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Energy-Efficient Unmanned Ground Vehicle (UGV) for Precision Root Zone Fertilizer Implantation toward Sustainable Agriculture

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INTRODUCTION

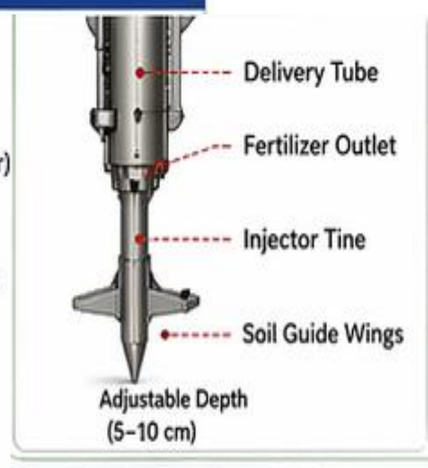
- Inefficient fertilizer application (broadcasting losses up to 40–60%)
- High energy consumption due to repeated field operations
- Environmental pollution (soil & water contamination)
- Lack of precision in small-scale farming systems.

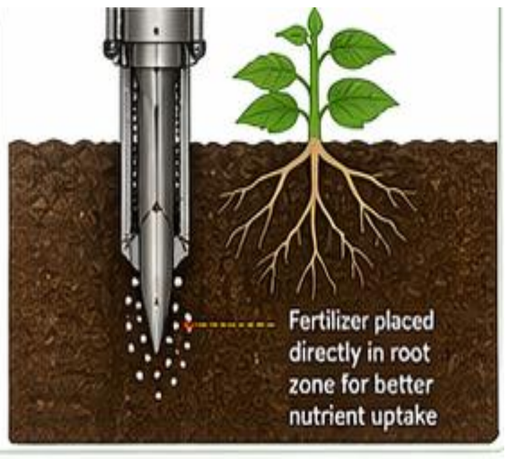
INNOVATION

- Direct root zone placement
- Energy-efficient operation
- Suitable for precision farming
- Reduced nutrient losses
- Autonomous/remote operation

METHODOLOGY

UGV SYSTEM ARCHITECTURE





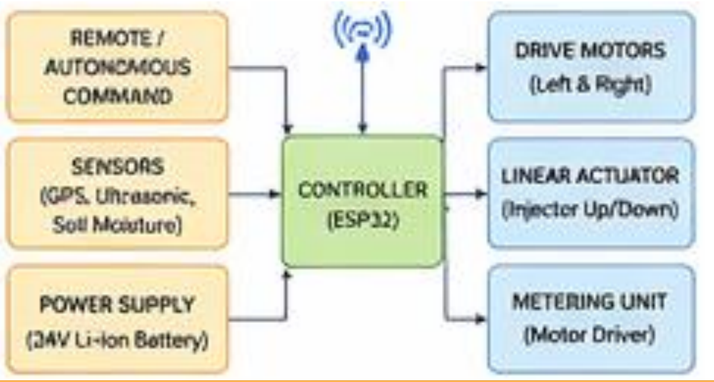
COMPARISON: CONVENTIONAL vs OUR SYSTEM

Parameter	Conventional Broadcasting	Our UGV System (Root Zone Implantation)	Improvement
Fertilizer Use Efficiency	40 – 60%	85 – 95%	↑ 30–50%
Nutrient Loss	High	Very Low	↑ Significant Reduction
Environmental Impact	High	Low	Better
Energy Consumption	High	Low	↑ 30–40% Less
Labor Requirement	High	Low	Reduced
Crop Yield	Moderate	Higher	Improved

WORKING PRINCIPLE

BENEFITS: Precise Placement • Higher Efficiency • Lower Costs • Sustainable Agriculture

SYETEM BLOCK DIAGRAM



EXPECTED OUTCOMES

- Fertilizer savings: **30–50%**
- Improved nutrient use efficiency
- Reduced environmental impact
- Lower operational energy consumption

ADVANTAGES

- Precision agriculture compatible
- Reduces labor dependency
- Suitable for small & medium farms
- Energy-efficient & cost-effective

CONCLUSION

- Precise root-zone fertilization improves nutrient use efficiency
- Reduces losses, costs, and environmental impact for sustainable farming

REFERENCES

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