concept of "replacing grain with trees." Addressing the large protein feed gap and heavy import dependence, as well as the limited suitable areas for alfalfa that prevent nationwide promotion, Shen Shihua proposed using perennial woody paper mulberry, which has broad adaptability and can be cultivated in most provinces, autonomous regions, and municipalities across China. Unlike traditional herbaceous crops, paper mulberry can significantly reduce annual cultivation time, labor, and material costs.

(2) Integration of new technologies to breed superior varieties. The hybrid paper mulberry breeding process employed both traditional interspecific hybridization for woody plants and modern breeding technologies including space mutation and molecular markers [4] to accelerate the integration of superior traits. Using the theory of distant hybridization advantage, with large paper mulberry as the male parent and small paper mulberry as the female parent, the team obtained the first generation hybrid through interspecific hybridization and molecular marker biotechnology, combined with space mutation breeding via Shenzhou spacecraft. This yielded "KeGou 101," the only woody functional, high-protein hybrid paper mulberry variety in China and worldwide. This variety is a small tree reaching up to 10 meters in height, with a broad crown, vigorous branching, large thick leaves that are smooth and hairless, white sap in tender branches and leaves, and a well-developed root system with many lateral roots distributed mainly in shallow surface layers without damaging cultivated soil. As a female plant with sterile seeds, it propagates through tillering without uncontrolled spread or biological invasion. Hybrid paper mulberry features rapid growth, high yield, superior quality, multiple resistances, tolerance to harvesting, and resistance to diseases and pests, offering tremendous application prospects in feed, papermaking, ecological greening, and food [5-8]. This

represents a major breakthrough in woody plant breeding—an indigenous, non-transgenic variety with independent intellectual property rights.

(3) New breakthroughs in agronomic traits. While maintaining the excellent characteristics of wild paper mulberry, the hybrid variety has achieved even superior agronomic traits. First, hybrid paper mulberry leaves have high utilization rates and enable efficient mechanized harvesting. Lignin content is reduced by over 2% compared to wild paper mulberry, with whole-plant lignin at approximately 16% and neutral detergent fiber at about 35%. This represents a leap from using only leaves to using the whole plant (including stems), and from manual leaf picking to mechanized harvesting. Second, hybrid paper mulberry is nutritionally balanced and represents an ideal feed source. Crude protein content is increased by over 5% compared to wild paper mulberry, with whole-plant crude protein reaching 20%, comparable to alfalfa—the king of forage crops—making it suitable as a functional protein feed raw material to "replace grain with trees." The amino acid and mineral nutrient content is rich and balanced, easy to digest and absorb [9], and it also contains flavonoids, alkaloids, pectin, and physiologically active substances. It is not only an ideal feed source but can also improve livestock immunity, reduce antibiotic use, or even eliminate it. Third, hybrid paper mulberry is tolerant to harvesting and has a long lifespan. One planting yields benefits for many years, with 3-5 harvests annually, continuous harvesting for 15-20 years, and minimal soil disturbance, thus minimizing soil erosion. Fourth, hybrid paper mulberry has vigorous vitality and strong adaptability. It can be cultivated in most areas of temperate and southern China, in the Hexi Corridor and southern Xinjiang with irrigation, and in valley plains of Tibet at altitudes up to 3,500 meters. It is an excellent species for ecological greening of barren hills, rocky desertification areas, desertified land, and saline-alkali soils. No pesticides are used during growth, eliminating pesticide pollution and residue problems at the source.

2.2 Industrial Technology Research and System Construction After more than a decade of industrial promotion, hybrid paper mulberry has been widely piloted and demonstrated in over 20 provinces, autonomous regions, and municipalities nationwide. The integrated "forest-feed-livestock" ecological agriculture and animal husbandry circular economy model has been established, focusing on "five modernizations" in the production technology system across seedling, planting, harvesting, processing, and breeding stages. The "three products" construction strategy emphasizes selecting the right variety, maintaining quality, and building brands.

(1) Improved variety source. The hybrid paper mulberry "KeGou 101" bred by the Institute of Botany features smooth, nearly hairless leaves, low lignin content, tolerance to mowing, whole-plant rotational utilization, and high yield. Wild paper mulberry has poor quality, allows only leaf harvesting as feed, has low yield, cannot be mechanized, and fails to meet modern agriculture and animal husbandry development needs. Counterfeit and inferior strains not only

cause economic losses but also easily discourage farmers. Therefore, superior varieties are crucial in promoting the paper mulberry industry.

(2) Factory-scale seedling propagation. Due to low lignin content and lignin monomer ratios differing from other forest trees like poplar and willow, traditional forest cutting techniques are unsuitable for hybrid paper mulberry propagation. Additionally, cutting propagation is season-limited and prone to disease transmission. Although individual cutting seedlings are inexpensive, their high mortality rate results in higher average planting costs per mu than tissue culture seedlings, causing losses to governments and people during early industrial promotion. Therefore, seedling propagation employs plant cell detoxification and tissue culture for rapid mass propagation, producing non-woven container seedlings through factory-scale, standardized, and large-scale production. The process includes three main steps: subculture expansion, root induction, and greenhouse acclimation. The first two steps are conducted in sterile tissue culture workshops with a cycle of about 50 days; greenhouse acclimation adapts seedlings to external environments over approximately 40 days. Tissue culture seedlings are complete plants cloned from cell lines, robust with numerous roots and free from diseases and pests. Their genetic and agronomic traits are stable, fully expressing the excellent characteristics of hybrid paper mulberry.

(3) Standardized planting. Hybrid paper mulberry has strong drought resistance, tolerance to barren conditions and salinity, pollution resistance, and pest resistance [6]. It can be planted in areas with salinity below 0.6%, extreme low temperatures above -20°C, annual precipitation above 300 mm, and frost-free periods exceeding 180 days. Therefore, hybrid paper mulberry tissue culture seedlings can be planted in spring, summer, and autumn in most suitable regions of China. In flat plains and gentle slopes, wide-narrow row spacing with large plant distances can be adopted to maximize photosynthesis and ventilation, ensuring yield, quality, and harvesting lifespan, with 400-600 plants per mu. In hilly and mountainous areas with poorer site conditions, 500-700 plants per mu ensure effective population density of sprouting plants per unit area. Ecological greening forest planting density is determined according to needs. Some seedling enterprises should be identified that promote excessive planting density for short-term profit.

(4) Mechanized harvesting. Hybrid paper mulberry feed forests can be planted for one year and harvested continuously for over 15 years, achieving one-time planting with multi-year benefits. When hybrid paper mulberry grows to about 1 meter, the portion above 10-20 cm from the ground can be harvested whole-plant with stems and leaves, crushed, processed, and packed for silage fermentation without adding bacterial agents. It can also be processed into dry powder and pellet feed. Large silage harvesters can be used in flat plains; medium and small silage harvesters for gentle slopes and terraces; and handheld or backpack small machinery for mountainous areas, followed by crushing and silage packing. Under permissible cost conditions, fermentation agents can be

added to accelerate the fermentation process and improve digestion and absorption rates of silage feed for pigs and poultry.

(5) Scientific breeding. As a crude protein and functional feed raw material, hybrid paper mulberry "KeGou 101" can effectively alleviate three major bottlenecks: insufficient total feed raw materials, antibiotic residues, and environmental pollution. Feeding experiments show that hybrid paper mulberry feed has certain antibacterial capabilities, significantly reducing mastitis in dairy cows, improving quality and efficiency, lowering breeding costs, and gaining market recognition for meat, egg, and milk quality. According to local conditions, key breeding species should be identified, targeting major livestock especially cattle, sheep, and pigs. Using hybrid paper mulberry silage feed, the feed system, breeding stock system, disease prevention system, and processing and circulation system should be integrated to create safe, healthy, premium, and characteristic commercial brands.

3. Practice and Social Benefits of Hybrid Paper Mulberry Industry in Targeted Poverty Alleviation in Heze, Shandong

Technology-driven poverty alleviation is an important component of industrial development for poverty elimination. The hybrid paper mulberry industry offers quick results, low barriers, easy operation, multiple benefits, and sustainability. Promoting hybrid paper mulberry can utilize saline-alkali, rocky desertification, and desertified land in contiguous poor areas that are difficult to cultivate, serving as a pioneer species for ecological construction and soil conservation in ecologically sensitive regions. Additionally, hybrid paper mulberry features rapid growth, high yield, strong stress resistance, and high feed protein content, with one-time planting enabling multi-year harvesting. It can effectively meet feed demands of poor households and develop breeding industries that promote poverty elimination, thereby increasing farmers' incomes and achieving a combination of economic, social, and ecological benefits. Therefore, it holds great potential for promotion.

Heze City in Shandong is a major agricultural city, with Mudan District, Cao County, and Yuncheng County designated as national "grain-to-forage" demonstration counties. Heze is the main production area for Luxi Yellow Cattle, Small-tailed Han Sheep, and Green-hair Goats. Local farmers have long traditions of raising cattle and sheep, with sheep inventory ranking first among agricultural regions nationwide for many years and cattle inventory ranking third in Shandong. Simultaneously, Heze is a poverty-stricken area in Shandong, with over 200,000 registered poor households and more than 400,000 impoverished people, accounting for over 50% of the province's total.

3.1 Specific Practice Measures for Hybrid Paper Mulberry Poverty Alleviation Work in Heze, Shandong Gaozhuang Town in Mudan District is a traditional agricultural township with a population of 61,000, including 944 registered poor households (1,969 people), of which 723 households (1,511 peo-

ple) have been lifted out of poverty, leaving 221 households (458 people) still impoverished, with two provincial-level key poverty alleviation villages. Since October 2016, Heze City has implemented hybrid paper mulberry technology-driven poverty alleviation work in Gaozhuang Town, Mudan District. To date, it has established one closed-loop industrial chain demonstration base covering "breeding-planting-harvesting-processing-breeding," three modern animal husbandry demonstration counties, and nine efficient characteristic animal husbandry poverty alleviation counties. This has forged a path for industrial development of hybrid paper mulberry "forest-feed-livestock" in plain and beach areas characterized by high efficiency, product safety, resource conservation, and environmental optimization. Through the "three incomes" model of land rent, wages, and interest-free capital, plus the "three zeros" model of zero investment, zero risk, and zero distance, the project has helped 105 poor households with 365 people increase income and escape poverty, and over 1,200 households with more than 4,300 people embark on a path to prosperity through the paper mulberry industry.

(1) Formulating paper mulberry industry poverty alleviation planning. In accordance with national industrial poverty alleviation policies and new requirements for targeted poverty alleviation, Mudan District Government of Heze City has focused on expanding and strengthening the paper mulberry industry to promote poverty elimination. Following the industrial development approach of "planting-breeding-processing" and "production-supply-marketing," the district has implemented a "two-step" strategic deployment combining paper mulberry poverty alleviation projects with targeted poverty elimination.

Step 1: Pilot demonstration (2016-2017). Establish a 5,000-mu whole-industrial-chain demonstration base in Mudan District. Through the "research institution + enterprise + cooperative + farmer" poverty alleviation model, the project has built complete industrial chains including factory-scale seedling propagation, large-scale planting, mechanized harvesting, scientific silage processing, and welfare breeding. It has managed relationships of land leasing, labor employment, and stem-leaf purchasing among farmers, poor households, and enterprises; developed cattle and sheep breeding technologies; and guided approximately 3,000 farmer households to raise 1,000 head of large livestock, guiding farmers and poor households to change their mindset and cultivate planting enthusiasm among the masses.

Step 2: Comprehensive promotion (2018-2020). Expand hybrid paper mulberry planting area to 100,000 mu in Mudan District; construct five 10,000-ton-level feed processing bases to solve terminal processing issues; cooperatively build 15 10,000-head beef cattle bases to stimulate local breeding through credit sales of hybrid paper mulberry silage feed; establish five biological fertilizer demonstration bases to coordinate ecological and green agriculture development; and drive 150,000 farmer households, including 5,000 poor households, with average household income of approximately 15,000 yuan.

(2) Promoting paper mulberry base construction through "three

modernizations and three unifications." Following the principles of scale, standardization, and specialization, the project has unified planting technical regulations, quality standards, and paper mulberry varieties. Through "three modernizations and three unifications," the project has optimized regional layout and developed concentrated contiguous areas. Currently, 5,000 mu of demonstration planting has been completed with survival rates above 98% and vigorous growth, while six hybrid paper mulberry planting bases are under construction. Pilot demonstrations prove that hybrid paper mulberry adapts well to the hydrological, geographical, soil, and climatic conditions of Mudan District, Heze City, yielding three harvests in the first year with over 3 tons of silage feed per mu.

(3) "Dual-wheel drive" for hybrid paper mulberry processing. Utilizing whole-plant fermentation technology, the project vigorously develops both primary processing and intensive processing through "dual-wheel drive." Steel-structure greenhouses have been built in fields as primary processing facilities, where harvested paper mulberry undergoes initial processing, achieving 15,000 tons of hybrid paper mulberry silage feed production within the year. With expanded planting area and increased yield, intensive processing zones are gradually being constructed, focusing on building a 50,000-ton annual production capacity hybrid paper mulberry silage feed processing plant.

(4) "Two increases and two decreases" to promote large-scale cattle breeding. Hybrid paper mulberry silage feed is approximately 18% cheaper than traditional feed, effectively reducing breeding costs. Moreover, the advantages of feeding cattle with paper mulberry feed are prominent: cattle favor it, grow quickly, with digestion and utilization rates around 90%. Growth rate, disease resistance, meat quality, and taste are significantly superior to conventionally raised cattle. Through increasing breeding income and safety control while reducing breeding costs and disease risks, large-scale cattle breeding can be promoted, achieving annual output of 5,000 head.

(5) "Internal introduction and external alliance" to build a paper mulberry industry cluster. Seizing favorable opportunities for environmentally friendly breeding and focusing on upgrading the paper mulberry industry, the project has introduced six large-scale breeding enterprises through investment attraction, local relocation, and external partnerships, and cooperated with 12 surrounding breeding enterprises, achieving annual output of over 10,000 sheep and 30,000 pigs. Simultaneously, the hybrid paper mulberry industrial chain has been enriched by developing more than 10 paper mulberry products including paper mulberry tea, cakes, and feasts, providing strong support for industrialization.

3.2 Significant Social Benefits of Hybrid Paper Mulberry Poverty Alleviation Work Developing hybrid paper mulberry with the "three incomes" and "three zeros" poverty alleviation model in Mudan District, Heze City, has achieved organic unity of ecological, economic, social, and poverty alleviation

benefits, creating a new path for poor households to escape poverty and become prosperous.

(1) Poor households transfer land and receive land rent. The hybrid paper mulberry project adopts an "enterprise + farmer" land transfer model. The company has transferred 5,000 mu of land in six villages including Jialou, Zhuzhuang, Huangying, and Nantou in Gaozhuang Town for hybrid paper mulberry planting, enabling farmers to receive approximately 1,500 yuan per mu annually in rent, helping over 50 poor households in Gaozhuang Town escape poverty through land transfer.

(2) Poor households work for the company and receive wages. "One person, one job" employment-based poverty alleviation is a reliable, stable, and effective method. Poor households are prioritized for jobs in land preparation, greenhouse acclimation, paper mulberry planting, field management, feed processing, and cattle breeding to earn wage income. During the seedling planting period, wages are paid at no less than 50 yuan per person per day, providing over 60 temporary jobs daily, with more than 20 poor households employed. This creates stable income sources.

(3) Poor households apply for financial loans and receive interest-free capital. The project actively explores a "paper mulberry + finance" poverty alleviation model, finding stable economic sources for poor households without labor capacity, wealth-generating pathways, skills, or those who are elderly, weak, sick, or disabled. Currently, Gaozhuang Town has abundant financial poverty alleviation loan products, including "Fumin Farmer Loans" supporting poor households and "Fumin Production Loans" supporting production and operation entities. Following the "government guarantee, enterprise operation, poor households benefit" model, enterprises have signed assistance agreements with 120 poor households in Gaozhuang Town. The government provides interest subsidies of over 0.3% to enterprises, rural commercial banks provide enterprises with loans up to 50,000 yuan per household for purchasing fattening calves, and according to agreements, enterprises distribute no less than 2,000 yuan annually to each contracted poor household.

(4) Poor households receive dividends from poverty alleviation funds with zero capital investment. Adopting a "government + enterprise + poor households" approach, the government has invested poverty alleviation funds to build 60 winter-warm greenhouses, which enterprises lease at approximately 20,000 yuan each for seedling greenhouses, generating 1.2 million yuan in annual rental income. This benefits poor households across 30 villages in the town, with each village receiving 40,000 yuan in income for redistribution according to the number of poor households in the village, with poor households' participation in distribution reaching about 90%.

(5) Poor households obtain interest-free loans with zero income risk. Organizing poor households under 60 years old to utilize "Fumin Farmer Loans," each household can apply for 30,000-50,000 yuan loans from Heze Rural Com-

mercial Bank to purchase 3-6 fattening calves weighing 200-500 jin. Through a calf trusteeship poverty alleviation model, households sign trusteeship contracts with enterprises that are responsible for insurance, feeding, and disease prevention. Using paper mulberry feeding for 10-12 months, each paper mulberry-fed cattle can grow to 1,200-1,500 jin, with net weight gain of nearly 1,000 jin. Sold at approximately 13 yuan/jin, gross income is about 13,000 yuan. Enterprises and poor households share profits at a 78:22 ratio, with poor households receiving about 3,000 yuan per head, enabling annual income increases exceeding 10,000 yuan.

(6) Poor households earn money at their doorstep with zero employment distance. Currently, enterprises have signed labor contracts with over 30 villagers from Jialou, Zhuzhuang, and Zhaozhuang Villages, with monthly wages of 2,000-4,000 yuan per person, including 12 poor households mainly engaged in cleaning and breeding work, earning over 2,000 yuan monthly with insurance provided by the enterprise, truly achieving family poverty elimination through one person's local employment.

4. Opportunities and Recommendations for Hybrid Paper Mulberry Industry Poverty Alleviation

4.1 Opportunities for Hybrid Paper Mulberry Technology-Driven Poverty Alleviation 4.1.1 Urgent demand to win the poverty alleviation battle.

Since the 18th Party Congress, the CPC Central Committee with Comrade Xi Jinping at its core has incorporated poverty alleviation into the "five-in-one" overall layout and "four-pronged comprehensive strategy," making it a key task for achieving the first centenary goal. The 19th Party Congress identified targeted poverty alleviation as one of three critical battles for building a moderately prosperous society in all respects. In 2018, poverty alleviation entered the final sprint stage. Following the overall deployment of the 19th Party Congress on winning the poverty alleviation battle, and based on the implementation progress of the "Decision of the CPC Central Committee and the State Council on Winning the Poverty Alleviation Battle" and prominent issues in practice, the central government formulated and issued the "Guiding Opinions of the CPC Central Committee and the State Council on Winning the Three-Year Action of Poverty Alleviation" in June, resolutely completing the task of lifting 30 million rural poor people out of poverty within three years.

The Chinese Academy of Sciences fully recognizes the major strategic significance of targeted poverty alleviation and has always attached great importance to technology-driven poverty alleviation, with President Bai Chunli making multiple instructions on paper mulberry poverty alleviation work. The Bureau of Science and Technology for Development of the Chinese Academy of Sciences has established special poverty alleviation projects to support pilot demonstrations of hybrid paper mulberry industry poverty alleviation, further improving the industrial technology system and standardization system. Under the guidance

of the State Council Poverty Alleviation Office, the academy leadership decided to have the Institute of Botany lead the establishment of a high-tech enterprise for transferring and transforming hybrid paper mulberry scientific and technological achievements, together with CAS Venture Capital and the R&D team, to strengthen seedling control and industrial technology support for the national "Hybrid Paper Mulberry Poverty Alleviation Project." A series of measures have provided policy and conditional guarantees for paper mulberry poverty alleviation pilot work. The most fundamental aspect of poverty alleviation remains developing industries to increase income and eliminate poverty. Therefore, developing the paper mulberry poverty alleviation industry represents a new approach and pathway for comprehensive poverty alleviation and building a moderately prosperous society. Deep poverty areas have few industries but suitable conditions for vigorously developing the paper mulberry industry.

4.1.2 Agricultural supply-side structural reform. Industrial poverty alleviation is the main approach to poverty elimination and an important path for agricultural supply-side structural reform. China's animal husbandry development model urgently needs transformation, and feed raw materials are key factors in improving meat, egg, and milk quality and influencing animal husbandry development and livestock product quality. To meet new requirements in current planting development, optimize planting structure, and improve comparative benefits of agricultural planting, reducing corn cultivation and planting high-protein feed is necessary. Additionally, the China-U.S. trade war has prompted China to change the current situation of excessive dependence on imported soybeans in its feed industry, diversify feed raw materials, and enhance the international competitiveness of China's feed industry and animal husbandry. Therefore, promoting hybrid paper mulberry cultivation as feed offers many advantages and represents an important pathway for planting structure adjustment.

4.2 Recommendations for Future Hybrid Paper Mulberry Technology-Driven Poverty Alleviation (1) Persist in scientific and technological innovation and strengthen technological support. We must fully leverage the scientific research advantages of high-level talents in academician and expert workstations, improve the efficiency of paper mulberry technology transformation, increase research investment and development efforts, accelerate the formulation of standards for planting, breeding, and processing, hold various forums and academic exchanges, and promote the promotion and use of paper mulberry products.

(2) Ensure objective media publicity and accurately guide paper mulberry industry poverty alleviation. We should improve understanding of the paper mulberry industry among industry insiders, government officials, the scientific community, poor households, and other sectors of society; increase case summaries, publicity for organizations and individuals, and rewards.

(3) Innovate industrial poverty alleviation models. We must adapt mea-

sures to local conditions, combine planting and breeding, adhere to market entities and enterprise participation, and drive poor households. We should encourage enterprises, cooperatives, and other business entities to innovate development methods, support local governments in combining east-west poverty alleviation cooperation and targeted assistance to create various docking platforms, introduce modern business concepts and industrial development models into paper mulberry poverty alleviation, and innovate whole-industrial-chain models that involve poor households.

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Note: Figure translations are in progress. See original paper for figures.