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## PRECISION FARMING AND PATENTING IN AGRICULTURAL SUSTAINABILITY

~ *Malavika Nambiar P*

### Introduction

The 1960s marked a pivotal moment in agricultural history with the emergence of the need for a Green Revolution. This transformative period was driven by the urgent necessity to increase food production and enhance the quality of food crops to meet the demands of a rapidly growing global population.<sup>1</sup> The first Green Revolution introduced groundbreaking new technologies, including high-yielding varieties of seeds, synthetic fertilizers, pesticides, advanced irrigation techniques, and the mechanization of farming practices. These innovations significantly boosted agricultural productivity and helped avert widespread hunger in many parts of the world.<sup>2</sup>

However, as we move deeper into the 21st century, the agricultural sector faces new challenges that call for another wave of innovation: the Second Green Revolution, often referred to as Precision Farming. This modern phase emphasizes the integration of cutting-edge technologies to optimize farming practices. Precision farming involves the use of GPS technology, data analytics, drones, IoT devices, and other advanced tools to monitor and manage crops with unprecedented accuracy. This approach aims to maximize yields, reduce resource usage, and minimize environmental impact, thereby ensuring long-term agricultural sustainability.

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<sup>1</sup> Parul Rishi, *Green Revolution in India, Objectives, Significance, History*, PHYSICS WALLAH, March 14, 2024, <https://www.pw.live/exams/ssc/green-revolution-in-india/> (last visited Jun 1, 2024).

<sup>2</sup> Autumn Spanne, *Green Revolution: History, Technologies, and Impact*, TREEHUGGER, June 23, 2021, <https://www.treehugger.com/green-revolution-history-technologies-and-impact-5189596> (last visited Jun 1, 2024).

A crucial aspect of this technological evolution in agriculture is the role of intellectual property, particularly patenting. As new technologies and innovations emerge, patenting becomes essential to protect the intellectual property rights of inventors and companies.<sup>3</sup> This protection incentivizes further research and development, leading to continuous improvements in agricultural practices. However, the intersection of precision farming and patenting also raises important questions about access, equity, and the global distribution of technological benefits.<sup>4</sup>

In this article, we will explore the intricate relationship between precision farming and patenting within the context of agricultural sustainability. We will examine how precision farming technologies are revolutionizing agricultural practices, the role of patents in fostering innovation, and the potential implications for farmers, consumers, and the environment. By understanding these dynamics, we can better appreciate the opportunities and challenges that lie ahead in our quest for a sustainable and equitable agricultural future.

### Precision Agriculture: Optimizing Agricultural Production

Precision agriculture (PA) is a comprehensive system designed to optimize agricultural production through the application of crop information, advanced technologies, and management practices. According to Professor Pierre C. Robert, "PA basically means adding the right amount of input at the right time and the right location within a field. It's all about managing specific sites following the fundamentals of 3R."<sup>5</sup> This innovative approach focuses on the precise management of agricultural inputs such as water, fertilizers, and pesticides to enhance crop yields, reduce waste, and promote environmental sustainability.

By leveraging tools such as GPS technology, remote sensing, data analytics, and variable rate technology (VRT), precision agriculture enables farmers to make informed decisions tailored to the unique conditions of specific areas within their fields. This site-specific management strategy helps in efficiently utilizing resources, thereby improving overall farm productivity and

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<sup>3</sup> Giovanni Avola et al., *Precision agriculture and patented innovation: State of the art and current trends*, 76 WORLD PATENT INFORMATION 102262 (2024).

<sup>4</sup>ibid

<sup>5</sup> SANJEEV KUMAR, S.N. SARAVAIYA & A.K. PANDEY, *PRECISION FARMING AND PROTECTED CULTIVATION: CONCEPTS AND APPLICATIONS* (2021), <http://dx.doi.org/10.1201/9781003196846> (last visited Jun 1, 2024).

profitability.<sup>6</sup> As a result, precision agriculture represents a significant advancement in modern farming, contributing to the sustainability of agricultural systems in the face of growing global food demands and environmental challenges.

### Precision Agriculture and Agricultural Sustainability

Precision agriculture offers numerous benefits, particularly in the efficient utilization of resources and improved efficiency. By leveraging advanced technologies and machinery, farmers can significantly enhance the efficiency of labor, land, and time in their farming operations. Tools such as GPS-guided equipment, automated machinery, and sensor-based technologies streamline various farming tasks, ensuring that every input is used optimally and effectively.<sup>7</sup>

Another key advantage of precision agriculture is data-driven decision-making. This approach enables farmers to make science-based, real-time decisions by providing site-specific knowledge through technology and data analytics.<sup>8</sup> With access to detailed information from sources like soil sensors, weather stations, and satellite imagery, farmers can tailor their management practices to the specific conditions of their fields. This precision leads to improved productivity and sustainability, optimizing crop performance and resource use efficiency.

Reducing the environmental impact of farming is a significant benefit of precision agriculture. The implementation of Variable Rate Technology (VRT) and the timely application of agrochemicals and precision irrigation systems help minimize environmental harm.<sup>9</sup> VRT ensures that fertilizers and pesticides are applied only where and when they are needed, reducing runoff and pollution. Precision irrigation systems deliver water directly to plant root zones, conserving water and preventing over-irrigation.

Precision sustainable agriculture also fosters transdisciplinary research by bringing together researchers from various disciplines, stakeholders, and farmers to address common agricultural

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<sup>6</sup> Jennifer Clapp & Sarah-Louise Ruder, *Precision Technologies for Agriculture: Digital Farming, Gene-Edited Crops, and the Politics of Sustainability*, 20 GLOBAL ENVIRONMENTAL POLITICS 49 (2020).

<sup>7</sup> Prof. Dr. Peter Kogut, *Precision Agriculture: Technology To Boost Crop Farming*, EOS DATA ANALYTICS (2022), <https://eos.com/blog/precision-agriculture/> (last visited Jun 1, 2024).

<sup>8</sup> R. Bongiovanni & J. Lowenberg-Deboer, *Precision Agriculture and Sustainability*, 5 PRECISION AGRICULTURE 359.

<sup>9</sup> The Environmental Benefits of Precision Agriculture - ATLAS, ATLAS - AGRICULTURAL INTEROPERABILITY & ANALYSIS SYSTEM (2021), <https://www.atlas-h2020.eu/the-environmental-benefits-of-precision-agriculture/> (last visited Jun 1, 2024).

challenges collaboratively.<sup>10</sup> This collaborative approach promotes innovation, accelerates the adoption of new technologies, and supports the development of practical solutions for sustainable farming practices. These diverse groups can devise and implement strategies that enhance agricultural sustainability by working together.

The fundamental goals of sustainable agriculture environmental health, economic profitability, and social and economic equity are often referred to as the “three legs” of the sustainability stool.<sup>11</sup> Precision agriculture plays a crucial role in achieving these goals by promoting practices that protect natural resources, increase farm profitability, and ensure equitable access to the benefits of technological advancements.

### Patent Analysis in Precision Agriculture

Patents play a crucial role in shaping the trajectory of precision farming by incentivizing innovation and technological advancement in agricultural practices.<sup>12</sup> By providing legal protection for new technologies and methods developed for precision agriculture, patents encourage investment in research and development. This legal framework ensures that inventors and companies can benefit from their innovations, fostering a continuous cycle of improvement and the adoption of cutting-edge technologies in farming.

### Phases of Technological Development in Precision Agriculture<sup>13</sup>

The evolution of precision agriculture can be traced through four distinct phases of technological development<sup>14</sup>:

**Motorized Mechanization (1960-1999):** During this period, the primary innovations were related to machinery and device control. This phase focused on mechanizing farm operations, significantly

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<sup>10</sup> Jessica Lindblom et al., *Promoting sustainable intensification in precision agriculture: review of decision support systems development and strategies*, 18 *PRECISION AGRICULTURE* 309 (2016).

<sup>11</sup> Sustainable Agriculture, LEARN SCIENCE AT SCITABLE, <https://www.nature.com/scitable/knowledge/library/sustainable-agriculture-23562787/> (last visited Jun 1, 2024).

<sup>12</sup> Wanderson de Vasconcelos Rodrigues da Silva & Renata Silva-Mann, *Precision Agriculture: technological monitoring based on patent analysis*, 11 *RESEARCH, SOCIETY AND DEVELOPMENT* e42611326852 (2022).

<sup>13</sup> Giovanni Avola et al., *Precision agriculture and patented innovation: State of the art and current trends*, 76 *WORLD PATENT INFORMATION* 102262 (2024).

<sup>14</sup> *ibid*

increasing efficiency and productivity. The introduction of motorized equipment transformed traditional farming practices, laying the groundwork for more advanced technologies in the future.

**Mechanical Automation (2000-2009):** This phase saw the improvement of existing mechanization tools by adding precision functions for various farm operations. Innovations such as automated irrigation systems and crop harvesting machines emerged, enhancing the accuracy and effectiveness of agricultural processes. These advancements built upon the foundation of motorized mechanization, further streamlining farming operations.

**Digital Mechanization (2010-2019):** The integration of digital technologies into agricultural machinery and processes marked this phase. Key advancements included the use of drones for aerial crop monitoring and mapping, and GPS-guided tractors. These technologies enabled more precise management of farm activities and resource use, transforming how farmers monitor and manage their fields.

**Digital Automation (2010-present):** In this ongoing phase, digital technologies have further upgraded existing mechanical tools by incorporating precision functions such as sensors and controllers. Unmanned aerial vehicles (UAVs) equipped with AI image processing technologies now provide aerial imagery for monitoring crop health, detecting issues in farm plots, and recommending actions to optimize crop management practices. Additionally, innovations like the Fasal Kranti, a solar-powered IoT device for precision farming, employ sensors to measure various macro-climatic and micro-climate conditions. Data collected from such devices is processed into actionable advisories for farmers, who receive farm-specific recommendations via a mobile app.

#### Fasal Kranti: An Innovation in Precision Farming

Fasal Kranti is an Indian-based innovation in precision farming that exemplifies the integration of IoT and advanced sensor technologies. This solar-powered IoT device employs sensors to measure various macro-climatic and micro-climate conditions.<sup>15</sup> Macroclimates refer to the overall climate

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<sup>15</sup> Agriculture Post, *Fasal wins patent for Fasal Kranti, a solar-powered IoT device for precision farming*, AGRICULTURE POST (2022), <https://agriculturepost.com/agritech/fasal-wins-patent-for-fasal-kranti-a-solar-powered-iot-device-for-precision-farming/> (last visited Jun 1, 2024).

of a large geographic area, while microclimates are localized climates of a small-scale area affected by topography, soil, and vegetation.

The data collected from the Fasal Kranti device undergoes processing to generate actionable advisories for farmers. These advisories, delivered through a mobile app, are tailored to specific farm conditions and provide preventive assistance for disease and pest control, alerting farmers on which treatments to use and when to use them.<sup>16</sup> The irrigation advisory feature helps save water by providing the right amount of water required at the right time. By facilitating the easy transfer of data through a network of connected software and sensors, Fasal Kranti supports efficient and sustainable farming practices.<sup>17</sup>

Thus, patents are crucial for fostering innovation and technological advancement in precision farming, providing the necessary legal protection and incentives for research and development. The distinct phases of technological development in precision agriculture have led to significant efficiency, productivity, and sustainability improvements, with innovations like Fasal Kranti demonstrating the potential of IoT and digital technologies to revolutionize farming practices.

## Conclusion

Precision agriculture is vital for achieving agricultural sustainability, optimizing resource use, and improving productivity while minimizing environmental impacts. By integrating advanced technologies such as GPS, IoT, drones, and data analytics, precision agriculture allows for precise management of farming practices, resulting in enhanced efficiency and reduced wastage of resources like water and fertilizers.<sup>18</sup>

Patents play a crucial role in this domain by creating a competitive environment that motivates continuous improvement in precision farming solutions. They provide legal protection for new inventions, ensuring that innovators can benefit from their developments, which in turn encourages investment in research and development. This legal framework fosters technological progress by

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<sup>16</sup> *ibid.*

<sup>17</sup> Himani Kamboj, *The newly patented Fasal Kranti: The journey so far*, FASAL, April 4, 2022, <https://medium.com/fasalapp/the-newly-patented-fasal-kranti-the-journey-so-far-a7cb387de51a> (last visited Jun 1, 2024).

<sup>18</sup> Manju Gerard, R Kalpana Sastry & K Srinivas, *Patent landscape for Internet of Things (IoT) in agriculture in India*, 35 AGRICULTURAL ECONOMICS RESEARCH REVIEW 101 (2022).

safeguarding the interests of inventors and companies, allowing them to recoup their investments and reinvest in further advancements.

Moreover, patents encourage diverse stakeholders, including researchers, technology developers, and agribusinesses, to contribute to precision farming innovation. This collaborative approach leads to a broad array of solutions that can address agricultural challenges globally, from improving crop yields and reducing environmental impact to enhancing food security and farmer profitability.<sup>19</sup> By promoting a culture of innovation and collaboration, patents ensure that precision agriculture continues to evolve, supporting the development of sustainable and efficient farming practices.<sup>20</sup>

In summary, the synergy between precision agriculture and patents is essential for driving the future of farming. Patents not only protect and incentivize innovation but also stimulate a diverse and dynamic ecosystem of stakeholders working towards common goals. This ongoing technological advancement is crucial for meeting the growing global food demand sustainably, preserving natural resources, and ensuring economic viability for farmers worldwide.

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<sup>19</sup> Yafei Li et al., *Agricultural technology as a driver of sustainable intensification: insights from the diffusion and focus of patents*, 44 *AGRONOMY FOR SUSTAINABLE DEVELOPMENT* (2024).

<sup>20</sup> Challenges and Opportunities in Precision Agriculture, , in *SOIL-SPECIFIC FARMING* 406 (2015), <http://dx.doi.org/10.1201/b18759-20> (last visited Jun 1, 2024).