Developing Distinctive Resource Plants to Boost Beautiful China Construction (Postprint)

Authors: Shi Lei, Liu Zheng' an, Wang Lijun, Shu Qingyan, Sun Meiyu, Duan Wei, Li Hui

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Abstract

Constructing a three-industry integration model for characteristic resource plants constitutes an important approach to resolving the "three lives" (ecology, production, livelihood) conflicts in natural protected areas and ecologically fragile regions. Through the comprehensive excavation and utilization of superior traits of China' s characteristic resource plants—including oil peony, wine grapes, and aromatic plants—technical integration can be implemented across variety selection, cultivation, harvesting and processing, product research and development, and other domains. By conducting industrial demonstrations in natural protected areas and ecologically fragile regions, the generated economic benefits can enable local populations to cease dependence on wild resources for their livelihoods, thereby achieving effective biodiversity conservation, fulfilling people' s aspirations for a better life, promoting the sustainable development of ecological civilization, and contributing to the construction of Beautiful China.

Full Text

Developing Characteristic Resource Plants to Build a Beautiful China

SHI Lei*, LIU Zheng' an, WANG Lijun, SHU Qingyan, SUN Meiyu, DUAN Wei, LI Hui
(1 Institute of Botany, Chinese Academy of Sciences, Beijing 100093, China)

Abstract

Constructing a three-industry integration model for characteristic resource plants represents an important approach to resolving the "three lives" contradiction—ecology, production, and livelihood—in natural protected areas and ecologically fragile regions. This study systematically integrates technologies

for variety screening, cultivation, harvesting, processing, and product development to fully exploit the superior traits of China' s characteristic resource plants: oil tree peony, wine grape, and aromatic plants. By implementing industrialization demonstrations in natural protected areas and ecologically fragile regions, the economic benefits generated can reduce local communities' dependence on wild resources, achieve effective biodiversity conservation, satisfy people' s aspirations for a better life, promote sustainable ecological civilization development, and contribute to building a Beautiful China.

Keywords: characteristic resource plants, three industries integration mode, natural protected areas, ecologically fragile region
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China' s natural protected areas and ecologically fragile regions often overlap significantly with impoverished zones, where local livelihoods heavily depend on natural biological resources. This dependency leads to environmental degradation and rapid biodiversity loss, exacerbating the "three lives" contradiction and constraining regional economic development [1,2]. Characteristic resource plants refer to distinctive plant species that can be utilized under current social, economic, and technological conditions. Internationally, there are successful cases of characteristic resource plant utilization, such as lavender in Provence on the southern slopes of the French Alps, which has transitioned from wild collection to commercial cultivation and processing over a century of development, supporting France' s perfume and tourism industries [3,4]. Similarly, approximately 174 km^2 of land in and around Napa Valley in San Francisco, USA, has been designated as an American Viticultural Area, making it one of the world' s most famous wine-producing regions and generating excellent ecological, economic, and social benefits [5].

Since the 18th National Congress of the Communist Party of China, the Party Central Committee with Comrade Xi Jinping at its core has elevated ecological civilization to a national strategic priority, focusing on the sustainable development of the Chinese nation and the broader vision of building a community with a shared future for mankind. This strategic direction provides clear guidance for addressing the "three lives" challenges in natural protected areas and ecologically fragile regions [6-8]. This paper selects oil tree peony, wine grape, and aromatic plants for integrated technology development in screening, cultivation, harvesting, processing, and product research. By addressing key technical challenges in the integration of primary, secondary, and tertiary industries (hereinafter referred to as "three-industry integration"), we explore new models of ecological industrialization in natural protected areas and ecologically fragile regions. This approach aims to reduce community dependence on protected wild resources, thereby achieving the dual objectives of effective biodiversity conservation and meeting people' s needs for a better life, while providing technical support for national ecological civilization and Beautiful China initiatives.

1.1 Ecological High-Value Oil Tree Peony

China is the origin center of tree peony worldwide. With flowers for ornamental purposes, roots for medicinal use, and seeds for oil extraction, tree peony represents a unique national resource plant [9-11]. Peony has been utilized as an ornamental and medicinal plant for over 2,000 years. Recent research reveals that oil tree peony can produce 2,250 kg/ha of seeds with oil content exceeding 20%, featuring over 90% unsaturated fatty acids and α-linolenic acid content up to 40%, making it a precious high-quality woody edible oil resource [Figure 1: see original paper]. Furthermore, peony integrates ornamental, medicinal, oil, and cultural values, delivering significant ecological, economic, and social benefits. Its suitability for three-industry integration and adaptability for development in and around protected areas make it an excellent solution for balancing conservation and development.

In 2011, the Ministry of Health announced the approval of two types of seed oil as new resource foods. Subsequently, the 2014 and 2015 documents "Opinions on Accelerating the Development of Woody Oil Industry" and "Opinions on Accelerating the Advancement of Ecological Civilization Construction" provided direction for the oil tree peony industry. However, as an emerging agricultural and forestry sector, oil tree peony urgently requires the development of supporting cultivation techniques suitable for different climates and habitats, as well as comprehensive utilization technologies for peony seed oil extraction, purification, and related product development.

1.2 High-Resistance Quality Wine Grapes

Grape species are perennial vines with high nutritional value in their fruits, which can be consumed fresh, used for winemaking, drying, or juice production. Currently, grapes have become the second largest cultivated fruit tree globally, with 80% used for winemaking [12]. Winemaking offers high added value and can be combined with winery tourism, facilitating high-level integration of primary, secondary, and tertiary industries. There are 71 species in the grape genus worldwide, with wild species concentrated in three regions: Europe-West Asia, North America, and East Asia. Approximately 8,000 cultivated varieties are distributed across all continents. China, located in the East Asian distribution center, has 40 known grape species, making it one of the world' s richest origins of grape genetic resources. Currently, the most commonly cultivated grapes in China are *Vitis vinifera* varieties, followed by American species and hybrids of European and American varieties. Despite their good quality, these varieties have poor stress resistance, particularly requiring soil burial for winter protection in northern China, which limits their cultivation and planting.

Wild grapes such as *Vitis amurensis*, *Vitis davidii*, and *Vitis heyneana* are also used directly for fresh consumption or winemaking. Although these wild grapes possess strong stress resistance, their poor quality limits widespread application. Researchers have utilized wild resources as parents to cross with cultivated va-

rieties, developing several excellent grape varieties for production. For example, the Institute of Botany, Chinese Academy of Sciences, has bred high-resistance quality wine grape varieties "Beihong" and "Beimei" through hybridization between wild *Vitis amurensis* and European cultivated varieties, hailed as a "model for utilizing wild resources in breeding"[13]. Due to their strong adaptability and high winemaking quality, these varieties show promise for demonstration and promotion in natural protected areas and ecologically fragile regions. However, research on the cultivation and processing technologies for these high-resistance quality grape resources remains insufficient. Wine-producing countries with developed industries have established optimal combinations of varieties and suitable cultivation regions, rational cultivation and winemaking techniques, and wine product types matched with production areas and varieties. Future work requires research and integration of cultivation and winemaking technologies tailored to different regional geographical and climate characteristics, establishment of winemaking techniques suitable for fruit quality features of different regions, and development of wine types compatible with terroir conditions [Figure 2: see original paper].

1.3 High-Value Characteristic Aromatic Plants

Aromatic plants are characteristic resource plants with fragrance and essential oil extraction potential, offering high economic value and playing important roles in food, medicine, daily chemical, and cultural tourism industries. There are 3,600 aromatic plant species worldwide, mainly distributed along the Mediterranean coast and throughout Europe, with approximately 400 species already developed and utilized. China has over 1,000 aromatic plant species distributed nationwide, with about 400 having utilization value and 150 already developed, primarily concentrated in Lamiaceae (lavender, rosemary, thyme, oregano, etc.), Lauraceae, Rutaceae, Apiaceae, and Brassicaceae. For example, lavender industry in Yili, Xinjiang, has developed vigorously under the technical guidance of the Institute of Botany, Chinese Academy of Sciences [Figure 3: see original paper]. Currently, lavender has become a geographical indication product in the region and earned the title "Hometown of Lavender in China," making significant contributions to regional economic development. Lavender essential oil possesses important medicinal and aromatic value. The whole genome, terpene component biosynthesis, and molecular mechanisms of glandular trichome development have been elucidated, which is significant for metabolic regulation and molecular breeding of lavender' s main components [14-16].

Due to their long industrial chain, easy processing, and ornamental value, cultivating aromatic plants in natural protected areas and ecologically fragile regions can increase local farmers' income and address conservation-development conflicts. Compared with Western countries, China still lags in new variety breeding and supporting cultivation and harvesting processing technologies for aromatic plants. Establishing a technical system integrating variety screening, cultivation, harvesting, processing, and product development is crucial for supporting

Beautiful China and rural revitalization initiatives.

2 Practice in Constructing Three-Industry Integration Models for Characteristic Resource Plants

The research team from the Institute of Botany, Chinese Academy of Sciences (hereinafter referred to as "the project team") has established a three-industry integration model and application demonstration for characteristic high-value resource plants—oil tree peony, wine grapes, and aromatic plants—in natural protected areas and ecologically fragile regions [Figure 4: see original paper]. The project team conducted systematic research on breeding, cultivation techniques, harvesting and processing technologies, functional product development, demonstration, and promotion of characteristic high-value resource plants [Figure 5: see original paper] [17].

2.1 Practice in Constructing the Three-Industry Integration Model for Ecological High-Value Oil Tree Peony

Addressing national strategic needs and specific project requirements, the Institute of Botany, Chinese Academy of Sciences, conducted systematic research and practice on oil tree peony germplasm screening, high-yield and quality cultivation techniques, and high-value processing technologies. Collaborating with multiple enterprises and institutions [Figure 6: see original paper], the team demonstrated and promoted approximately 6,200 hectares in Heishan Nature Reserve (Heyang and Heye in Shaanxi Yulin, Changzhi in Shanxi), Funiu Mountain National Nature Reserve (Luoyang, Shangqiu, and Sanmenxia in Henan), Wuling Mountain National Nature Reserve (Tangshan in Hebei), Nansi Lake Nature Reserve in Shandong (Jining in Shandong), Yancheng National Rare Bird Nature Reserve (Nantong and Yancheng in Jiangsu), and Anhui Yellow River Old Course Provincial Nature Reserve (Fuyang and Suzhou in Anhui). The research revealed that oil tree peony possesses soil conservation, carbon sequestration and oxygen release, water conservation, and biodiversity protection functions. Its annual water conservation capacity reaches 1,228.8 m^3/ha, soil conservation 335.8 t/ha, windbreak and soil fixation 8.8 t/ha, carbon sequestration and oxygen release 2.2 t/ha, with total ecosystem service value of 4,659.1 yuan/ha. Among these, the photovoltaic model demonstrated and promoted approximately 1,333.3 hectares, capable of producing about 3,000 tons of peony seeds annually, generating approximately 72,000,000 kWh of electricity, and reducing annual CO_2 emissions by about 176,400 tons. The promotion of oil tree peony cultivation has expanded viewable areas and extended the peony flowering period, increasing tourism revenue and achieving economic, ecological, and social benefits.

The main practical achievements include three aspects:

(1) **Establishment of an efficient oil tree peony cultivation technical system.** The team screened "Fengdan"peony resources suitable for growth

in the Loess Plateau, Central Plains, and under photovoltaic panels. They developed specialized peony mulch film with breathability, moisture retention, weed prevention, and durability characteristics, along with artificial pollination devices [18-20]. Integrating 12 specific cultivation techniques including land preparation, improved variety selection, seedling treatment, timely planting, rational density, specialized mulch covering, intertillage weeding, timely pruning, water and fertilizer management, assisted pollination, biological pest control, and timely harvesting, the team innovated three cultivation technology models suitable for different habitats: "high-yield, stable-yield, high-quality, low-cost cultivation model for oil tree peony," "efficient cultivation model for oil tree peony in Loess Plateau," and "innovative model of photovoltaic + oil tree peony development and application." These achievements represent the integration of multiple technologies and device inventions. According to novelty searches conducted by the Institute of Scientific and Technical Information of China and Lanzhou Consulting Center of Chinese Academy of Sciences in 2020 and 2021, no similar reports were found, and these technologies are at a leading level compared with domestic and international counterparts. The demonstration base in Central Plains (Qinyang, Henan) achieved yield of 4,315.5 kg/ha, representing a 47.8% increase over the previously reported maximum yield of 2,920.5 kg/ha, with average annual income increase of 12,000 yuan/ha. In Loess Plateau region (Jiaxian, Northern Shaanxi), the water conservation capacity reached 143.5 mm/ha, exceeding that of natural restoration vegetation. Oil tree peony growth, biomass, and seed yield under photovoltaic panels were significantly better than outside the photovoltaic area, with 2-year seedlings reaching 2,718.9 kg/ha after 4 years in the photovoltaic cultivation system, compared to 1,485.6 kg/ha outside, while maintaining the same electricity generation level as similar photovoltaic power stations.

(2) **Establishment of an integrated oil tree peony processing and utilization technical system to achieve three-industry integration.** To increase the added value of oil tree peony, the team evaluated 53 indicators from seeds in different demonstration areas, screening 6 key indicators to establish an evaluation model for rapid seed quality identification [21], and discovered that the seeds possess 2-year strategic reserve capability. They developed a "fatty acid solution + melt coupling suspension crystallization and layer crystallization process" for separating high-content α-linolenic acid (60%-70%) from peony seed oil [22], and obtained high-purity α-linolenic acid (99.65%) through column chromatography, establishing a key technical system for potential α-linolenic acid utilization reserves. They also developed a nano-emulsion encapsulation technical system for α-linolenic acid and peony seed oil [23], solving storage challenges associated with high unsaturated fatty acid content. The team established effective component extraction technical systems from peony petals, stamens, and seed coats [24,25]. By-products from oil tree peony

(roots, stems, leaves, and seed meal) showed potential for replacing antibiotics, promoting growth in lambs and piglets, and reducing egg cholesterol when added to feed. These achievements lay the foundation for developing new natural medicines, functional foods, and antibiotic-replacing feed additives.

(3) **Application in ecological restoration and new energy fields.** The research findings have been applied in Yellow River basin management, Loess Plateau ecological restoration, and photovoltaic new energy fields, providing a unique Chinese solution using oil tree peony to address rural revitalization, "three lives" issues, and beautiful countryside construction in natural protected areas and ecologically fragile regions.

2.2 Practice in Constructing the Three-Industry Integration Model for High-Resistance Quality Wine Grapes

Residents in and around Changbai Mountain Nature Reserve have long depended on forests and understory resources for livelihood, creating prominent "three lives" contradictions. Wild mountain grapes are important local resource plants, but their low sugar and high acid content make it difficult to produce quality wine. The Institute of Botany, Chinese Academy of Sciences, hybridized European "Muscat" with wild mountain grapes to develop the "Beimei" and "Beihong" series varieties, which feature strong cold resistance and disease resistance, high sugar, and high acid content, demonstrating potential for balancing economic, ecological, and social benefits. The research primarily relied on relevant units in Heilongjiang, Jilin, and Liaoning provinces to conduct the following demonstration experiments in the Changbai Mountain region [Figure 7: see original paper]. The main practical achievements include three aspects:

(1) **Establishment of "Beimei" and "Beihong" cultivation technical systems.** The team developed and integrated 10 technologies, with the core being winter cultivation without soil burial (complete exemption or simple covering) for 3-year-old trees and simplified pruning techniques. They established a series of cultivation technical regulations and standards [26].

(2) **Establishment of "Beimei" ice wine brewing technical system with international awards.** The team developed enterprise standards for ice wine brewing technology, applied for 3 wine detection technology invention patents (1 authorized) [27], and obtained 1 wine packaging utility model patent. The produced ice wine won Silver Award at Brussels International Wine Competition (2018), Silver Award at 13th G100 International Wine & Spirits Competition (2019), and Silver Award at Decanter World Wine Awards (2022).

(3) **Economic, social, and ecological benefits.** This research created a key technical system for cultivation and winemaking of "Beimei" and "Beihong" in Northeast China and achieved certain promotion and application.

The three-industry integration industry involving cultivation demonstration, wine processing, and cultural tourism covers broad areas with long benefit periods and high economic returns. In addition to winemaking income, the soil burial-free or simple cold protection techniques for "Beimei" and "Beihong" save 1/4-1/3 of cultivation costs, while simplified pruning techniques save 1/3 of summer pruning labor. The project primarily relies on companies or leased farmland from farmers, or cooperatives formed with farmers, to develop winery tourism, providing numerous job opportunities for surrounding farmers, consolidating poverty alleviation achievements, and achieving rural revitalization. The winter soil burial-free or simple cold protection cultivation of "Beimei" and "Beihong" in Northeast China, which basically avoids soil excavation, prevents damage to soil and trees caused by traditional variety burial and excavation, representing an innovation in Chinese wine grape cultivation.

2.3 Practice in Constructing the Three-Industry Integration Model for High-Value Characteristic Aromatic Plants

The Institute of Botany, Chinese Academy of Sciences, conducted systematic research and practice on aromatic plant resources [Figure 8: see original paper]. Aromatic plants are important characteristic resource plants, including lavender, rosemary, rose, thyme, and oregano, widely applied in daily chemical, food, medicine, and other industries. The research team independently bred "Jingxun No. 1" lavender with high essential oil quality. Through three-industry integration, they built a complete industrial chain encompassing cultivation, processing, and tourism. In the Yili River Valley at the northern foothills of Tianshan Mountains near the Western Tianshan National Nature Reserve in Xinjiang, the team conducted demonstration and promotion of lavender and other aromatic plants relying on the Xinjiang Production and Construction Corps Fourth Division. In Fuyang City, Anhui Province, as the experimental base, the Institute of Botany signed a cooperation project "Research and Demonstration of Industrialized Development Integration Technology for Aromatic Plants" with Fuyang Municipal People' s Government. The team completed construction of a 20-hectare germplasm resource nursery with 5 families, 22 genera, and 107 species (varieties) in Fuyang National Agricultural Science and Technology Demonstration Park, serving as the Fuyang backup repository for the National Aromatic Plant Germplasm Resource Bank, laying the foundation for creating a 500,000-mu Central Plains aromatic plant cultivation belt. The main practical achievements include four aspects:

(1) **New variety breeding of aromatic plants.** The team compiled DUS (Distinctness, Uniformity, and Stability) testing guidelines for aromatic plants such as basil, rosemary, and thyme. They screened 14 excellent aromatic plant varieties suitable for Central Plains region and bred 5 new varieties including lavender "Luoshen," "Jinli," "Tianshan Feixue," "Tianshan Jingling," and oregano "Zhinü." They completed polyploid induction

breeding technology for oregano and other aromatic plants, applying for 1 invention patent.

(2) **Establishment of aromatic plant cultivation and processing technologies.** The team established a furrow-ridge interchange cultivation model without soil burial for lavender in cold and arid regions, solving problems of high mortality rate, low yield, and high winter soil burial costs in Xinjiang lavender cultivation. They compiled 3 enterprise standards for cultivation techniques of aromatic plants including rosemary, oregano, and Asian mint, providing support for developing excellent variety cultivation in Central Plains region. They also developed 2 product processing technical standards for lavender in Central Plains region, "Dried Lavender Flower Granules" and "Lavender Cut Flower Grades and Specifications."

(3) **Aromatic plant product development.** The team obtained 5 authorized patents [28-32] and applied for 7 invention patents in aromatic plant breeding, rapid propagation, cultivation, gene function, functional component extraction, food antioxidants, cosmetic raw materials, and antibiotic-replacing feed additives.

(4) **Demonstration and promotion of aromatic plants.** The team established a 107-hectare demonstration base and promoted 1,340 hectares in Yili, Xinjiang. In Fuyang, Anhui, they established a germplasm resource nursery, demonstrated 67 hectares, and promoted 871 hectares, laying the foundation for creating a Central Plains aromatic plant cultivation belt. The project "Key Technology Integration and Three-Industry Integration Model Construction for Aromatic Plant Industrialization" passed achievement evaluation, establishing a high-quality development model for three-industry integration of aromatic plants encompassing "germplasm resource bank—new variety breeding—standardized planting—harvesting and processing—product development—industrial planning and demonstration promotion."

3 Future Work on Three-Industry Integration Models for Characteristic Resource Plants

The three-industry integration models developed for oil tree peony, wine grapes, and aromatic plants have achieved full industrial chain technical reserves and research, with certain demonstrations and promotions implemented, realizing the unification of economic, ecological, and social benefits. In considering the implementation of rural revitalization and Beautiful China strategies, the universality of these models during demonstration and promotion should be noted, respecting the biological characteristics of the plants and local cultural, geographical, and ecological elements. Meanwhile, as these three types of plants are non-grain crops but fall within the national scope of comprehensive food sources, it is recommended to promote them on non-cultivated land such as forest gaps and marginal land to ensure the red line of cultivated land protection.

Combining local economic development needs, both single-plant and multi-plant combination models should be considered to maximize economic and environmental utilization. Most importantly, as the cultivation and processing technical systems for these three characteristic resource plants are relatively mature, efforts should further extend relevant industrial chains, increase industrial functions, and enhance industrial levels to achieve innovation in development modes, continuously generating new business forms, technologies, business models, and spatial layouts. Ultimately, this will promote the development and integration of related industries, achieve harmonious coexistence between humans and nature, and realize the dual goals of Beautiful China and rural revitalization.

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