Journal of Informatics Education and Research
ISSN: 1526-4726
Vol 5 Issue 2 (2025)

Flying into the Future: A Cross-Cultural Examination of Nano-Drone Adoption in India and The Netherlands

[1]Pashma
[2] Jolly Masih
[3] Sameer Yadav
[4] Pratisha Agrawal
[5] Pawani Chadha
BML Munjal University
Gurugram
India

Abstract
This study investigates the adoption of nano-drone technology in precision agriculture, specifically examining farmers in India and the Netherlands. Nano-drones, equipped with AI-integrated sensors and high-resolution cameras, offer substantial potential for enhancing agricultural productivity and sustainability. They facilitate applications such as early pest detection and precise resource management, thus reducing environmental impact through the efficient use of pesticides and water. However, adoption rates are influenced by a complex interplay of socio-economic, cultural, and regulatory factors, as well as technological readiness, which vary across regions. A mixed-methods approach was utilised, combining qualitative and quantitative data collection with social media analysis. Semi-structured interviews with 40 farmers, alongside expert consultations, provided insights into farmers' attitudes, experiences, and expectations. A survey of 100 farmers (50 from each country) was conducted to assess awareness, adoption rates, perceived benefits, and barriers. The findings revealed that Dutch farmers exhibited greater awareness and adoption of nano-drone technology, with 40% demonstrating high awareness, compared to 30% of Indian farmers. Adoption rates were also higher in the Netherlands, where 30% of farmers had witnessed nano-drones in use, compared to 12% in India. Barriers to adoption were more pronounced in India, where 70% of farmers cited cost as a major obstacle, compared to 50% in the Netherlands. Both groups acknowledged the potential environmental benefits, with 60% of Indian farmers and 55% of Dutch farmers identifying sustainability as a primary motivator. The study underscores the need for tailored policies, financial support, and region-specific training to foster broader adoption of nano-drones in precision agriculture.

Keywords: Nano-drone technology, precision agriculture, farmer perceptions, technology adoption, socio-economic barriers

1. Introduction

The agricultural sector is currently navigating a critical juncture, tasked with addressing the growing global food demand while simultaneously reducing its environmental impact and enhancing the sustainability of production systems. These dual pressures have catalysed a substantial push towards the adoption of advanced technological solutions across the agricultural value chain. One of the most promising innovations in this domain is nanotechnology, which presents a range of applications capable of revolutionising agricultural practices. A particularly notable advancement within this field is the development of nano-drones—small, lightweight unmanned aerial vehicles (UAVs), typically weighing less than 250 grams. These drones are designed to improve precision and efficiency in agricultural operations by enabling targeted interventions, high-resolution real-time monitoring, and optimised resource management strategies (Mogili & Deepak, 2018; Maes & Steppe, 2019). The compact size and enhanced manoeuvrability of nano-drones provide access to intricate, spatially variable field environments, offering significant advantages over larger aerial platforms and traditional ground-based monitoring methods.

The potential of nano-drones lies in their capacity to capture high-resolution multispectral and thermal imagery, which allows for early detection of plant stress, disease, and nutrient deficiencies. This timely and spatially explicit data empowers farmers to implement targeted interventions, such as the precise application of fertilisers and pesticides only where and when needed. This approach reduces the overall use of agrochemicals, mitigating environmental degradation and off-target effects on biodiversity and human health, while also improving crop yields and enhancing resource use efficiency. Furthermore, the integration of nano-sensors, capable of gathering diverse environmental and plant physiological data, alongside sophisticated data analytics platforms, facilitates the development of intelligent decision support systems. These systems optimise irrigation schedules based on real-time soil moisture readings and evapotranspiration rates and enable the implementation of integrated pest management strategies, thus reducing reliance on broad-spectrum chemical treatments (Radoglou-Grammatikis et al., 2020; Yallappa et al., 2017).

However, the translation of this technological potential into widespread practical application within agricultural systems is not uniform across different geographical regions. The pace and extent of nano-drone adoption are influenced by a complex interplay of socio-economic conditions, cultural norms, and infrastructure. Technologically advanced nations, such as The Netherlands, have demonstrated a relatively rapid assimilation of smart farming technologies, including sensor networks, autonomous machinery, and advanced data analytics infrastructure, which has facilitated the integration of nano-drones (Barnes et al., 2019; Kernecker et al., 2020). In contrast, countries like India face several barriers to adoption, including financial constraints that limit access to advanced technologies for smallholder farmers, limited access to specialised training, and uncertainties surrounding regulatory frameworks for unmanned aerial systems (Pathak et al., 2019; Kutter et al., 2011). Additionally, the diversity of agricultural practices, farm sizes, and socio-economic conditions in large and heterogeneous countries like India further complicates the uniform adoption of such technologies, requiring tailored approaches to meet the unique needs of different farming communities (Bryman, 2016; Creswell & Plano Clark, 2017).

This paper presents a comparative analysis of the perceptions of farmers in India and The Netherlands regarding the adoption of nano-drone technology. The study examines levels of awareness, perceived benefits, practical barriers, and socio-cultural influences that shape attitudes towards the integration of these technologies. By exploring these factors, the research aims to generate insights that will inform technology developers, policymakers, and agricultural stakeholders, enabling them to tailor their strategies to the specific needs and constraints of different regions. Ultimately, this work seeks to contribute to the equitable and sustainable adoption of nano-drones across global agricultural systems (Kutter et al., 2011; Michels et al., 2020). Through this comparative lens, the research will foster a deeper understanding of the factors influencing the uptake of agricultural technologies, facilitating the integration of nano-drones in a manner that supports enhanced productivity, resource management, and environmental stewardship.

2. Literature Review

The emergence of nanotechnology has opened new avenues for innovation in precision agriculture, offering tools for enhanced productivity, resource efficiency, and sustainability. Nanomaterials, defined by their structural dimensions within the 1–100 nanometre range, exhibit unique physicochemical properties that have been successfully harnessed across various domains—including electronics, medicine, and now, agricultural science (Maes & Steppe, 2019). In agriculture, nanotechnology has been primarily leveraged through the deployment of nanosensors, nano-fertilisers, nano-pesticides, and drone-enabled delivery mechanisms.

Nano-drones, equipped with high-resolution cameras and AI-integrated sensors, represent a significant leap in precision farming. Their applications span from early disease detection to spatial variability analysis in soil fertility, facilitating timely and precise interventions (Mogili & Deepak, 2018). They enable a marked reduction in chemical input use by targeting specific areas, thereby addressing environmental concerns linked to over-fertilisation and pesticide runoff. Studies by Tarafdar et al. (2012) and Mukhopadhyay et al. (2017) further validate the potential of nano-formulations in enhancing nutrient absorption, soil health, and crop resilience—particularly in water-scarce regions.

Nonetheless, the adoption of nano-technologies is shaped not only by technical efficacy but also by socio-economic and behavioural dimensions. The Technology Acceptance Model (TAM) and related adoption frameworks suggest that ease of use, perceived usefulness, and social influence are critical predictors of technology uptake in agriculture (Pierpaoli et al., 2013; Kernecker et al., 2020). Furthermore, region-specific constraints—such as regulatory environments, financial capacity, and cultural perceptions—can either impede or accelerate diffusion.

In developed nations like The Netherlands, favourable regulatory frameworks, high technological literacy, and institutional support have fostered early and widespread adoption of agri-tech solutions (Eastwood et al., 2017). In contrast, smallholder-dominated economies such as India face structural barriers including fragmented landholdings, limited access to finance, and inadequate training infrastructure. Social dynamics, particularly the role of farmer cooperatives and community-led initiatives, play a pivotal role in mediating access and acceptance.

The current literature thus calls for a contextualised understanding of technology adoption. This study addresses this gap by contrasting two distinct geographies—India and The Netherlands—to explore how localised socio-cultural and economic conditions influence farmers' perspectives on nano-drones. The analysis contributes to a more nuanced global discourse on agri-innovation and offers insights for designing inclusive, scalable, and sustainable technology dissemination strategies.

3. Research Methodology

This study adopted a sequential, cross-sectional mixed-methods research design, combining qualitative and quantitative data collection with social media analysis. The dual objectives were to explore the perceptions of farmers regarding nano-drones and to identify context-specific factors that influence adoption in India and The Netherlands.

3.1 Qualitative Phase

The qualitative component was designed to capture the lived experiences, beliefs, and expectations of farmers in both regions. Semi-structured interviews were conducted with a purposely selected sample of 20 farmers per country, supplemented by 5 agricultural experts and key stakeholders. The selection criteria ensured diversity in farm size, crop type, and technological exposure.

The interviews were guided by a literature-informed framework, focusing on variables such as awareness, perceived advantages, socio-cultural influences, and institutional support. Wherever feasible, interviews were conducted in person; virtual sessions were arranged in cases of geographic or logistical constraints. Audio recordings were transcribed verbatim and complemented by field notes. Reflexivity was maintained through a researcher journal to minimise bias (Ortlipp, 2008).

3.2 Quantitative Phase

Building upon insights from the qualitative phase, a structured survey was developed to quantitatively assess variables such as awareness levels, perceived barriers, willingness to adopt, and training needs.

Journal of Informatics Education and Research
ISSN: 1526-4726
Vol 5 Issue 2 (2025)

The instrument underwent a pilot test to ensure validity and clarity. The final survey was administered to 100 farmers (50 in India, 50 in The Netherlands), with data collected through both in-person and online means. The sample was stratified to represent regional, economic, and educational diversity.

The sample size was determined using power analysis as per Cohen (1992), ensuring statistical reliability. Descriptive and inferential statistics were employed to analyse survey data, while thematic coding was applied to qualitative transcripts. Data triangulation was employed to cross-validate findings from interviews, surveys, and social media content.

4. Data Analysis and Findings

This section presents a detailed examination of the empirical results obtained through surveys and interviews conducted with farmers across India and the Netherlands. The analysis offers insights into demographic variations, awareness levels, perceived advantages, barriers to adoption, social and cultural influences, environmental considerations, ease of use, and farmers' support expectations concerning nano-drone technology.

4.1 Farmer Demographics

A total of 100 farmers were surveyed across various Indian and Dutch regions, representing a wide array of landholding sizes, educational qualifications, and agricultural practices. Of these respondents, 52% were small-scale farmers (owning less than 2 hectares), 30% were categorised as medium-scale (2–5 hectares), and 18% were large-scale (exceeding 5 hectares) (*see Fig 1*).

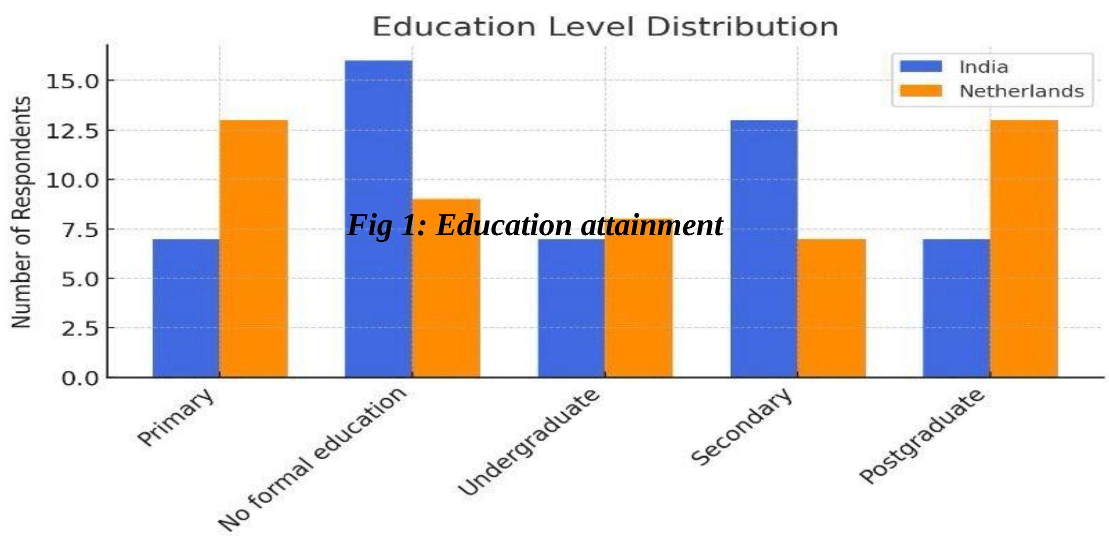

Fig 1: Education attainment

Educational attainment varied notably among participants, with 22% reporting no formal education. Additionally, 46% had completed primary or secondary-level education, while 32% had attained higher secondary or undergraduate qualifications.

A comparative analysis of educational backgrounds between Indian and Dutch farmers reveals distinct trends: Dutch farmers exhibit a higher incidence of postgraduate education, while Indian farmers display a greater concentration at the primary and secondary education levels. This disparity is indicative of the differing preparedness for technology adoption.

Journal of Informatics Education and Research
ISSN: 1526-4726
Vol 5 Issue 2 (2025)

4.2 Awareness and Adoption Trends

The study found significant differences in the sources of agricultural knowledge between Indian and Dutchfarmers(*seeFig2*).

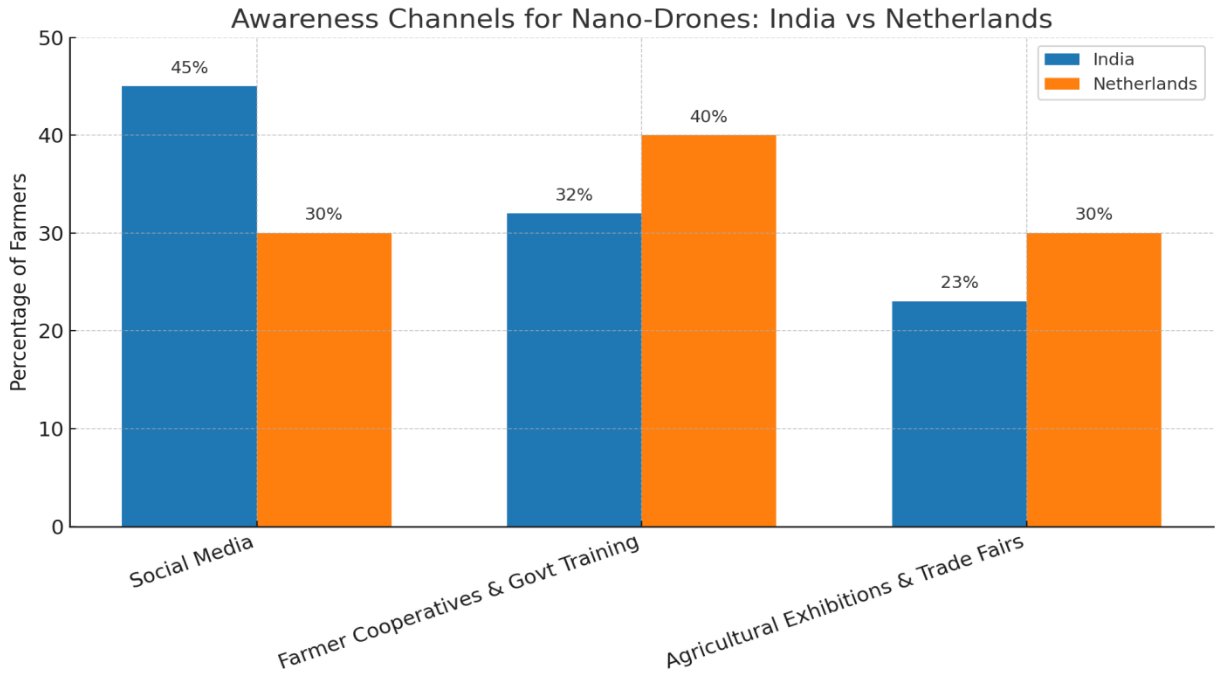

Fig 2: Awareness Channels

In India, 45% of farmers reported learning about agricultural technologies through social media platforms such as YouTube, Facebook, and WhatsApp, highlighting the growing role of digital platforms in shaping agricultural practices. This was notably higher than the 30% of Dutch farmers who turned to social media for information, suggesting that social media is a more prevalent and trusted source of learning for Indian farmers. The findings indicate that Indian farmers are increasingly relying on digital tools to access agricultural knowledge, possibly due to limited access to traditional resources or a more active engagement with online platforms.

On the other hand, 32% of Indian farmers acquired knowledge through farmer cooperatives and government-led training initiatives, which was lower than the 40% of Dutch farmers who benefited from these traditional learning channels. This indicates that while formal agricultural education structures are important in both countries, they are relatively more effective or widely utilized in the Netherlands. Additionally, 23% of Indian farmers were introduced to agricultural technologies at exhibitions and trade fairs, which is slightly lower than the 30% in the Netherlands. This suggests that while exhibitions and trade fairs serve as a platform for knowledge exchange in both countries, they might have a greater impact in the Netherlands, where such events may be more established or better attended.

Despite the encouraging levels of awareness, adoption remains limited: only 30% of respondents had observed a nano-drone in operation, and merely 12% had personally utilised one on their farms. Younger and more educated farmers demonstrated significantly higher openness towards experimentation and adoption.

4.3 Perceived Benefits of Nano-Drones

The findings reveal notable differences in the perceived benefits of agricultural technology adoption between Indian and Dutch farmers (*see Fig 3*).

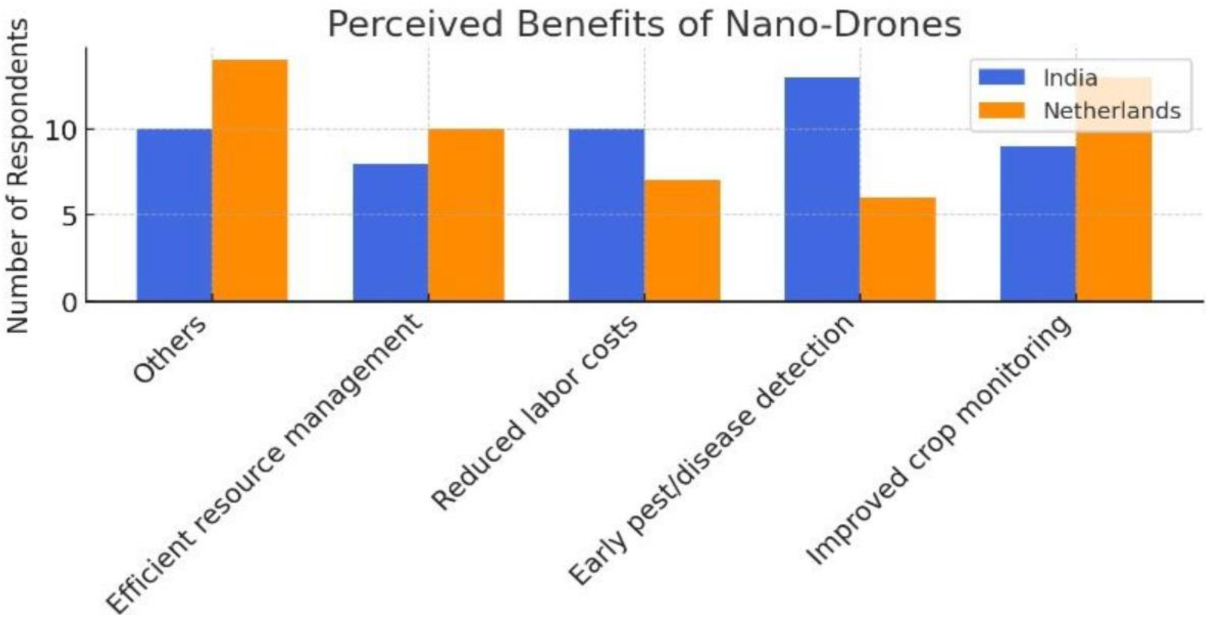

Fig 3: Perceived Benefits

In terms of efficient resource management, only 10% of Indian farmers (N=5) reported significant improvement, compared to 20% (N=10) of their Dutch counterparts, indicating a relatively greater impact in the Netherlands. Conversely, a higher proportion of Indian farmers (20%, N=10) reported a reduction in labour costs due to technology adoption, in comparison to 16% (N=8) in the Netherlands, suggesting that labour-saving technologies may hold more value or necessity in the Indian agricultural context.
With respect to early pest and disease detection, 30% of Indian farmers (N=15) identified this as a major benefit, substantially exceeding the 12% (N=6) of Dutch farmers who did the same. This suggests that such capabilities are particularly critical in India, potentially due to greater vulnerability to pests and diseases. However, when considering improved crop monitoring, 26% (N=13) of Dutch farmers acknowledged its benefits, compared to 18% (N=9) of Indian farmers, indicating a stronger emphasis or effectiveness of monitoring technologies within the Dutch agricultural system.

4.4 Barriers to Adoption

The survey identified substantial challenges hindering adoption (*see Fig 4*).

Fig 4: Perceived Barriers

Journal of Informatics Education and Research
ISSN: 1526-4726
Vol 5 Issue 2 (2025)

The study indicated that both Indian and Dutch farmers experienced a comparable lack of support, with 26% (N=13) of respondents in each country citing this as a major barrier to adopting agricultural technologies. Technical complexity was also reported as a challenge by 14% (N=7) of Indian farmers and 12% (N=6) of Dutch farmers, suggesting that while it remains a concern, its prevalence is relatively balanced between the two regions. However, regulatory barriers were significantly more pronounced in India, where 32% (N=16) of farmers identified them as a hindrance, compared to only 18% (N=9) in the Netherlands, indicating a need for more streamlined and farmer-friendly regulations in the Indian context. Conversely, high costs associated with agricultural technologies were a more prominent issue for Dutch farmers, with 24% (N=11) reporting it as a barrier, compared to 12% (N=6) in India. This disparity may be attributed to differences in technological standards, subsidy structures, or expectations surrounding returns on investment in each country. These findings highlight that while certain challenges such as lack of support and technical complexity are universally shared, others—such as regulatory burdens and cost—vary significantly between contexts, necessitating country-specific strategies to foster greater adoption of innovative agricultural solutions.

4.5 Environmental Sustainability Considerations

Environmental considerations emerged as a significant motivating factor influencing farmers' decisions toadoptnano-dronetechnologies(*seeFig* *5*).

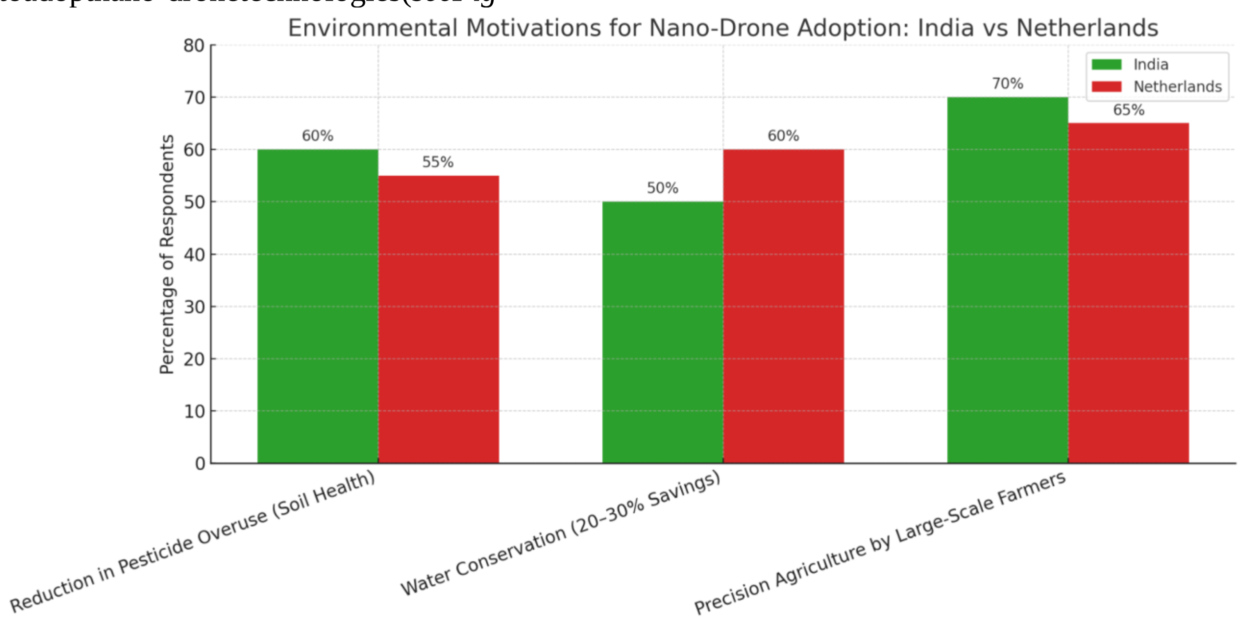

Fig 5: Environmental sustainability considerations

A notable proportion of farmers from both India and the Netherlands recognised the potential of nano-drones in reducing pesticide overuse, thereby contributing to improved soil health—this view was shared by 60% of Indian farmers and 55% of their Dutch counterparts. Such reductions are likely to enhance the long-term fertility of agricultural land and mitigate the ecological damage caused by conventional spraying practices.

In addition, water conservation benefits were acknowledged by a substantial number of respondents, particularly in relation to the precision spraying capabilities of nano-drones. Approximately 50% of Indian farmers and 60% of Dutch farmers reported experiencing 20–30% savings in water usage. Furthermore, a strong inclination towards sustainable agricultural practices was evident among large-scale farmers in both regions, with 70% of Indian and 65% of Dutch farmers endorsing the role of

precision agriculture as a pathway towards environmental stewardship. These findings underscore the alignment of technological adoption with broader sustainability goals in modern agriculture.
The suitability of nano-drones also varied by crop type: rice and wheat farmers were most interested, while fruit and vegetable growers reported limitations due to canopy density.

4.6 Ease of Use and Technical Complexity

Ease of use continues to pose a significant challenge in the adoption of drone technology among farmers in both India and the Netherlands (*see Fig 6*).

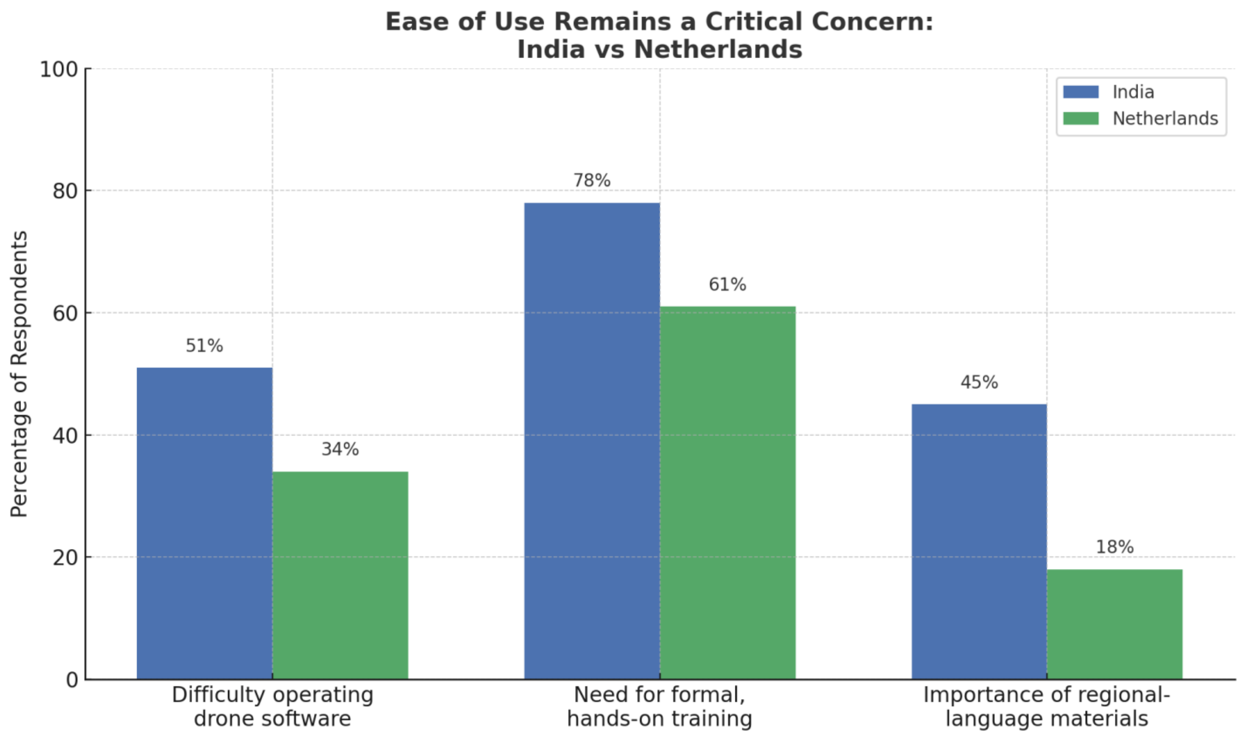

Fig 6: Ease of use concern

Notably, 51% of Indian farmers and 34% of their Dutch counterparts reported experiencing difficulty in operating drone software, underscoring a gap in user-friendliness and digital literacy across both contexts. This suggests that while technological familiarity may be comparatively higher in the Netherlands, operational complexity remains a barrier to widespread adoption in both regions.
Furthermore, 78% of Indian farmers and 61% of Dutch farmers expressed the necessity for formal, hands-on training prior to utilising drone systems, indicating a strong demand for structured educational support. Additionally, 45% of Indian farmers, as compared to only 18% of Dutch farmers, emphasised the need for instructional materials in regional languages. This finding highlights the importance of linguistic accessibility and culturally tailored resources in enhancing technology adoption, particularly within diverse and multilingual farming communities such as those in India.

4.7 Support Requirements and Policy Expectations

Farmers expressed a well-defined set of expectations aimed at enhancing the wider adoption of agricultural innovations (*see Fig 7*).

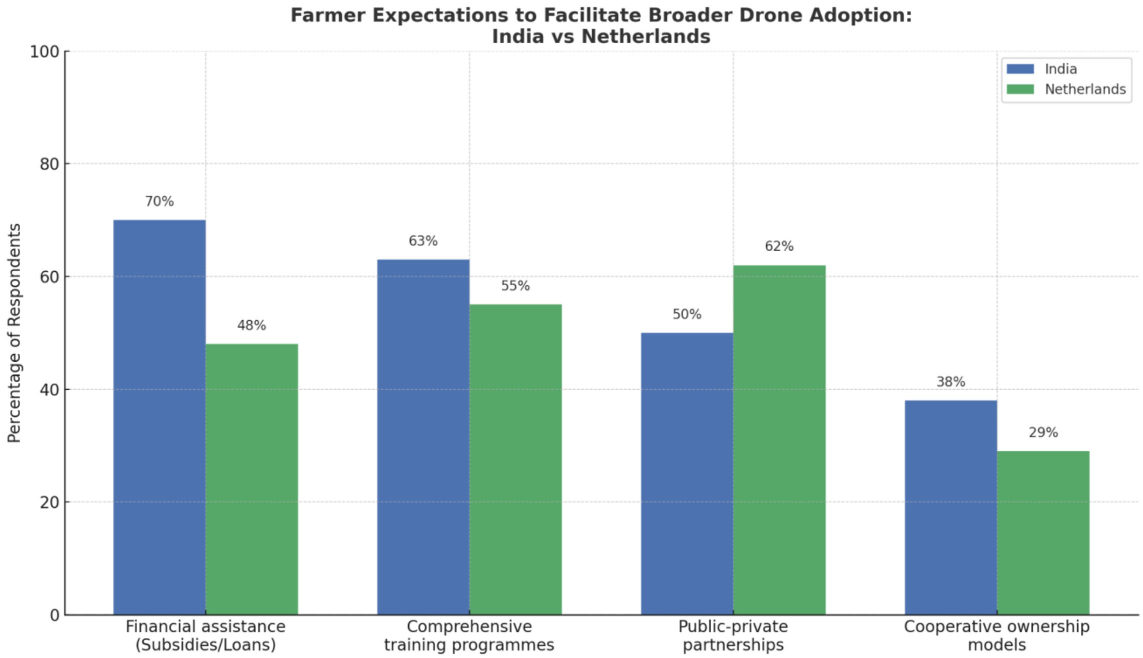

Fig 7: Support requirements

A significant proportion—70% of Indian farmers and 48% of Dutch farmers—emphasised the importance of financial assistance in the form of subsidies or low-interest loans to support their investment in new technologies. Additionally, 63% of Indian and 55% of Dutch farmers highlighted the critical need for comprehensive training programmes to ensure effective and confident utilisation of advanced tools and practices.

Public-private partnerships were also endorsed by 50% of Indian farmers and 62% of their Dutch counterparts as a strategic approach to improve accessibility to emerging agricultural solutions. Furthermore, cooperative ownership models were suggested by 38% of Indian farmers and 29% of Dutch farmers as a means to alleviate individual financial pressure, reflecting a preference for shared responsibility and community-based investment structures. These insights collectively underscore the necessity of a supportive ecosystem encompassing financial, educational, and collaborative frameworks to accelerate technology adoption in agriculture.

4.8 Comparative Insights: India and The Netherlands based on qualitative analysis

The comparative analysis revealed that Dutch farmers benefit from superior educational attainment, technical proficiency, and institutional support, all of which contribute to higher levels of awareness and adoption. Conversely, Indian farmers are more reliant on cooperatives and social networks for knowledge dissemination and support (*see Table 1*).

Journal of Informatics Education and Research
ISSN: 1526-4726
Vol 5 Issue 2 (2025)

Table 1: Qualitative Analysis of farmers from India and Netherlands

Factor	India	Netherlands
Information Sources	Farmer cooperatives, social media	Workshops, expert consultations
Education Level	Lower literacy, reliance on visuals	Higher education, technical knowledge
Awareness	Low, needs awareness campaigns	Moderate, benefits from demonstrations
Support Needed	Training and subsidies	Technical assistance and subsidies
Key Benefits	Crop monitoring, resource efficiency	Labor cost savings, resource efficiency
Challenges	Regulatory barriers, high cost	High cost, technical complexity

The comparative analysis of key factors influencing agricultural technology adoption in India and the Netherlands reveals distinct socio-economic and infrastructural differences between the two contexts. In India, farmers primarily rely on informal information channels such as cooperatives and social media platforms, reflecting a grassroots-driven approach to knowledge dissemination. Conversely, Dutch farmers benefit from structured access to expert consultations and formal workshops, indicating a more institutionalised knowledge exchange system. This divergence in information sources underscores the need for tailored communication strategies in each setting.

Education level is another critical differentiator. Indian farmers often face challenges related to lower literacy rates and therefore depend heavily on visual aids and simplified instructions for technology adoption. In contrast, Dutch farmers typically possess higher levels of education and technical proficiency, which facilitates smoother integration of complex innovations. Consequently, awareness levels also differ: Indian farmers require targeted campaigns to elevate basic understanding, while their Dutch counterparts respond well to practical demonstrations, suggesting a more advanced baseline of technological familiarity.

Support structures and perceived benefits further influence adoption trajectories. Indian farmers express a strong need for fundamental training and financial subsidies to overcome initial barriers, with key benefits centred around improved crop monitoring and resource efficiency. Dutch farmers, while also requiring subsidies, emphasise technical assistance and highlight labour cost savings alongside resource efficiency as primary motivators. However, both groups encounter cost-related obstacles, with Indian farmers additionally constrained by regulatory hurdles, and Dutch farmers facing the challenge of technical complexity. These findings point to the necessity of context-specific interventions to enhance the efficacy of agricultural innovations.

Conclusion

This study provides valuable insights into the adoption of nano-drone technology among farmers in India and the Netherlands. Surveying 100 farmers across both countries revealed significant differences in demographics, education, and information sources. Indian farmers, with lower levels of formal education, largely rely on social media and informal networks, with 45% of Indian farmers using platforms like YouTube and WhatsApp for agricultural knowledge. In contrast, Dutch farmers benefit from more structured, institutional support systems, with 40% of them gaining knowledge through formal workshops and cooperatives.

Despite high levels of awareness, adoption rates remain limited. Only 30% of respondents had seen a nano-drone in use, and just 12% had used one personally. However, both groups recognised the potential benefits, such as improved pest detection and resource efficiency, with 30% of Indian farmers and 12% of Dutch farmers identifying pest detection as a major benefit. Indian farmers highlighted labour cost reduction (20%), while Dutch farmers focused more on crop monitoring (26%).

Key barriers identified included lack of support (26% in both countries), technical complexity (14% in India and 12% in the Netherlands), and high costs (24% in the Netherlands, 12% in India). Environmental sustainability emerged as a motivating factor for both groups, with 60% of Indian and 55% of Dutch farmers recognising the potential for reduced pesticide use.

The findings suggest a need for tailored support, including financial assistance, training, and region-specific resources. Context-specific policies and communication strategies are essential to overcoming barriers and ensuring broader adoption of innovative agricultural technologies.

Ethical Considerations

Informed consent was obtained from all participants. Anonymity and confidentiality were maintained throughout the study, and ethical approval was secured from the host institution prior to data collection.

No Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this paper. The research was conducted with full integrity, and no financial or personal conflicts influenced the study design, data collection, analysis, or interpretation.

Funding

This research was funded by BML Munjal University under Seed Grant project titled "Exploring Cross-Cultural Farmer Adoption of Nano-Drones in Agricultural Practices: A Study in India and the Netherlands", as per the award letter (Ref. No. BMU/RDC/SG/2024-01).

Author Contributions

Dr. Jolly Masih conceptualised the study and supervised the research process. Pashma and Sameer Yadav led the data collection and analysis for both the qualitative and quantitative phases. Pratisha Agrawal and Pawani Chadha contributed to the literature review and qualitative analysis. All authors contributed to writing and editing the manuscript.

Acknowledgements

The authors wish to express their sincere gratitude to Prof. Pratik Modi (BML Munjal University) and Prof. Aard Groen (University of Groningen, the Netherlands) for their valuable contributions to this pilot study. Their expertise was instrumental in framing the questionnaire, which will serve as the foundation for a larger, future study. Their insights and guidance were crucial in shaping the structure of the questionnaire based on the primary findings of this research.

Limitations of Study

Despite its comprehensive scope, this study has several limitations. Firstly, the sample size, while representative of the two countries, is relatively small and may not fully capture the diversity of farming practices within each region. Furthermore, the study relies on self-reported data from farmers, which may be subject to bias. The results are also limited by the short duration of the research and the cross-sectional design, which does not allow for longitudinal insights into the long-term adoption of nano-drones. Lastly, the focus on India and The Netherlands limits the generalisability of the findings to other agricultural contexts. Future research could benefit from a broader, more diverse sample and a longer follow-up period to capture the evolving dynamics of nano-drone adoption in agriculture.

Future Applications of Research

This study provides foundational insights into the perceptions of farmers regarding nano-drone adoption in agriculture. Future research could expand upon these findings by exploring the longitudinal impact of nano-drones on farm productivity and sustainability. Additionally, studies could investigate the effectiveness of region-specific training programs or explore the potential integration of nano-drones with other precision agriculture technologies, such as satellite imaging and AI-powered analytics. These applications could enhance crop monitoring, optimize resource usage, and contribute to sustainable agricultural practices worldwide.

References

1. Barnes, A. P., Soto, I., Eory, V., Beck, B., Balafoutis, A., Sánchez, B., & Gómez-Barbero, M. (2019). Exploring the adoption of precision agricultural technologies: A cross-regional study of EU farmers. *Land Use Policy, 80*, 163–174. https://doi.org/10.1016/j.landusepol.2018.10.004
2. Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press. https://doi.org/10.1093/he/9780199689453.001.0001
3. Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (3rd ed.). Sage Publications.
4. Eastwood, C., Klerkx, L., & Nettle, R. (2017). Dynamics and distribution of public and private research and extension roles for technological innovation and diffusion: Case studies of the implementation and adaptation of precision farming technologies. *Journal of Rural Studies, 49*, 1–12. https://doi.org/10.1016/j.jrurstud.2016.11.008
5. Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822X05279903
6. Hassler, S. C., & Baysal-Gurel, F. (2019). Unmanned aircraft system (UAS) technology and applications in agriculture. *Agronomy*, *9*(10), 618. https://doi.org/10.3390/agronomy9100618
7. Hunt Jr, E. R., & Daughtry, C. S. T. (2018). What good are unmanned aircraft systems for agricultural remote sensing and precision agriculture? *International Journal of Remote Sensing, 39*(15–16), 5345–5376. https://doi.org/10.1080/01431161.2017.1410300
8. Kernecker, M., Knierim, A., Wurbs, A., Kraus, T., & Borges, F. (2020). Experience versus expectation: Farmers' perceptions of smart farming technologies for cropping systems across Europe. *Precision Agriculture*, *21*(1), 34–50. https://doi.org/10.1007/s11119-019-09651-z
9. Kutter, T., Tiemann, S., Siebert, R., & Fountas, S. (2011). The role of communication and cooperation in the adoption of precision farming. *Precision Agriculture, 12*(1), 2–17. https://doi.org/10.1007/s11119-009-9150-0
10. Lowenberg-DeBoer, J., Huang, I. Y., Grigoriadis, V., & Blackmore, S. (2020). Economics of robots and automation in field crop production. *Precision Agriculture, 21*(2), 278–299. https://doi.org/10.1007/s11119-019-09667-5
11. Maes, W. H., & Steppe, K. (2019). Perspectives for remote sensing with unmanned aerial vehicles in precision agriculture. *Trends in Plant Science, 24*(2), 152–164. https://doi.org/10.1016/j.tplants.2018.11.007
12. Michels, M., Fecke, W., Feil, J. H., Musshoff, O., Pigisch, J., & Krone, S. (2020). Smartphone adoption and use in agriculture: Empirical evidence from Germany. *Precision Agriculture, 21*(2), 403–425. https://doi.org/10.1007/s11119-019-09675-5
13. Mogili, U. R., & Deepak, B. B. V. L. (2018). Review on application of drone systems in precision agriculture. *Procedia Computer Science*, *133*, 502–509. https://doi.org/10.1016/j.procs.2018.07.063
14. Ortlipp, M. (2008). Keeping and using reflective journals in the qualitative research process. *The Qualitative Report, 13*(4), 695–705. https://doi.org/10.46743/2160-3715/2008.1579

15. Pathak, H. S., Brown, P., & Best, T. (2019). A systematic literature review of the factors affecting the precision agriculture adoption process. *Precision Agriculture*, *20*(6), 1292–1316. https://doi.org/10.1007/s11119-019-09653-x
16. Paxton, A., Mishra, A. K., Chintawar, S., Roberts, R. K., Larson, J. A., English, B. C., & Martin, S. W. (2011). Intensity of precision agriculture technology adoption by cotton producers. *Agricultural and Resource Economics Review*, *40*(1), 133–144. https://doi.org/10.1017/S1068280500004561
17. Pierpaoli, E., Carli, G., Pignatti, E., & Canavari, M. (2013). Drivers of precision agriculture technologies adoption: A literature review. *Procedia Technology*, *8*, 61–69. https://doi.org/10.1016/j.protcy.2013.11.010
18. Radoglou-Grammatikis, P., Sarigiannidis, P., Lagkas, T., & Moscholios, I. (2020). A compilation of UAV applications for precision agriculture. *Computer Networks*, *172*, Article 107148. https://doi.org/10.1016/j.comnet.2020.107148
19. Tufekci, Z. (2014). Big questions for social media big data: Representativeness, validity, and other methodological pitfalls. *Proceedings of the International AAAI Conference on Web and Social Media*, *8*(1), 505–514. https://doi.org/10.1609/icwsm.v8i1.14517
20. Yallappa, D., Veerangouda, M., Maski, D., Palled, V., & Bheemanna, M. (2017). Development and evaluation of drone-mounted sprayer for pesticide applications to crops. In *2017 IEEE Global Humanitarian Technology Conference (GHTC)* (pp. 1–7). IEEE. https://doi.org/10.1109/GHTC.2017.8239330