Title of the Research

Design & Development of Pesticide Spraying Drone for Agricultural Application

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গবেষণা প্রস্তাব

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Statement of the Problem:

The adoption of agricultural spraying drones in Bangladesh faces several challenges.

1. **Limited education:** There is a lack of education among farmers regarding the safe use of such high-tech equipment.
2. **High cost:** The high cost of agricultural drones increases the production expenses for farmers.
3. **Restrictive Regulations:** Bangladeshi drone regulations limit the capacity and availability of international solutions.
4. **Foreign Dependence:** Existing regulations limit the capacity and capabilities of agricultural drones available internationally, leading to dependency on foreign suppliers for spare parts, training, and technical expertise. This reliance on foreign sources also strains the country's foreign currency reserves.
5. **Lack of Maintenance Technicians:** Bangladesh is still in shortage of drone maintenance technicians. Such lack of expertise may prohibit scaling up of this technology to rural people. For any type of maintenance farmers may need to visit the capital, which will make the solution unsustainable.
6. **Crop and Environment Suitability:** The suitability of drones for various crops and growing conditions remains uncertain. Addressing these challenges necessitates the local development and customization of agricultural drones to make them more accessible and cost-effective for Bangladesh's agricultural sector.

Overcoming the aforementioned challenges is crucial to ensure their effective and safe utilization and sustainability. Therefore, it is highly important to conduct research in terms of local perspective and develop in-house expertise.

Objectives of the Study:

1. To master the drone manufacturing technology through development of a locally tailored and affordable pesticide spraying drone.
2. Develop skilled technicians for maintenance to ensure long-term sustainability.
3. Protect environment and health from pesticide hazards.
4. Implement precision agriculture through optimum use of pesticide.
5. Maximize yield and profitability for the farmers by reducing manual labor.
6. Create new jobs in agriculture (e.g.: drone operator, drone technicians, drone sales etc.)
7. Support young entrepreneurs in the agricultural sector.
8. Contribute to Bangladesh's transition to “Smart Bangladesh” through participation in the Fourth Industrial Revolution.

Review of Literature:

Agricultural spraying drones, also known as unmanned aerial vehicles (UAVs), have garnered significant attention in modern agriculture due to their potential to revolutionize traditional spraying methods. These drones are equipped with sprayers capable of applying pesticides, herbicides, and fertilizers to crops with precision and efficiency.

According to a study by Li et al. (2018), agricultural spraying drones offer several advantages over conventional spraying methods. Firstly, they can cover large areas of crops at high speeds, reaching up to 30 acres per hour, as demonstrated by Ma et al. (2020). This rapid coverage not only saves time but also allows for timely application of agrochemicals, which is crucial for crop health and yield optimization.

Moreover, agricultural spraying drones contribute to environmental sustainability by reducing chemical drift and minimizing the overuse of agrochemicals. Traditional spraying methods often result in chemical drift, where pesticides and fertilizers are carried away by wind or water, causing environmental pollution and harm to non-target organisms. However, drones can be programmed to apply chemicals with precision, thereby reducing environmental contamination, as highlighted in the research by Wang et al. (2019).

Furthermore, agricultural spraying drones have been shown to enhance operational efficiency and cost-effectiveness. By minimizing the need for manual labor and optimizing spraying routes, drones can significantly reduce production costs for farmers. This aligns with the findings of Chen et al. (2021), who reported a notable decrease in labor requirements and operational expenses with the adoption of drone technology in agriculture.

However, challenges remain in the widespread adoption of agricultural spraying drones, particularly in regions like Bangladesh. Issues such as high initial investment costs, limited technical expertise among farmers, and regulatory constraints hinder the effective utilization of drone technology in agriculture. Addressing these challenges through localized development and customization of drone technology is crucial for maximizing its benefits in the context of Bangladesh's agricultural landscape. Therefore, there is need for more research that will focus on a tailored approach considering local farming practices, regulatory frameworks, and socio-economic factors.

Rationale of the Study:

The development of locally produced and customized agricultural spraying drones addresses the specific challenges faced by Bangladesh's agricultural sector. By reducing reliance on expensive foreign imports and tailoring drone technology to local farming conditions, this research aims to enhance the accessibility, affordability, and effectiveness of agricultural spraying practices in Bangladesh.

Methodology:

Phase 1: Prototype Development and Testing

1. **Initial Design:** Based on market research and analysis of farmer needs, develop a scaled-down, functional prototype focusing on affordability, ease of use, and compliance with regulations.
2. **Material Selection:** Prioritize readily available and cost-effective local materials for prototype construction.
3. **Manufacturing:** Utilizing local resources and expertise, fabricate the prototype drone, focusing on efficient and replicable manufacturing techniques.
4. **Testing and Evaluation:** Conduct rigorous testing under controlled conditions to assess:

- **Load carrying capacity:** Simulate actual spraying payloads to determine maximum weight limit.
- **Battery life and flight time:** Measure flight duration with various payloads and operating modes.
- **Recharge time:** Monitor and analyze charging speed for efficient operation planning.
- **Maneuverability and stability:** Evaluate control responsiveness and flight stability in different wind conditions.
- **Data collection and analysis:** Gather and analyze data from sensors to optimize performance and efficiency.

5. **Prototype Refinement:** Based on test results, iterate and refine the prototype design to address identified limitations and improve performance parameters.

Phase 2: Final Drone Development and Testing

1. **Final Design:** Incorporating data and insights from prototype testing, finalize the design of the full-scale production drone, ensuring compliance with regulations and optimized functionality.
2. **Production Line Development:** Establish a sustainable and scalable production line utilizing identified local resources and manufacturing techniques.
3. **Quality Control:** Implement a rigorous quality control system to ensure consistency and reliability in drone production.
4. **Field Testing and Evaluation:** Conduct comprehensive field tests under various real-world agricultural conditions to assess:
    - **Effectiveness in spraying:** Evaluate accuracy, coverage, and impact on target crops and pests.
    - **Usability in field conditions:** Analyze farmer interaction, controllability, and ease of operation.
    - **Durability and environmental resilience:** Test performance under diverse weather conditions and potential hazards.
5. **Finalization and Documentation:** Based on field test results, further refine the design and document all processes, procedures, and specifications for large-scale production.

Expected Output:

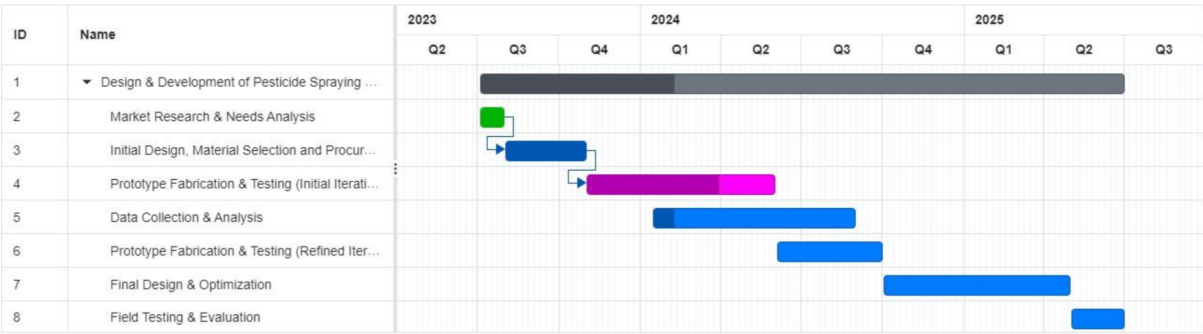
The expected output of this research includes the development of a locally produced pesticide spraying drone tailored to Bangladesh's agricultural needs. Additionally, the study aims to provide guidelines and recommendations for the effective and safe use of agricultural drones in the local context. The tentative specification which will be justified in this research work is as below:

Following parameters for the final drone are set as an initial goal of this research. These are subjected to change based on further study.

Parameters	**Specifications**
Tank Capacity	10 liters
Number of Rotors	6
Total Drone Weight without payload	3.5 Kg
Total Drone weight with Payload	24.5 kg
Pump max flow rate	3.5 Liter /min
Spray Nozzles	4
Spray Width flying at height of 3 m	2 - 4 m

Acre covered per hour at 4 m/s speed, flat terrain with one single plot farm	6 acres
Battery recharge time	30-35 min
Endurance	8 - 10 min
Safety Features	Low Battery Warning
	Signal Loss- Return to Home triggered Automatically
	Medicine Empty Tank- Return to Home triggered Automatically
	Break Point - Recorded- will return to same point for spray

Action Plan and Tentative Budget:



Time Frame:

Tasks	Start Date	End Date	Days Count	%Completed
Market Research & Needs Analysis	3-7-23	31-7-23	21 days	100
Initial Design, Material Selection and Procurement	1-8-23	31-10-23	66 days	100
Prototype Fabrication & Testing (Initial Iteration)	1-11-23	31-5-24	153 days	70
Data Collection & Analysis	15-1-24	30-8-24	165 days	10
Prototype Fabrication & Testing (Refined Iteration)	3-6-24	30-9-24	86 days	0
Final Design & Optimization	1-10-24	30-4-25	152 days	0
Field Testing & Evaluation	1-5-25	30-6-25	43 days	0

Total – 2 years

Tentative Budget:

Following budget is tentative and are subjected to change based on further study.

Total Budget: 10,60,000.00 BDT Only (Approximately)

<table>
<tr><th colspan="2">Tentative equipment list with cost</th></tr>
<tr>
<td>8 Pairs of CF / Nylon Propeller (23”) and 8 Motors (170 kv, 14 kg thrust)

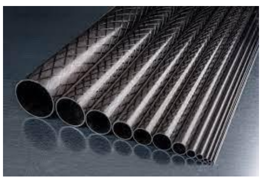
BDT 250,000</td>
<td>Smart Charger with power of 1200 W, up to 6S charging rate of 20 A

BDT 250,000</td>
</tr>
<tr>
<td>Navigation System (RADAR, GPS, Collison Avoidance etc)

BDT 140,000</td>
<td>Ground Control and Radio (including consultancy for controller development)

BDT 2,20,000</td>
</tr>
<tr>
<td>HD Camera, Gimbal etc.

BDT 110,000</td>
<td>Carbon Fiber Sheets and Composite Manufacturing Accessories for Drone Frame


BDT 50,000</td>
</tr>
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Spray System, Nozzle, Pumps etc.   **BDT 40,000**	

References:

1. Chen, X., Wu, H., Wu, B., & Guo, W. (2021). Economic analysis of unmanned aerial vehicle in agriculture: a case study in China. Journal of Cleaner Production, 287, 125341.
2. Li, H., Wang, C., Li, X., Zhou, X., & Song, D. (2018). Research and development of agricultural UAV in China. Journal of the Saudi Society of Agricultural Sciences, 17(2), 127-134.
3. Ma, Z., Shen, G., & Tang, T. (2020). Study on Plant Protection UAV Flight Path Optimization. Journal of Physics: Conference Series, 1529(4), 042067.
4. Wang, L., Wang, J., Li, Y., Yang, X., Li, J., & Li, G. (2019). Experimental study on flight speed of pesticide spraying drone. Journal of Physics: Conference Series, 1168(3), 032007.