Assessing Small Unmanned Aircraft System Crop Spraying Efficiency

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Agriculture is a very essential part of our society as well as the crop spraying that goes along with it to keep all of the crops healthy and thriving to continue the bountiful harvest that our farmers collect. As times continue to evolve and society begins to develop more intricate farming and establish farmland in rough terrain areas, innovation is needed to stay up to date and to continue increasing the number of crops that can be produced to sustain our society. One way to create this innovation is by utilizing new and advanced technology that can access the needs of the farm easier. Small unmanned aircraft systems (sUAS), often referred to simply as a drone, is a new and very innovative piece of technology that is proving to have many possible uses, including in agriculture.

In this study, the effectiveness of using an sUAS to replace current crop spraying methods is examined. In prior research about the efficacy of drones in an agricultural setting, it is shown that due to their small stature sUAS can offer many benefits including being used for spot spraying crops for weeds and pests. Researchers have examined the effectiveness of drone spraying by studying droplet dispersion that is given as well as the spray rates that are offered. An experiment that was conducted in California compared the effects of a drone crop sprayer to a fixed-wing crop sprayer on commercial alfalfa using several parameters including the labeled use rate, residue levels, and spray coverage. This research was concluded with the statement, "The results of this study provide confidence supporting the use of small-scale multi-rotor UAVs [or sUAS] ... According to the parameters tested, UAV application quality and crop protection performance were comparable to that of the conventional fixed wing airplane application" (Li et al., 2021).

In this study, an analysis was conducted that included interviews with farmers and other agricultural workers. This allowed first-hand input from the intended users of the product and to be added to the research and focus the rest of the project toward those main topics. The DJI Agras T16 was flown and tests were administered to gain valuable data about the droplet dispersion, the spray, and the most efficient flight speed and height. With this data and the research variables, a cost-benefit analysis chart was constructed in Microsoft Excel that would compare the different benefits and costs between the multiple options that could arise while using a spray drone, a common ground sprayer, and a common crop-dusting plane. The data gathered in the cost-benefit analysis chart was used to collaboratively create a program using Java in Eclipse and GitHub. This outputted a user-friendly table that would allow farmers, or other interested parties, to alter the table and see what the outcome would be with their given

options. For example, the farmers could create their own scenarios and see the possible outcomes. This would be helpful to users when considering different options since it weighs out the benefits and costs for them.

During the efficiency testing in this research experience, many results were discovered about sUAS and how they could be beneficial in agriculture. The testing and research were able to show the ideal flight speed and materials that would be needed to produce an efficient flight to spray a full field. However one of the main conclusions that were made in this research was that as of now, the more beneficial use for crop spraying drones would be for spot spraying crops instead of spraying an entire field. This is due to the technology still being in testing and advancement stages; However, drones can still be very useful with spot spraying because it allows for a safer, less expensive process since there would be less pesticide involved. This would also allow less room for harmful chemical exposure to both workers and surrounding plants and animals. Another main result that was discovered was that to be the most efficient, the drone would need to use an ultra-low-volume pesticide to maximize its spray tank capacity, this is essentially a spray that is far more concentrated. This would allow for more ground to be covered and fewer refill trips to be made.

Crop sprayers are one of the most commonly used forms of crop protection in farmlands. Integrating a new, efficient method of crop spraying is a convenient, helpful, and safe strategy for farmers that allows them to study and understand their crops more. Agricultural workers will be able to have a better understanding of their crops and in turn, will have a better return on investment as well as higher crop production. Farmers will be able to engage with their crops and target problem areas which is more beneficial than spraying an entire field.

1. Li, X., Giles, D. K., Andaloro, J. T., Long, R., Lang, E. B., Watson, L. J., & Qandah, I. (2021). Comparison of UAV and fixed‐wing aerial application for alfalfa insect pest control: Evaluating efficacy, residues, and spray quality. *Pest Management Science*. https://doi.org/10.1002/ps.6540