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Patenting Trends in Agricultural Climate Innovation: A Global Analysis with a Focus on China

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Abstract: Agriculture faces mounting pressure to both adapt to climate change and mitigate its environmental impact. Green technology innovation is central to this challenge, yet little is known about how global patenting trends reflect the balance between adaptation and mitigation efforts. This study analyzes 13,727 agricultural climate-related patent families to assess temporal, geographical, and institutional patterns in innovation. The results reveal that adaptation technologies dominate the patent landscape, with innovations focusing on water management, soil stabilization, and climate-resilient crops, whereas explicit mitigation technologies, such as carbon sequestration and low-emission fertilizers, remain limited. China emerges as the overwhelming leader in agricultural climate patents, driven by state-led research funding and policy incentives, particularly during the 2016–2017 surge. However, the high abandonment rate of Chinese patents suggests a short-term, institution-centric patenting strategy rather than sustained commercialization. In contrast, U.S., German, and Japanese firms maintain patents as strategic assets with stronger long-term retention. The study highlights key policy and market implications, emphasizing the need for greater industry engagement and cross-sector collaboration to ensure that green agricultural technologies transition from research outputs to commercially viable solutions.

Keywords: *Green Patents; Climate Change; Agriculture;*

1. Introduction

Climate change poses challenges to global agriculture, requiring adaptation and mitigation strategies (Malhi et al., 2020; Grigorieva et al., 2023). Green technological innovation, often tracked through patents, plays a key role in this transition (Favot et al., 2023; Fabrizi et al., 2018). China leads in agricultural green patenting due to regulatory policies and state-driven innovation (Deng et al., 2022; Sun, 2022), yet many patents are abandoned before commercialization (Tolliver et al., 2020). Trust in environmental policies also affects technology adoption (Cologna & Siegrist, 2020; Zhang et al., 2020). This study examines patent trends to assess policy-driven innovation and its global impact (VijayaVenkataRaman et al., 2011).

2. Methodology

2.1 Data Collection & Scope

This study examines patent families related to agricultural climate adaptation and mitigation, sourced from Orbit Intelligence, a leading patent analytics platform. The dataset includes 13,743 patent families filed until December 31, 2024, covering inventions related to climate-resilient agricultural technologies. After data cleaning, removing duplicates and erroneous entries, the final dataset comprises 13,727 unique patent families. The focus is on patents that provide technological solutions for climate change adaptation (e.g., drought-resistant crops, soil conservation) and mitigation (e.g., carbon sequestration, emission reduction in farming).

2.2 Patent Search Strategy

Patents were identified using International Patent Classification (IPC) and Cooperative Patent Classification (CPC) codes, covering climate mitigation (Y02P) and adaptation (Y02A) technologies, including water-saving irrigation (A01G-025/00), biopesticides (A01N-025/00), and soil stabilization (E02D-003/00).

2.3 Data Processing

Duplicates were removed, assignee names standardized, and legal status categorized as Alive (granted/pending) or Dead (lapsed/revoked/expired), with manual verification ensuring accuracy.

2.4 Patent Analysis

Patents were analyzed across:

1. **Temporal Trends** – Filing patterns over time.
2. **Geographical Distribution** – Leading patenting countries.
3. **Assignees & Inventors** – Key institutional and corporate players.
4. **Technological Landscape** – Categorization by domain.
5. **Legal Status** – Patent retention and abandonment rates.

3. Results

3.1 Temporal Trends

Patent filings surged post-2010, peaking in 2017 (1,555 applications) due to policy interventions. A decline post-2022 suggests shifting priorities.

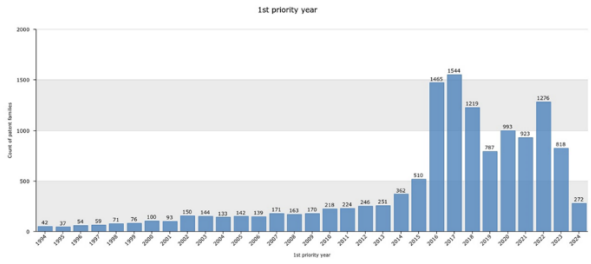

Figure 1. First Priority Year (1994-2024)

3.2 Geographical Distribution

China dominates with 10,088 priority filings, nearly 10× the U.S. (1,185), followed by Japan (1,113), South Korea (286), and the European Patent Office (266).

3.3 Assignees & Inventors

Chinese universities and institutes lead patenting, while Western firms (e.g., BASF, Corteva Agriscience) focus on long-term strategic protection. Over 95% of top inventors are Chinese.

3.4 Technological Trends

Most patents focus on adaptation, with key areas in chemistry (pesticides, fertilizers) and engineering (irrigation, mechanization). Soil stabilization (1,572 patents) and precision irrigation (386 patents) are prominent.

3.5 Legal Status

63.2% of patents are inactive, with 38.9% abandoned for non-payment. China exhibits high short-term filing rates, while U.S. and European firms maintain patents longer.

4. Discussion

China leads in agricultural climate innovation but follows a different patenting strategy than the West. Adaptation technologies dominate, reflecting policy priorities, while mitigation efforts remain limited. A peak in 2016–2017 aligns with China's Five-Year Plan and *Made in China 2025*, though high abandonment rates suggest patents often serve research performance metrics rather than commercialization. The post-2020 decline may indicate a policy shift toward mitigation. Strengthening university-industry collaboration and enhancing IP utilization through licensing could improve commercial impact.

5. Conclusion

Agricultural green innovation remains adaptation-focused, with China filing the most patents but facing high abandonment rates. Weak commercialization pathways limit impact, necessitating research on adoption and industry engagement strategies.

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