# SOCIALIZATION AND APPLICATION OF DRONE SPRAYER TECHNOLOGY IN EAST BOGOR DISTRICT

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## ABSTRACT

The Subur Hasil Tani Farmers' Group Association (Gapoktan) in Cibadak village, East Bogor District, still faces challenges in conventional plant spraying, such as requiring a considerable amount of time, high labor costs, uneven spray distribution, and low knowledge regarding drone sprayer technology. This Community Service Activity (PKM) aims to enhance farmers' knowledge, understanding, and basic skills in utilizing drone sprayer-based agricultural mechanization technology to support precision agriculture. The implementation method includes Focus Group Discussions (FGD) to identify partner needs, socialization regarding the concept, benefits, safety aspects of using drone sprayers, and field practice demonstrations of drone operation. The results of the activities show an increase in participants' understanding of the working principles, benefits, operational procedures of drone sprayers, and an increase in farmers' readiness to adopt agricultural mechanization technology. An approach that integrates discussions, socialization, and field practices has proven effective in strengthening technological literacy, building farmers' trust in modern agricultural innovations, and encouraging the adoption of more efficient, safe, productive, and sustainable agricultural mechanization.

**Keywords:** Drone Sprayer, Agricultural Mechanization, Precision Agriculture, Farmer Capacity Building, Community Empowerment.

## 1. INTRODUCTION

UAV adoption can improve farm income and reduce time for spraying operation (Quan et al., 2023). Besides the speed of application, the efficiency of drone sprayers is also affected by the system's ability to achieve uniform spray distribution. The optimal planning of flight-path is an important aspect of improving the consistency of area. The transformation toward modern agriculture has become an important agenda for improving national productivity and food security. Along with the development of smart farming and precision agriculture concepts, the utilization of agricultural mechanization technologies has increasingly been adopted to assist farmers in managing cultivation activities more effectively, efficiently, and sustainably. One of the rapidly developing innovations is the use of Unmanned Aerial Vehicles (UAVs), or drone sprayers, as agricultural mechanization equipment for the application of pesticides, liquid fertilizers, and plant nutrients. One of the innovations emerging in precision agriculture is the use of UAVs or drones for crop monitoring and pesticide application.

This technology enables monitoring and spraying processes to be carried out with the support of sensors, automation systems, and more precise application techniques (Hafeez et al., 2023). Various studies have shown that drone sprayers can improve spraying accuracy, reduce excessive chemical use, accelerate application time, and minimize operators' exposure to pesticides compared with conventional spraying methods. This technology has also become an important component of precision agriculture because it enables agricultural inputs to be applied more accurately according to crop requirements (Hafeez, 2023).

The development of drone sprayer technology in Indonesia in recent years has shown an increasingly positive trend. The growing demand for modern agricultural mechanization is reflected in the increasing number of manufacturing companies, distributors and drone-based spraying service providers. This condition is caused by the declining availability of agricultural labor, increasing cultivation costs, and growing demand for higher land productivity. In addition to spraying, drones are increasingly being used for land mapping, monitoring crop health, early detection of pest and disease attacks and collecting agricultural data from aerial images (Chin, 2023). Such a development demonstrates that drones have developed from a mere support tool to an integral part of data-driven decision-making for precision agriculture systems.

In addition, UAV technology is being used more and more to increase the accuracy and efficiency of spraying operations by more optimized flight-path planning and area coverage (Nanavati et al., 2023). However, implementation of drone sprayer technology at the farmer level still faces many challenges . Most farmers continue to rely on manual spraying using knapsack sprayers, which require considerable labor, involve relatively long application times, and may result in less uniform spraying quality. This condition becomes increasingly complex in agricultural areas with hilly, terraced, or otherwise difficult to access topography, where spraying effectiveness is often suboptimal. In addition to affecting the efficiency of pesticide and liquid fertilizer use, manual methods also increase farmers' exposure to chemicals, which may adversely affect their health and occupational safety in the long term. The use of drone sprayers has shown the potential to overcome many of these limitations and with faster, more accurate spraying and the ability to get into areas hard to reach by humans or conventional gear. From an operational and economic point of view, the use of UAVs for pesticide application also has the potential to shorten labor time and improve farming coverage in UAV-based spraying operations (Nanavati et al., 2023).

The problems are also encountered by the Gabungan Kelompok Tani/Gapoktan Subur Hasil Tani Farmers Group Association in Cibadak Village, Tanjungsari District, Bogor Regency, as a partner in this community service activity. The Gapoktan has considerable potential for developing farming activities. However, crop spraying is still predominantly conducted using conventional methods. Based on the results of the initial identification conducted together with the partner, several major problems were identified, including lengthy spraying times, high labor requirements, uneven spray distribution, and limited access to modern agricultural mechanization technologies. Furthermore, most members of the farmers' group do not yet possess adequate knowledge regarding the working principles of drone sprayers, safe operational techniques, effective spraying procedures, or developments in regulations and competency certification for agricultural drone operators, which are currently being implemented by various training institutions and professional associations.

This condition indicates a gap between the rapid development of agricultural mechanization technology and the level of technology adoption among farmers. On the one hand, drone sprayer technology has developed into a proven solution capable of improving spraying efficiency and agricultural productivity (Morales, 2025). On the other hand, most farmers, particularly those belonging to rural farmers' groups, still face limitations in knowledge, operational skills, and access to training on the use of this technology. Although UAV technology has considerable potential to improve agricultural efficiency, the availability of such technology does not automatically encourage adoption at the farmer level. Factors such as perceptions of technological benefits, resource availability, social conditions, and farmers' knowledge and understanding may influence their decisions to adopt UAV technology (Wachenheim et al., 2021). Consequently, innovations that are already available cannot yet be utilized optimally to improve farming productivity. This condition demonstrates that the primary challenge in implementing drone sprayers does not merely lie in the availability of the technology but also in enhancing the capacity of human resources as users of the technology.

Based on these problems, this community service activity aims to improve the knowledge and understanding of members of the Subur Hasil Tani Gapoktan regarding agricultural mechanization technology based on drone sprayers, enhance basic skills in drone operation and spraying techniques in accordance with the principles of precision agriculture, and provide insights into occupational safety aspects and the importance of operator competency in the use of agricultural drones. This capacity building effort is expected to encourage farmers' readiness to adopt mechanization technology, thereby making cultivation processes more efficient, productive, safe, and sustainable. The solutions offered in this activity consist of socialization regarding the development of drone sprayer technology in the agricultural sector, training on operational principles and proper spraying techniques, direct demonstrations of drone sprayer use on agricultural land owned by the partner, and interactive discussions on opportunities to utilize drones as part of agricultural mechanization and technology-based spraying services. This approach is not solely oriented toward knowledge transfer but also provides farmers with practical experience, enabling them to gain a concrete understanding of the benefits and implementation of this technology in their daily cultivation activities

## 2. METHOD

**Location and Time**

The activity of community service was conducted on September 23, 2025 in Subur Hasil Tani Farmers Group Association (Gabungan Kelompok Tani/Gapoktan), Cibadak Village, Tanjungsari Sub-district, Regency of Bogor, West java The partner was selected for its strong potential for the development of agricultural mechanization as the group was awarded an agricultural drone by the Ministry of Agriculture in the 2023 fiscal year sprayer package through Dinas Tanaman Pangan, Hortikultura dan Perkebunan of Bogor Regency (Dinas Tanaman Pangan, Horticulture and Plantation/Distant Horizon). The participants consisted of members of the farmer groups under the

Subur Hasil Tani Gapoktan in Cibadak Village who are actively engaged in rice cultivation activities. The activity was attended by the academic community of Bina Nusantara University, farmers from the Subur Hasil Tani Gapoktan in Cibadak Village, and Agricultural Extension Center XII (Cariu District and Tanjungsari District).

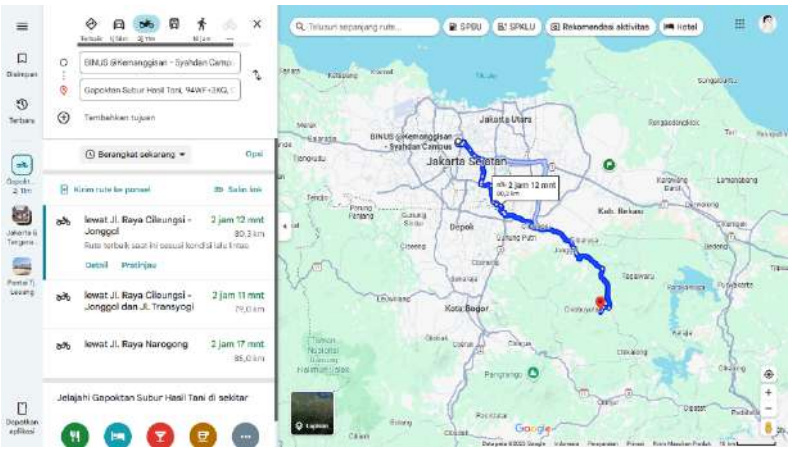


Figure 1. Partner Location

## IMPLEMENTATION MECHANISM

The implementation method consisted of three main stages, namely *Focus Group Discussion* (FGD), socialization, and field demonstration/practice, as illustrated in the figure below.

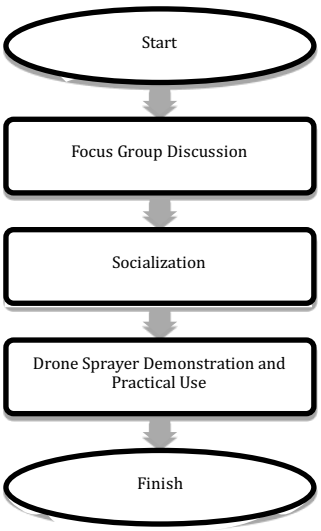


Figure 2. Flowchart of Community Service

The implementation phases were structured to incorporate the evaluation of participants' needs, the provision of applicable technical expertise and actual field experience. This strategy aims to provide the participants with the knowledge of the fundamentals of drone supported agricultural technology and witnessing its practical implementation in conventional farming practices. The application of UAV technology in agriculture has been associated with precision farming techniques especially crop monitoring and pesticide spraying (Gokool et al., 2023; Hafeez et al., 2023).

### Focus Group Discussion (FGD)

The first phase consisted of a Focus Group Discussion (FGD) with the farmers and other relevant stakeholders. A focus group discussion was organized to identify the existing problems in standard agricultural procedures, especially in relation to crop maintenance, pesticide application and labor requirements and the efficacy of conventional spraying methods. FGD was the first method to collect data directly from the participants because it offers the researcher an opportunity to explore the experience and perspective of the participants in an interactive discussion. The data obtained in this phase was later used to develop the basis for the selection of the materials and practical tasks to be presented in the next phases (Creswell, 2017). Moreover, the knowledge of farmers' perceptions and resources is crucial for the application of UAV-based agricultural technology. Previous research suggests that farmers' views, available resources

and social relations may affect the adoption of UAVs for pesticide application (Wachenheim et al., 2021). So the focus group discussion was not only about the technical issues, but also about how willing the participants were to accept the drone technology.

**Material Socialization (Sosialisasi Materi)**
The next stage was the distribution of materials related to the use of drone sprayer technology. The material was provided following the issues and requirements identified in the FGD. The talk dealt with the basic principles of agricultural drones, the role of drone sprayers, the main components of the apparatus, operational protocols, pre-spraying preparations, and safety precautions in use. The attendees were also introduced to the benefits of drone assisted spraying compared to the traditional spraying. Unmanned aerial vehicles (UAVs) can improve conventional agricultural methods by increasing operational efficiency and the application of agricultural inputs in cultivated areas with increased adaptability (Hafeez et al., 2023). Furthermore, UAVs can also assist precision agriculture to enable more targeted and systematic farming practices (Gokool et al., 2023). During socialization it was stressed that the success of drone spraying was not only dependent on the drone but also on the appropriate planning of operations. For a fair distribution we need to consider elements such as flight trajectories, coverage zones and application patterns. Data-centric trajectory planning has been identified as a critical component for maintaining consistent coverage operations for agricultural spraying drones (Nanavati et al., 2023).

**Demonstration and Field Practice (Demonstrasi/Praktik Penggunaan Drone Sprayer)**
The third phase was a demonstration and practical training in the field with the drone sprayer. The session began with a detailed description of the apparatus and its components and then the pre-operational configuration of the drone. Participants were then familiarized with the basic operational protocol which included equipment inspection, preparation of the spraying system, identification of the target area and planning of the flight path. During the session, the participants learned the basics of assessing the spraying zone, and how to keep a proper flight trajectory. This factor is significant because the choice of a suitable UAV flight trajectory can influence the uniformity and coverage of spraying activities (Nanavati et al., 2023). The initiative also introduced participants to the possible operational and financial benefits of UAVs for pesticide application, as mentioned in previous work on agricultural UAV use (Quan et al., 2023).

The first demonstration was performed by the facilitator to give the participants a definite picture of the proper operating procedure. Afterward, participants could observe the procedure and take part in it under supervision. During this phase, it was intended to combine the theoretical knowledge obtained in the socialization phase with its practical application in agriculture. Practical fieldwork ended with assessment and dialog session. Participants were asked to share their views on the understandability of the content, the operation of the drone sprayer and the potential use of the technology in their farming practices. Participants' understanding was assessed and identified for further clarification or improvement through feedback. The three phase implementation framework was set in a sequential order. The FGD served as the basis for identifying the participants' needs, the socialization phase supplied the needed theoretical and technical knowledge, while the demonstration/practice phase gave the opportunity for hands-on experience with the drone sprayer. The approach was to improve participants' knowledge and hands-on skills in drone-assisted agricultural technologies and to promote adoption of more efficient and precision-oriented farming practices.

## 3. RESULTS AND DISCUSSION

The implementation of this Community Service Program (PKM) is a concrete step to bridge the transformation from traditional to modern agriculture in the Subur Hasil Tani Farmers Group Association (Gapoktan). The goal of this activity is not only to introduce the drone sprayer mechanization technology but also to develop the deep understanding and practical skills to farmers through a continuous three-phase journey, namely, a Focus Group Discussion (FGD) to explore the root problems, material socialization to build the theoretical foundation, and field practices to experience directly.

**Uncovering Root Problems Through Focus Group Discussions (FGD)**
The preliminary stage began on July 29, 2025, with an interesting Focus Group Discussion (FGD) held at the BPP Region XII Office in Bogor Regency. The meeting became an important basis to recognize the current conditions, examine the needs of the partners, and map out the concrete obstacles faced by the beneficiary partner, the Gapoktan in Tanjungsari District, Bogor Regency. This open discussion provided the community service team with an in-depth knowledge of the traditional spraying techniques in use, including manual knapsack sprayers. The farmers freely admit that these manual methods are incredibly labor intensive, and add a lot to their operating costs, a problem compounded by the uneven, terraced terrain that often results in inconsistent spraying effectiveness. Moreover, the dialog also clearly exposed a serious lack of technological proficiency in the operational mechanism, safety measures, and

regulatory framework of agricultural drone application. These operational obstacles and constraints in literacy, however, did not diminish the farmers' sense of hope and eagerness, implying a high willingness to adopt and use Unmanned Aerial Vehicles (UAV) technology, if provided with appropriate resources and training.



Figure 3. Discussion with Head of BPP XIII Bogor Regency

The visual documentation of this interactive session is presented in the figure above. Beyond mapping the field challenges, this FGD was strategically structured to align the community service objectives with the expectations of both the agricultural extension officers and the farmers. The specific steps taken during the discussion, the intended targets, the active roles of the participants, and the final consensus achieved are systematically outlined in Table 1.

Table 1. Results of the FGD activity

| No | FGD Activity | Main Target | Participant Role | Achievement Result |
|---|---|---|---|---|
| 1 | Presentation of the plan for socialiatin activities and practial use of drone sprayers | Received support from BPP wilayah XII kab Bogor as the agricultural extension officer for the cariu and tanjungsari areas regarding drone sprayer technology | Following the presentation of the PkM plan, discussions, and Q&A sessions related to the technical aspects of the planned activities. | Participants understand the plan for the PkM activity on the implementation of drone sprayer technology. |
| 2 | Explanation of the benefit of implementing this technology to the beneficiaries | Providing an overview of the benefits of implementing drone sprayer technology | Following the presentation of the PkM plan, discussions, and Q&A sessions related to the technical aspects of the planned activities. | The PkM team received approval and guidance for partners who benefit from PkM activities. |

**Construction of the precision agriculture knowledge base (Socialization outcomes)**

The socialization phase was structured to be a knowledge bridge, based on the concern and enthusiasm found in the FGD. The objective of this particular activity was to familiarize the participants with the idea of drone sprayer based agricultural mechanization in a holistic manner. The session introduced the participants to the basic of aerial mechanization, the different part of drones how they function and the emergence of unmanned aerial vehicle (UAV) technology in the agricultural sector. The session also equipped the participants with the necessary information on pre flight preparation.

The most important moment of realization came when the conversation shifted to occupational health and safety (OHS). Farmers who had been used to the risk of exposure to chemical residues from manual spraying now realized that UAV's offered a vital layer od protection, with the farmers not having to come into direct contact with the toxic pesticides. The paradigm of "precision agriculture" also opened their eyes. They began to realize that data driven spraying is more than simply watering the fields, it is an orchestrated approach. The idea that the best corps production planning flight paths, calculating coverage zones and managing application patterns. The classical delivery of the material was very much enhanced by interactive discussions and Q&A in this session. This allowed the participants to gain a much more detailed understanding of the real-world barriers to implementing this technology at the grassroots farmer level, and the relative benefits it offers over traditional methods.




Figure 4. FGD with the BPP Region XII Bogor District

The above visual documentation reflects the dynamic interaction and engagement that takes place during this socialization phase. Table 2 provides a systematic assessment of the effectiveness of this educational intervention, that is, the specific activities conducted, the main goals targeted, the active participation of the involved persons, and the final consensus and accomplishments.

Table 2. Results of The Socialization Activity Achievements

| No | FGD Activity | Main Target | Participant Role | Achievement Result |
|---|---|---|---|---|
| 1 | Presentation of the plan for socialiatin activities and practial use of drone sprayers | Received support from BPP wilayah XII kab Bogor as the agricultural extension officer for the cariu and tanjungsari areas regarding drone sprayer technology | Following the presentation of the PkM plan, discussions, and Q&A sessions related to the technical aspects of the planned activities. | Participants understand the plan for the PkM activity on the implementation of drone sprayer technology. |
| 2 | Explanation of the benefit of implementing this technology to the beneficiaries | Providing an overview of the benefits of implementing drone sprayer technology | Following the presentation of the PkM plan, discussions, and Q&A sessions related to the technical aspects of the planned activities. | The PkM team received approval and guidance for partners who benefit from PkM activities. |

**Results of Field Demonstrations: Theory in Practice**

The final stage of the events was the application of the ideas from the discussion forum to the agricultural landscapes. The demonstration and practical application stage was a successful mechanism for translating technological concepts into a tangible sensory experience for the farmers. In this phase, the community service team gave a detailed demonstration on the working phases of the drone. The full-scale demonstration started with pre-flight preparations (pre-flight inspections) and equipment status checks, followed by detailed flight route planning. The facilitators gave Comprehensive explanation of changes in the main spray parameters such as flight altitude, speed, and spray width



Figure 5 Focus Group Discussion (FGD) with BPP Region XII, Bogor Regency

which enable the practical use of the spray solution on farmland. As you can see from the pictures above, the session was a success, from observing to getting involved. Following the comprehensive demonstration, the participants were given the invaluable opportunity to witness the drone operation process up close. But most importantly, they were allowed to independently try out a number of basic operational stages under the close supervision of the instructors. "The observations in the field were quite optimistic. The farmers pre-flight checked the equipment efficiently and readied the spraying systems. The farmers obtained a much more concrete and realistic understanding of operational time efficiency and have begun to project the financial benefits of integrating this technology into their day-to-day cultivation routines, as evidenced in the evaluation dialog that followed at the end of the session. This milestone was confirmed. Table 3 systematically documents the specific outcomes of this interactive session, listing activities, targets, participant roles, and accomplishments.

Table 3 Demonstration and Practical Activity Achievement Results

| No | Activity | Target Audience | Participant Role | Achievement Result |
|---|---|---|---|---|
| 1 | Demonstration of drone sprayer operation by the Community Service (*PkM*) Team | Representatives of the Subur Hasil Tani Farmers Group Association (*Gapoktan*) | Attending the presentation, participating in discussions, and engaging in technical Q&A. | Participants understand the working principles and implementation procedures of drone sprayer technology |
| 2 | Mentored flight practice of the drone sprayer by participants | Representatives of the Subur Hasil Tani Farmers Group Association (*Gapoktan*) | Conducting flight simulations and consulting when encountering technical difficulties. | Participants are capable and skilled in operating the drone sprayer unit independently |
| 3 | Evaluation and feedback session by participants | Representatives of the Subur Hasil Tani Farmers Group Association (*Gapoktan*) | Providing feedback, evaluations, and impressions based on their experience operating the drone sprayer | Participants gain a deeper understanding after conducting independent drone sprayer simulations |

**Weaving the Future: Discussion and Future Development Opportunities**

Finally, the combination of participatory field practices, informative socialization and empathetic FGDs has proved to be a successful recipe for balancing the fast pace of technological innovation with the adoption rates of rural farmers. The extensive strategy proved very successful in disseminating knowledge and, more significantly, in alleviating fears, so that farmers were assured of modern agricultural mechanization. With this, the Subur Hasil Tani Gapoktan has a strong foundation in accepting an efficient, safe, productive and sustainable agricultural system, both in terms of mental readiness and technical readiness. Future development opportunities. The presence of drone sprayers could significantly improve the functionality of this farming community. Unmanned aircraft, currently used as spraying aids, can potentially be used as a vital part of a complete precision agriculture system. In the future, unmanned aerial vehicles (UAVs) will be "eyes in the sky" to digitally map land contours, provide early detection tools for pest and disease attacks and periodically monitor crop health through the analysis of aerial imagery. The success of improving

HR capacity is the key initial step to the significant transformation to the era of smart farming in Bogor Regency. The first step is this community service activity.

## 4. CONCLUSION

The community service activity at the Subur Hasil Tani Farmers Group Association, Cibadak Village, Bogor Regency, has greatly empowered the local farming communities, because the knowledge and understanding of drone sprayer mechanization has increased. The technology has been introduced as a more efficient, effective and inherently safer alternative to conventional spraying methods, and has thus enabled a critical transformation of agricultural perspectives. The participants acquired a thorough knowledge of the working principles, practical advantages and essential safety issues of drone sprayers, as well as practical experience in observing and performing the basic operational steps of the technology through the well-integrated approach of Focus Group Discussions (FGD), theoretical socialization and practical field practices. This multi pronged approach was critical in that it served as a powerful bridge to link the wide gap between the rapid advances in agricultural technology and the traditionally low adoption rates at the grassroots farmer level. The results of this endeavor clearly demonstrate that the fusion of theoretical knowledge transfer with practical, on-site demonstrations is a highly effective strategy for improving technological literacy and, concurrently, fostering a profound level of farmer trust in modern agricultural innovations. Consequently, this intervention has significantly improved the ability of the beneficiaries to accept and progressively adapt agricultural mechanization in their day to day agricultural operations. This successful intervention lays a solid foundation for subsequent development through structured, continuous mentoring programs. Future endeavors may include holistic training of drone operators, formal certifications of competency, and joint efforts among higher education institutions, local governments, agricultural extension agents, and technology providers. The overall approach is expected to trigger the rapid adoption of drone sprayer technology in a big way, promote more widespread use of precision agriculture practices, and have a lasting effect on the long-term sustainability, operational efficiency and improved farm productivity of the agricultural sector in Bogor Regency, and beyond

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