

Research Advances in the Substitution of Chemical Fertilizers with Straw Application in China's Flue-Cured Tobacco Industry

Yanhong WANG[△], Shuo YUAN[△], Yushan BAO, Zhengcui LU, Xinyu FAN, Zuoxin TANG^{*}

College of Agriculture and Life Sciences, Kunming University, Kunming 650214, China

Abstract To systematically review research progress concerning the substitution of chemical fertilizers with straw application in China's flue-cured tobacco industry, a bibliometric analysis was conducted using CiteSpace on 181 relevant publications from 2005 to 2025, sourced from the China National Knowledge Infrastructure (CNKI) database. The results showed that the number of articles published in this field had exhibited phased growth, reaching a peak of 24 publications in 2023. Core journals served as the primary platforms for dissemination, with *Soils and Fertilizers Sciences in China* publishing the highest volume of articles. Keyword co-occurrence and cluster analysis identified "flue-cured tobacco", "organic fertilizer", "yield", "quality", and "chemical fertilizer reduction" as central research themes. The research mainly focused on enhancing the production quality of flue-cured tobacco while maintaining the health of tobacco planting soils. The principal reduction method involved decreasing single nitrogen application, accounting for over 70% of cases, with the typical reduction range between 10% and 40%. The primary materials used in combined applications were cake fertilizer (exceeding 40%) and straw (approximately 25%). The present study exhibits certain limitations, including an inadequate mechanism for the coordinated reduction of nitrogen, phosphorus, and potassium; reliance on a single model for straw resource utilization; and insufficient regional specificity. Future research should focus on enhancing the understanding of the synergistic effects between reduction ratios and co-applied materials, as well as developing a precise chemical fertilizer reduction and application technology system grounded in zoning and classification.

Key words Chemical fertilizer reduction, Flue-cured tobacco, Straw, Combined application, Bibliometric analysis

0 Introduction

Flue-cured tobacco is an important economic crop in China. Fertilization is a fundamental and widely employed measure to enhance tobacco production^[1–2]. However, the pursuit of high yields has frequently resulted in the excessive application of chemical fertilizers. Such overuse often induces a range of adverse effects, including soil acidification and compaction, reduced organic matter content, nutrient imbalances, diminished enzyme activity, reduced microbial populations, and environmental pollution^[3–4]. Meantime, the imbalance in the nutrient composition of tobacco leaves leads to insufficient aroma, elevated nicotine content, and disharmony among internal components, thereby greatly limiting improvements in both tobacco yield and quality^[3]. In contemporary tobacco cultivation, the demand for green agricultural development necessitates reducing fertilizer application while enhancing efficiency and ensuring environmental sustainability.

However, simply decreasing the use of chemical fertilizers is insufficient to satisfy the nutritional requirements for tobacco growth, yield, and quality. Organic fertilizers, characterized by their high organic matter content, provide a prolonged and sustained nutrient supply^[5]. The combined application of chemical fertilizers and straw has been shown to significantly improve the agronomic traits of flue-cured tobacco^[6], promote dry matter accumulation during the later growth stages, increase both yield and output value, and concurrently enhance intrinsic qualities such as chemical composition and sensory attributes of tobacco leaves^[7]. Nonetheless, some studies have reported that the combined use of straw and chemical fertilizers may inhibit leaf development during the early growth stages of flue-cured tobacco^[8]. It is therefore urgent to systematically sort out and optimize the proportions and methods of combined application of chemical fertilizers and straw. This approach aims to improve soil properties, enhance soil fertility, increase the production quality of tobacco plants, promote environmentally sustainable and ecological farming practices, and strengthen the capacity for sustainable development.

Utilizing the China National Knowledge Infrastructure (CNKI) database, this study employed CiteSpace software to perform a visual analysis of the literature concerning the effects of chemical fertilizers with straw application (substitution) on the physical, chemical, and biological properties of tobacco planting soil, as well as on the production quality of flue-cured tobacco. This analysis systematically delineated the developmental trajectory of the field, revealed its research context and emerging frontiers, and offered a foundational reference for future investigations, thereby aiming to advance theoretical innovation and promote sustainable development in related fields.

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[△]These authors contributed equally to this work.

Yanhong WANG, doctoral degree, lecturer, research fields: plant protection and resource utilization; Shuo YUAN, master's degree candidate.

^{*} Corresponding author. Zuoxin TANG, doctoral degree, associate professor, research fields: plant protection and resource utilization.

1 Data sources and methods

1.1 Data sources This study utilized relevant research literature from January 2005 to December 2025, sourced from the CNKI database. The search terms included combinations of "tobacco", "flue-cured tobacco", "tobacco planting soil", "flue-cured tobacco soil", "organic fertilizer", "organic material", "straw", and "chemical fertilizer". The database search was conducted on January 10, 2026, yielding an initial total of 328 records. Subsequently, dissertations, conference papers, review articles, book reviews, and clearly irrelevant studies were excluded. Each remaining record was then screened individually based on the title, abstract, and keywords. Consistent with the objectives of this study, only research conducted under field experimental conditions in China was retained; irrelevant and duplicate articles were removed, and studies with clearly defined types of chemical fertilizer reduction and straw application were selected. Ultimately, 181 valid documents were included in the analysis.

1.2 Data analysis and plotting methods A total of 181 Chinese literature records, obtained through screening, were exported in RefWorks format and saved as download_*.txt files^[9]. Keyword co-occurrence analysis was then performed using CiteSpace 6.3.R1. Deduplication and format conversion procedures were also implemented to facilitate the visualization of the knowledge structure, research hotspots, and developmental trends within this field through a comprehensive scientific knowledge graph^[10]. The parameter settings were as follows: YearPerSlice was set to 1; text processing utilized the software's default settings; keywords were selected as node types for co-occurrence and cluster analysis. During mutation analysis, the γ parameter was set to 0.1, while other thresholds remained at their default values. Ultimately, the knowledge map was generated using CiteSpace 6.3.R1 software^[11].

The stringr package in R language (4.5.2) was employed to extract the publication year information from the literature^[12]. During the literature screening process, the application of chemical fertilizers was documented in an Excel sheet (2021 version). Eventually, a line graph depicting the annual volume of published literature was generated using the ggplot2 package in R language.

2 Results and analysis

2.1 Analysis of the annual number of published articles As shown in Fig. 1, the research publication trajectory concerning the reduction of chemical fertilizers and the application of straw in the CNKI database from 2005 to 2025 can be categorized into four distinct phases: the exploratory period, the steady growth period, the plateau period, and the rapid development period. Between 2005 and 2010, the field was in its initial exploratory stage, characterized by a relatively low volume of publications, with fewer than 3 articles published annually. Notably, 2006 and 2007 recorded the lowest publication counts. From 2011 to 2017, the field experienced steady growth, with the number of publications in-

creasing incrementally to an average of approximately 7 articles per year. A peak of 8 articles was observed in 2011, followed by a slight decline, then a resurgence in 2014, culminating in 11 articles in 2015. The period from 2018 to 2020 represented a plateau phase, during which publication numbers stabilized at a relatively high level, averaging 13.3 articles annually; specifically, 14 articles were published in 2018, with 13 articles each in 2019 and 2020. Finally, from 2021 to 2025, the field underwent rapid development, exemplified by a surge to 24 publications in 2023. Although there was a modest decline in 2024 and 2025, the output remained comparatively high, with 18 and 15 articles published, respectively.

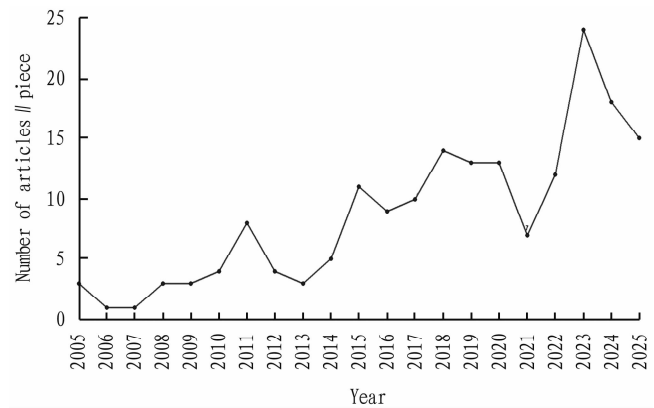


Fig. 1 Annual distribution of articles on the combined application of straw and chemical fertilizers in tobacco planting soil in China from 2005 to 2025

2.2 Publication journals As presented in Table 1, the top 10 journals within the CNKI database, ranked by the number of articles published on research concerning chemical fertilizer reduction and straw application, had collectively published 87 articles. These journals covered Peking University core journals, core science and technology journals, and general agricultural journals, with core journals serving as the primary platforms for disseminating research findings in this domain. Specifically, 44 articles (50.57% of the total) appeared in core journals. Among these, *Soils and Fertilizers Sciences in China* published 11 articles (12.64%), holding the highest impact factor of 3.494 in 2025 and ranking first on the list. This journal is recognized as an authoritative source in soil and fertilizer research, emphasizing studies on soil resources, plant nutrition and fertilization, and agricultural microbiology. The remaining core journals with high publication volumes also possessed impact factors exceeding 2.0 in 2025, underscoring their significance as venues for fundamental research related to agriculture and tobacco. Additionally, 43 articles (49.43% of the total) were published in core science and technology journals and general journals. Apart from the 11 articles published in the *Chinese Agricultural Science Bulletin*, the other journals each published between 6 and 10 articles, primarily featuring fundamental and regional research contributions in this field.

Table 1 Top 10 Chinese journals on research concerning straw-based organic fertilizer combined with chemical fertilizer in China from 2005 to 2025

No.	Journal	Number of articles piece	Impact factor in 2025
1	<i>Chinese Agricultural Science Bulletin</i>	11	2.077
2	<i>Soils and Fertilizers Sciences in China</i>	11	3.494
3	<i>Southwest China Journal of Agricultural Sciences</i>	10	2.681
4	<i>Chinese Tobacco Science</i>	10	2.606
5	<i>Journal of Anhui Agricultural Sciences</i>	9	0.897
6	<i>Guizhou Agricultural Sciences</i>	8	1.361
7	<i>Acta Agriculturae Jiangxi</i>	8	1.313
8	<i>Hunan Agricultural Sciences</i>	7	0.762
9	<i>Acta Tabacaria Sinica</i>	7	2.950
10	<i>Journal of Yunnan Agricultural University</i>	6	2.057

2.3 Keywords and cluster analysis Keywords serve as a highly condensed representation of research topics. Analyzing the evolution of keywords can reveal shifts in research hotspots within the field^[13]. In this study, the node type was designated as the keyword, and both the co-occurrence network and clustering map of keywords from 2005 to 2025 were constructed (Fig. 2). The co-occurrence network revealed that "flue-cured tobacco" was the most frequently occurring keyword. Additionally, keywords such as "organic fertilizer", "yield", "quality", "production quality", "chemical fertilizer reduction", "tobacco planting soil", and "chemical fertilizer" exhibited relatively high co-occurrence frequencies. Collectively, these keywords constituted the primary framework of research in this domain, with the ultimate objective of enhancing the yield and quality of flue-cured tobacco and improving the management of tobacco planting soil.

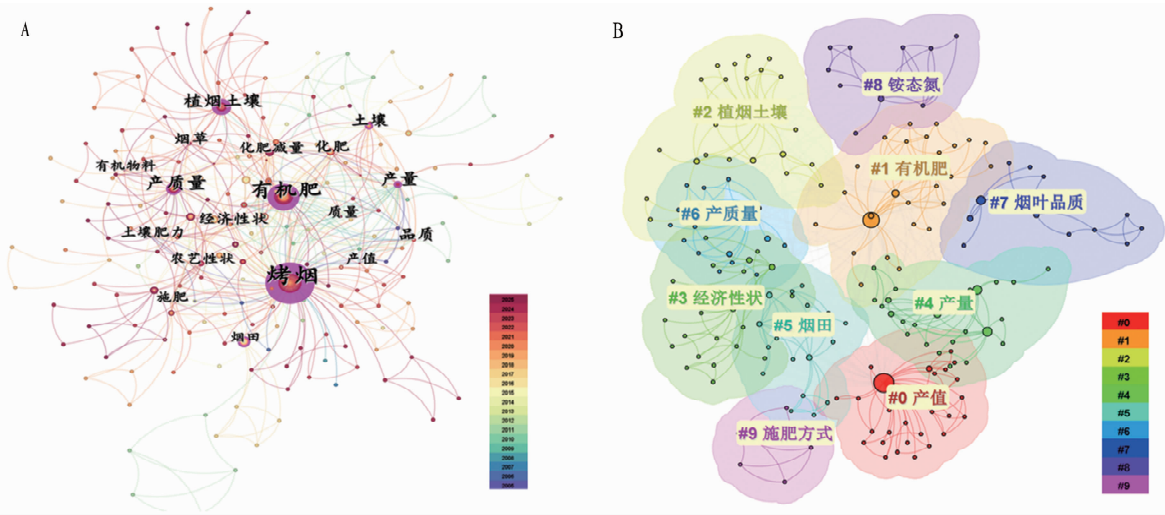
A total of 10 cluster units were identified through cluster analysis. Clusters #0 (output value), #4 (yield), #6 (production quality), and #3 (economic trait) formed the core research trajectory focused on "yield and output value". These clusters were densely interconnected, emphasizing the regulation of cultivation measures on the yield and economic benefits of flue-cured tobacco, aligning with the research objective of enhancing the quality and efficiency of the tobacco industry. Notably, cluster #0 (output value) was the largest and functioned as a central hub linking various research directions. Clusters #1 (organic fertilizer), #2 (tobacco planting soil), #8 (ammonium nitrogen), and #9 (fertilization method) constituted significant branches related to soil and nutrient management. The nodes within cluster #1 (organic fertilizer) were particularly dense. Current research hotspots included the substitution of organic fertilizers, regulation of nutrients such as ammonium nitrogen, and optimization of fertilization methods, reflecting a shift from traditional chemical fertilizer application toward sustainable nutrient management models. Furthermore, these clusters were closely associated with cluster #2 (tobacco planting soil), collectively supporting investigations into soil health and efficient nutrient utilization. Clusters #7 (tobacco leaf quality) and #5 (tobacco field) represented research directions concerning

quality and cultivation regulation, which were extensively linked to clusters focused on yield and soil nutrient management, thereby illustrating the comprehensive nature of the research system.

2.4 Keyword burst detection Fig. 3 presents the top 20 keyword burst maps in this domain from 2005 to 2025. The keyword "quality" exhibited a burst period from 2005 to 2011, with a burst intensity of 2.21, signifying its status as an early research focus and underscoring the importance of tobacco leaf quality as a fundamental aspect of the tobacco industry's development. The keyword "chemical fertilizer reduction" demonstrated a burst period from 2022 to 2025, with a burst intensity of 2.93, ranking highest among all keywords and representing a current focal point in cutting-edge research.

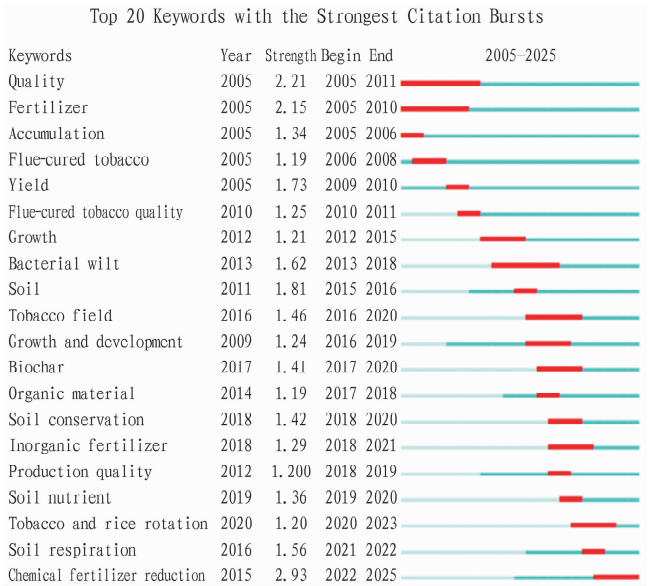
Based on the burst periods, the evolution of research hotspots can be categorized into four distinct stages. From 2005 to 2010, the field was characterized by basic research, with prominent keywords including "quality", "fertilizer", "accumulation", "flue-cured tobacco", and "yield". During this stage, investigations primarily focused on fundamental aspects of flue-cured tobacco production, particularly examining the effects of chemical fertilizer application on production quality of flue-cured tobacco. Between 2011 and 2015, research became more specialized, as evidenced by the emergence of keywords such as "flue-cured tobacco quality", "growth", "bacterial wilt", and "soil". The burst period for "bacterial wilt" extended from 2013 to 2018. The research emphasis shifted from solely enhancing yield to exploring crop growth mechanisms as well as disease prevention and control, with soil-related studies increasingly gaining prominence. From 2016 to 2020, the field underwent a significant transformation in research focus. Keywords such as "tobacco field", "growth and development", "biochar", "organic material", "soil conservation", and "soil nutrient" emerged intensively. The burst intensity for "tobacco field" reached 1.46, indicating heightened attention to soil management within tobacco cultivation. During this period, organic amendments and fertilization techniques became central topics of investigation. The research objectives evolved from solely enhancing production quality to emphasizing sustainable production practices that prioritize soil health. Since 2021, chemical fertilizer reduction has become a primary research focus, reflecting a paradigm shift from traditional chemical-dependent approaches toward green production strategies that integrate chemical fertilizer reduction, crop rotation improvements, and soil conservation. The progression of research hotspots from 2005 to 2025 closely aligns with the developmental trajectory of China's tobacco industry, which has transitioned from expanding production volume and improving quality to disease control and ultimately to green and sustainable development. Moving forward, green, low-carbon, and ecological cultivation practices are expected to remain the predominant directions in this field.

2.5 Analysis of chemical fertilizer reduction methods and the types and functional composition of straw materials In the existing literature, research predominantly focused on single reduction of nitrogen application, which constituted over 70% of



NOTE In Fig. A, each node corresponds to a keyword. The size of the node and the font reflects the frequency of the keyword’s occurrence , with larger sizes indicating higher frequencies. Different colors denote different years. The purple color on the outermost circle signifies the centrality of the node; higher centrality values indicate stronger connectivity within the network. In Fig. B, each color represents a distinct cluster. Generally, a clustering result is considered reasonable when the *Q* value exceeds 0.3 and the *S* value is below 0.5.

Fig.2 Keyword co-occurrence network (A) and clustering map (B) from 2005 to 2025



NOTE The length of the red bar represents the burst intensity and duration of the keyword.

Fig.3 Keyword burst diagram

the studies. Most experiments implemented gradient nitrogen reduction treatments, with the primary reduction range spanning from 10% to 40%^[14–15], among which 20% and 30% reductions were the most frequently employed^[16–19]. Some studies included control groups with no nitrogen application and extreme nitrogen reduction treatments ranging from 50% to 80%^[20–21], underscoring the pivotal role of nitrogen in the nutrient regulation of flue-cured tobacco. The single reduction of nitrogen application primarily emphasizes achieving a balance between nitrogen supply and demand. Utilizing organic materials to supplement nitrogen nutrients is a relatively well-established technical approach. The pro-

portion of total coordinated reductions involving nitrogen, phosphorus, and potassium was approximately 20% , with simultaneous reductions of all three elements typically ranging from 10% to 40% . This strategy is predominantly applied in tobacco planting soils exhibiting nutrient surpluses, aiming to mitigate issues related to excessive nitrogen and imbalanced phosphorus-potassium ratios under traditional fertilization practices , thereby promoting balanced nutrient supply and minimizing environmental risks. However, this model presents regulatory challenges and necessitates the development of differentiated fertilization plans tailored to soil fertility. Distinctive reduction models, such as coordinated reductions of carbon, nitrogen, and phosphorus or reductions in potassium alone, accounted for less than 10% of applications. These approaches have generally been adapted to specific tobacco-growing regions and soil conditions, and a universally applicable technical system has yet to be established.

Regarding material selection, cake fertilizers were primarily utilized, supplemented by straw. Research focusing on the combined application or substitution of cake fertilizers accounted for over 40% of the studies. Among these, sesame cake fertilizer^[22–24] and rapeseed cake fertilizer^[4,25] were the most extensively employed, alongside oil cake fertilizer^[26] and soybean cake fertilizer^[27]. The proportion of combined application typically ranged from 10% to 50% . Cake fertilizers provide a slow release of nutrients, supply carbon sources, and enhance the quality of tobacco leaves. The amino acids and organic acids generated during their decomposition facilitate the accumulation of aroma precursor substances in tobacco leaves, aligning with the objectives of producing high-quality flue-cured tobacco. Therefore, cake fertilizer is an ideal material for organic substitution. The proportion of crop straw accounted for approximately 25% , with sources including wheat^[28], rice^[29], corn straw, and tobacco stalks^[30]. Bio-organic

fertilizer constituted roughly 20%, derived from raw materials such as edible fungi residue, medicinal residue^[31–32], mushroom residue^[33], distiller's grains, *etc.*^[34]. The application rate predominantly ranged from 10% to 30%, serving functions related to nutrient provision and the regulation of soil microorganisms. Furthermore, several studies have integrated biochar, silicon fertilizer, and other amendments to develop a composite system characterized by "nutrient supply, microbial regulation, and soil improvement", which currently represents a prominent research focus. Although the prevalence of compound application models, such as those combining chemical fertilizers, cake fertilizers, and straw, remains low, the number of published articles on this topic is increasing rapidly. These models leverage the complementary functions of diverse materials to coordinate both rapid and sustained nutrient release, thereby offering an effective technical strategy to address the limitations associated with asynchronous nutrient release from single organic materials.

3 Discussions and prospects

3.1 Development context of research and evolution of academic popularity The bibliometric analysis conducted in this study elucidates the phased developmental trajectory of research concerning chemical fertilizer reduction and straw application in flue-cured tobacco cultivation. This evolutionary pathway is closely aligned with national agricultural policy directions and the industry's demand for green transformation. During the initial exploratory phase, flue-cured tobacco was primarily regarded as an economic crop within the framework of yield enhancement through chemical fertilizer application, with research predominantly focusing on fertilizer use and yield outcomes^[35–37]. However, this period was characterized by a limited holistic understanding of the soil-crop-environment system. Subsequently, in the phase of steady development, the emergence of terms such as "bacterial wilt" and "growth" signaled a shift in research focus toward physiological and pathological aspects, encompassing microscopic mechanisms including the microbiome and root exudates. Research during this stage predominantly examined the effects of reduced chemical fertilizer application on the growth and agronomic traits of flue-cured tobacco^[38–39]. During the plateau phase, keywords such as "biochar"^[40] and "organic material" appeared prominently within clusters, reflecting the extensive involvement of soil science, materials science, and microbial ecology. Research during this period primarily concentrated on the effects of combined straw organic fertilizer application or substitution of chemical fertilizers on soil properties and microbial communities^[38,41–45]. After entering the phase of rapid expansion, the focus of research transcended mere technological enhancements, advancing toward the reconstruction of the functional services provided by agricultural ecosystems^[22,45]. This progression represents a disciplinary self-awareness, largely driven by overarching national frameworks, including the "dual carbon" objectives^[42–43,45], farmland protection red lines, and the law on quality and safety of agricultural prod-

ucts. The interplay of policy directives, technological advancements, and industrial demands has collectively facilitated the iterative refinement of research priorities. Future investigations are expected to emphasize the establishment of regulatory thresholds grounded in process simulation, comprehensive environmental impact assessments across entire life cycles, and policy scenario modeling, and there is a pressing need to develop an integrated research paradigm that spans multiple scales and disciplines.

3.2 Composition characteristics and optimization directions of chemical fertilizer reduction and combined application technology

The current system of chemical fertilizer reduction and combined applications in flue-cured tobacco cultivation has established fundamental characteristics, including diversified reduction methods, structured application materials, and integrated technical models. Nevertheless, significant potential for optimization remains. Regarding reduction methods, research predominantly focuses on the singular reduction of nitrogen application, typically employing a gradient reduction ranging from 10% to 40%, with 20% and 30% being the most common levels. In contrast, coordinated reduction models encompassing nitrogen, phosphorus, and potassium collectively account for less than 20% of studies, indicating a prevailing research bias toward "prioritizing nitrogen reduction over comprehensive nutrient management". From the perspective of application materials, cake fertilizer constitutes over 40% of usage, making it the most widely employed organic material^[46]. It serves dual functions of nutrient supply and quality control, aligning closely with the requirements for high-quality flue-cured tobacco production. The combined application of straw residues^[30,47] and bio-organic fertilizer-based materials^[48] accounts for approximately 25% and 20%, respectively. However, the application methods remain relatively limited, primarily involving the combined use of a single material. Research on multi-component compound regulation involving "straw, bio-organic fertilizer and chemical fertilizer" is lacking. Although compound application methods are increasing, challenges such as poor material compatibility, asynchronous nutrient release, and insufficient regional specificity persist. A standardized and promotable technical system has yet to be established.

3.3 Research limitations and prospective directions for future development

In recent years, tobacco production has increasingly emphasized the practice of straw returning to the field. Numerous studies have investigated the reduction of chemical fertilizers and the application of various types of straw-based organic fertilizers through approaches such as site-specific fertilization experiments^[18] and field trials^[3,31,40,49]. These studies have examined the effects of decreasing chemical fertilizer usage and applying different proportions of straw-based organic fertilizers on nutrient accumulation during tobacco growth^[28], plant development^[50–51], chemical composition and quality attributes of tobacco leaves post-roasting^[52], soil fertility and enzyme activity in tobacco planting soils^[53], soil microbial communities^[31,38–39,44], as well as the overall impact of continuous chemical fertilizer reduction

combined with different organic fertilizer applications on the ecological stoichiometric characteristics of carbon, nitrogen, and phosphorus in tobacco planting soils^[44]. Current research predominantly emphasizes reducing the use of chemical fertilizers while maintaining total nitrogen levels, increasing the application of straw-based organic fertilizers^[54], or comparing the effects of reducing chemical fertilizer application with the combined use of various straw organic fertilizers. Generally, nitrogen reduction alone is the primary focus, but studies addressing the coordinated reduction of nitrogen, phosphorus, and potassium remain insufficient. This limitation hinders the ability to meet the nutrient requirements of tobacco-growing regions with varying soil fertility. The application of mixed materials is often imbalanced, with an excessive proportion of cake fertilizer, and the utilization models for straw and other materials are relatively singular. Research on the coupling mechanisms between reduction ratios and applied materials lacks depth, resulting in inadequate analysis of the synergistic interactions among nutrient release, soil microbial succession, and tobacco leaf quality formation. The regional specificity of current practices is limited, and there is an absence of technical regulations categorized by climate, soil type, and planting systems. Future development should prioritize differentiated reduction strategies based on soil fertility classifications, enhance the coordinated management of nitrogen, phosphorus, and potassium, and advance research on the synergistic effects of varying reduction ratios and combined application materials. It is essential to establish a chemical fertilizer reduction and combined application technology system tailored to the soil fertility characteristics of distinct tobacco-growing regions. A multi-component compound application model incorporating "straw, bio-organic fertilizer, and chemical fertilizer" should be developed to improve the synchronized nutrient supply capacity. Long-term field experiments are necessary to elucidate the interaction mechanisms among soil, crops, and the environment. Furthermore, a standardized technical framework for zoning and classification should be implemented to facilitate the practical application of research findings. Ultimately, the coordinated advancement of chemical fertilizer reduction, soil conservation, quality enhancement, and ecological security will support the high-quality, green, and sustainable development of the flue-cured tobacco industry.

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6.9 Management after pruning in the following year After the second pruning is completed, soil fertility management should still be carried out, but the fertilizer application rate can be reduced by one-third compared with that described in Section 6.3. Pest and disease control, canopy protection, and tipping and leveling should be performed following the procedures and requirements specified in Sections 6.4, 6.5, and 6.6, respectively.

6.10 Spring tea plucking in the third year During the spring tea plucking in the third year, pickers should be organized to harvest all sprouted new buds on the retained branches as fully as possible. At this time, the spring tea yield is relatively high, generally increasing by about 100% compared with that in the second year, reaching 2 to 3 times the yield before heavy pruning. This truly achieves the purpose of renovating low-yielding tea plantations, realizing increased production, higher income, improved quality, and enhanced economic efficiency.

7 Conclusions

Renovation technologies for low-yielding tea plantations represent a continuously applied set of practices in tea-growing regions. However, due to differences in the technical proficiency of individual tea farmers, the operational procedures are not entirely consistent, leading to vastly different renovation outcomes. In particular, when considerable time and effort are invested in the renovation process without achieving the expected goals of increased production and income, the losses can be substantial, severely affecting farmers' normal earnings as well as their enthusiasm and confidence in tea cultivation. Two points need to be emphasized: first, the technical measures for renovating low-yielding tea plantations by heavy pruning, as elaborated in this paper, constitute a complete technical system in which all measures and steps are mutually complementary. In practice, it is essential to avoid taking

isolated measures out of context (for example, focusing only on pruning while neglecting soil fertility management or pest and disease control) as this may easily lead to poor renovation results or even complete failure. Second, the technical measures proposed in this paper are formulated based on the predominant cultivation of small to medium-leaf tea cultivars in Sichuan and the primary practice of plucking spring tea (particularly premium teas such as single buds, one-bud-and-one-leaf, and one-bud-and-two-leaves). If the tea cultivars, plucking standards, tea categories produced, or climatic and environmental conditions differ, the technical measures presented herein should serve only as a reference and should not be applied mechanically without adaptation.

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