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Dual Tank Sprayer Kit

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ABSTRACT

This study developed and evaluated a Dual Tank Sprayer Kit intended to provide small-scale pineapple farmers with a more efficient, ergonomic, and user-friendly device for applying herbicides and insecticides. Using a descriptive-developmental design, the study proceeded through planning, designing, fabrication, testing, revision, and evaluation phases. The prototype integrated a dual-tank system, automatic mixing mechanism, adjustable spray-strength control, hose and nozzle system, rechargeable battery, labeled switches, and knapsack-style support. Thirty small-scale pineapple farmers from Polomolok, South Cotabato evaluated the prototype using a validated checklist questionnaire in terms of design, ergonomics, and usability. Data were analyzed using frequency count and mode. Findings showed that the Dual Tank Sprayer Kit was highly acceptable in all three evaluation areas. The design was valued for its separate tanks, color-coded and labeled controls, and ability to reduce the need for two sprayers. Ergonomic ratings showed that the prototype was generally safe, balanced, and comfortable to carry, although improvements in weight and prolonged-use comfort were recommended. Usability results indicated that the sprayer was easy to operate, accessible, efficient, and understandable even for first-time users. The study concludes that the Dual Tank Sprayer Kit is a practical farm-tool innovation for small-scale pineapple farming, particularly for improving spraying convenience, reducing tool switching, and minimizing physical strain. Further refinement is recommended through weight reduction, protective tank housing, battery-capacity improvement, and broader field testing.

Keywords: *dual tank sprayer kit, agricultural innovation, ergonomics, pineapple farming, small-scale farmers, usability*

INTRODUCTION

Small-scale pineapple farming supports agricultural production and rural livelihood in many communities in the Philippines, especially in Mindanao. Farmers perform regular field-maintenance tasks such as spraying herbicides and insecticides to protect pineapple crops from weeds and pests. However, these tasks often depend on manual labor and conventional spraying tools, which increase time requirements, physical strain, and operational inconvenience.

One common difficulty encountered by pineapple farmers is the need to carry and operate separate spraying containers or tools for different agricultural solutions. Farmers may have to refill, switch equipment, and manually mix chemicals while working in open field conditions. These practices can reduce efficiency and increase fatigue, particularly when farmers work for extended periods on uneven terrain. Existing portable sprayers are usually single-tank tools, making simultaneous or alternating chemical application less convenient.

Previous literature on agricultural mechanization and ergonomic design emphasizes that appropriate tools can reduce labor burden, improve safety, and enhance productivity among smallholder farmers (Davis & Kotowski, 2015; Kaur et al., 2023; Wilson, 2000). From an agricultural innovation perspective, adaptive technologies are most useful when they respond directly to users' production barriers and physical working conditions (Dissanayake et al., 2022). In this context, the Dual Tank Sprayer Kit was conceptualized as a practical

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device that integrates two tanks, a motorized spraying mechanism, an automatic mixer, and user-friendly controls into one portable unit.

This study therefore focused on the development and evaluation of a Dual Tank Sprayer Kit for small-scale pineapple farming. Specifically, it aimed to design the kit, fabricate the prototype, and evaluate its acceptability in terms of design, ergonomics, and usability. The study contributes to farm-tool innovation by providing a prototype-based response to the need for efficient, safer, and more convenient spraying equipment for small-scale pineapple farmers.

Literature Review

Pineapple Farming, Chemical Application, and Smallholder Needs

Pineapple production requires continuous farm maintenance to control weeds, pests, and diseases. Herbicides and insecticides remain important in maintaining field conditions and protecting crops; however, the method of application affects labor efficiency, safety, and resource use. In small-scale settings, farmers often rely on affordable and locally available tools, but these may not be designed for prolonged field use or for multiple spraying needs.

Literature on pesticide application notes that proper spraying equipment, calibration, and safe handling are necessary to reduce chemical wastage and exposure risks (Damalas & Koutroubas, 2016; Matthews, 2008; Purdue Extension, 2019). Tank mixing or the use of multiple agricultural solutions may save time and labor, but it requires careful control and compatibility awareness to prevent ineffective application, clogging, or unsafe handling. Thus, a dual-tank mechanism with controlled switching and flushing procedures may improve convenience while retaining the need for safe chemical practices.

Agricultural Innovation and Ergonomic Tool Design

Agricultural innovation emphasizes the development and adoption of tools that respond to actual farm problems, such as high labor requirements, limited access to mechanization, and the need for productivity improvement. Dissanayake et al. (2022) explained that agricultural technology adoption is strengthened when innovations are practical, useful, and compatible with users' needs. For smallholder farmers, innovations must be affordable, portable, and understandable.

Ergonomic design is equally important in farm-tool development. Wilson (2000) emphasized that tools should be designed according to the physical capacity and working conditions of users. Davis and Kotowski (2015) further noted that farming tasks are associated with musculoskeletal strain, highlighting the need for improved tool design. In the present study, ergonomics was addressed through the knapsack-style frame, adjustable straps, back support, accessible switches, rounded edges, and hose length that allowed spraying without excessive bending.

Prior Arts and Design Direction

The reviewed prior arts included an automatic knapsack-type sprayer, a multi-purpose portable agricultural sprayer, and a multi-functional agricultural tool carrier. These prior designs showed useful features such as portability, spray control, remote operation, and tool organization. However, the study identified a design gap in relation to dual-tank functionality, automatic mixing, and ergonomic field use for small-scale pineapple farmers. The Dual Tank Sprayer Kit addressed this gap by combining dual tanks, motorized spraying, control switches, and backpack support into a single prototype.

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METHODS

Research Design

The study employed a descriptive-developmental research design. The developmental component covered the planning, design, fabrication, testing, revision, and evaluation of the Dual Tank Sprayer Kit prototype. The descriptive component was used to determine the acceptability of the prototype based on the responses of selected small-scale pineapple farmers.

Research Locale

The study was conducted in Polomolok, South Cotabato, a municipality known for pineapple production. Prototype testing and evaluation were conducted under field-related conditions involving small-scale pineapple farmers who had experience in spraying, weeding, and other farm-maintenance activities.

Participants and Sampling Technique

The respondents were thirty (30) small-scale pineapple farmers from Polomolok, South Cotabato. Purposive sampling was used because the study required respondents who had direct experience in pineapple cultivation and in using basic farm tools and sprayers. Their practical knowledge made them appropriate evaluators of the prototype.

Research Instrument

A checklist questionnaire was used to evaluate the prototype in terms of design, ergonomics, and usability. The instrument used a five-point acceptability scale: 5 = Highly Acceptable, 4 = Acceptable, 3 = Moderately Acceptable, 2 = Not Acceptable, and 1 = Highly Not Acceptable. The questionnaire was validated by three experts, whose ratings were 3.33, 4.16, and 4.50, resulting in an overall mean of 4.00, interpreted as Highly Valid.

Data Gathering Procedure

The researchers first designed and fabricated the prototype based on the needs of small-scale pineapple farmers. After initial testing, defects such as hose leakage, discomfort during prolonged use, tank-switching difficulty, and nozzle clogging were addressed through revisions. The selected farmers then examined and used the prototype during field demonstration and answered the checklist questionnaire. Their responses and comments were documented for analysis and further improvement.

Data Analysis

Frequency count was used to determine the number and percentage of responses under each acceptability category. Mode was used to identify the most frequently selected rating for each item and for the overall acceptability of the prototype in terms of design, ergonomics, and usability.

Ethical Consideration

The study secured appropriate permission prior to data collection. Respondents were informed about the purpose of the study and were asked to evaluate the prototype based on their experience. Their responses were treated with confidentiality and used only for research and prototype-improvement purposes.

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RESULTS AND DISCUSSION

The results are presented according to the design and fabrication process and the acceptability of the Dual Tank Sprayer Kit in terms of design, ergonomics, and usability. The discussion integrates the findings with the relevant literature on agricultural innovation, ergonomics, and small-scale farm-tool development.

Table 1. *Core specifications and development details of the Dual Tank Sprayer Kit*

Component/Aspect	Description based on the developed prototype
Main purpose	To assist small-scale pineapple farmers in applying herbicides and insecticides using one portable dual-tank sprayer.
Major features	Dual-tank system, automatic mixer, adjustable spray-strength dial, rechargeable battery with charging port, hose/nozzle system, switches, and knapsack support.
Body material	Stainless steel frame, housing, and tank bodies; selected for durability, strength, and chemical resistance.
Approximate design dimensions	About 22 inches high, 7 inches wide, and 5 inches deep, with a 20-inch hose length.
Development phases	Planning, construction, testing, revision, evaluation, and reporting over a 10-week development period.
Total project cost reported	Php 6,740.00, consisting of materials and contracted labor.

Figure 1. Prototype of the Dual Tank Sprayer Kit used in the study

The development process produced a functional prototype intended to reduce the need for separate sprayers during pineapple-field maintenance. The dual tanks allowed the preparation of two different agricultural solutions, while the motorized spraying mechanism and automatic mixer simplified operation. The use of stainless-steel supported durability and chemical resistance, although the same material contributed to weight-related concerns during prolonged use. This finding supports the principle that agricultural innovations should balance durability, affordability, portability, and user comfort.

Table 2. *Testing defects and revisions made before evaluation*

Defect observed during testing	Revision made
Leakage in hose connections	Hose connections were tightened and sealed using clamps and sealants.
Sprayer felt heavy and caused discomfort	Strap adjustment was improved and padding was added for better weight distribution.
Tank switching was not smooth	The control valve was adjusted and secured.

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Minor nozzle clogging occurred	The nozzle was cleaned and refined to ensure smoother spraying.

Table 3. Acceptability of the Dual Tank Sprayer Kit in terms of design

Design indicator	Most frequent rating	Interpretation
Color-coded and labeled dual tanks made the device understandable	5	Highly Acceptable
Tanks were easy to refill because lids were easy to open and close	4	Acceptable
Approximate weight was manageable during use	4	Acceptable
Switches were placed in accessible positions	5 and 4	Highly Acceptable and Acceptable
Dual-tank design allowed two agricultural solutions to be used	5	Highly Acceptable
Important parts were easy to notice because they were color-coded and labeled	5	Highly Acceptable
Overall design acceptability	5	Highly Acceptable

Design acceptability was highly favorable. The strongest design features were the dual-tank functionality and the color-coded labeling of parts, both of which helped users understand the system quickly. The design reduced the need to carry two sprayers and made spraying tasks more organized. However, some indicators related to weight, refilling, and back airflow were rated only acceptable, suggesting that future versions should consider lighter materials and improved tank housing.

Table 4. *Acceptability of the Dual Tank Sprayer Kit in terms of ergonomics*

Ergonomic indicator	Most frequent rating	Interpretation
Comfortable to carry because of airflow space	5	Highly Acceptable
Adjustable straps fit the user well	4	Acceptable
Approximate weight felt balanced while working	4	Acceptable
Handle was comfortable to hold	5 and 4	Highly Acceptable and Acceptable
Strap design helped reduce excessive fatigue	4	Acceptable
Soft foam back support followed the natural shape of the back	5	Highly Acceptable
Safe to operate during farm activities	5	Highly Acceptable
Hose length allowed comfortable spraying without excessive bending	5	Highly Acceptable
Overall ergonomics acceptability	5	Highly Acceptable

The ergonomic results indicate that respondents generally found the prototype safe, comfortable, and manageable. The highest ratings were associated with safety, hose length, air space, rounded edges, and back support. These findings are consistent with ergonomic design principles emphasizing reduced strain, comfortable posture, and safe interaction between user and tool. Nonetheless, strap adjustability, weight balance, and full-session use were rated acceptable, indicating that the prototype should be refined for longer field operations.

Table 5. *Acceptability of the Dual Tank Sprayer Kit in terms of usability*

Usability indicator	Most frequent rating	Interpretation
Hose and wires did not tangle because they were insulated	5	Highly Acceptable
Sprayer could apply herbicide and insecticide using one device	5	Highly Acceptable
Switches and parts were labeled and color-coded	5	Highly Acceptable
Toggle switches were easy to reach	5	Highly Acceptable

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Instructions were clear and concise	5	Highly Acceptable
Automatic spraying and mixing helped complete tasks more quickly	5	Highly Acceptable
Parts were accessible during use	5	Highly Acceptable
Kit reduced the need for two sprayers	5	Highly Acceptable
Overall usability acceptability	5	Highly Acceptable

Usability emerged as one of the strongest aspects of the prototype. Respondents highly accepted the accessibility of controls, ease of operation, automatic spraying and mixing functions, and reduction of multiple tools. These findings support Rogers' (2003) idea that technologies perceived as useful and simple are more likely to be accepted by intended users. The positive usability ratings suggest that the Dual Tank Sprayer Kit can simplify spraying tasks and reduce operational difficulty among small-scale pineapple farmers.

Table 6. *Improvement priorities based on prototype testing and acceptability results*

Priority area	Basis from findings	Suggested improvement
Weight reduction	Several design and ergonomics items were rated Acceptable rather than Highly Acceptable.	Consider durable plastic, lighter alloys, or hybrid materials for future versions.
Tank protection and appearance	The tanks were functional but exposed.	Enclose containers in a protective housing to improve safety, appearance, and durability.
Battery performance	The prototype used a rechargeable battery but may require longer operating capacity.	Upgrade battery capacity and provide a charge indicator for field use.
Mixer control	The automatic mixer was useful but strong mixing required secure lids.	Add a mixer-strength dial appropriate for different chemical viscosities.
User training	Some first-time users may need orientation.	Prepare a short user guide and demonstration protocol on safe operation and flushing procedures.

The findings show that the prototype was not only acceptable but also improvable. Because the study was limited to prototype development and user acceptability testing, the results should not be interpreted as evidence of long-term durability, commercial viability, or chemical-application efficacy. Broader testing across different farm conditions, longer operating periods, and varied user groups is necessary before recommending large-scale production.

CONCLUSION

The study successfully designed, fabricated, and evaluated a Dual Tank Sprayer Kit for small-scale pineapple farming. The prototype integrated dual tanks, automatic mixing, adjustable spray strength, rechargeable power, accessible switches, and a knapsack-style structure. Based on the responses of thirty small-scale pineapple farmers, the prototype was highly acceptable in terms of design, ergonomics, and usability. The findings indicate that the device can improve spraying convenience, reduce the need for multiple sprayers, support safer and more organized operation, and lessen physical strain during field activities. However, the prototype remains at a developmental stage and requires further refinement, particularly in relation to weight reduction, tank protection, battery capacity, and long-term field durability.

Recommendations

Small-scale pineapple farmers may consider the Dual Tank Sprayer Kit as a practical support tool for improving spraying efficiency and convenience during farm-maintenance activities, provided that proper chemical safety procedures are followed. Future developers should consider replacing some stainless-steel components with

durable lightweight materials to reduce user fatigue and improve portability. The two tanks should also be enclosed in protective housing to enhance safety, appearance, and resistance to external damage. The battery system, mixer control, and spray-strength adjustment should be improved to support longer and more flexible field use. Extension workers and agricultural-technology instructors may use the prototype as a basis for training smallholder farmers on safe, efficient, and ergonomic spraying practices. Future researchers should conduct longer field trials, durability testing, comparative performance testing against conventional sprayers, and cost-benefit analysis before recommending the prototype for wider adoption or commercial production.

References

Damalas, C. A., & Koutroubas, S. D. (2016). Farmers' exposure to pesticides: Toxicity types and ways of prevention. Toxics, 4(1), 1-10. https://doi.org/10.3390/toxics4010001

Davis, J. R., & Cornwell, P. J. (2018). Introduction to stainless steels. ASM International.

Davis, K. G., & Kotowski, S. E. (2015). Prevalence of musculoskeletal disorders for farmers and farm workers: A systematic review. International Journal of Industrial Ergonomics, 50, 134-145. https://doi.org/10.1016/j.ergon.2015.10.001

Dissanayake, C. A. K., Jayathilake, W., Wickramasuriya, H. V. A., Dissanayake, U., Kopiyawattage, K. P. P., & Wasala, W. M. C. B. (2022). Theories and models of technology adoption in the agricultural sector. Human Behavior and Emerging Technologies, 2022, 1-15. https://doi.org/10.1155/2022/9258317

Food and Agriculture Organization of the United Nations. (2024). FAOSTAT: Pineapple production data 2023. https://www.fao.org/faostat/en/#data

Green, J. M., & Beestman, G. B. (2007). Recently patented and commercialized formulation and adjuvant technology. Crop Protection, 26(3), 320-327.

International Organization for Standardization. (2019). ISO 9241-210: Ergonomics of human-system interaction-Part 210: Human-centred design for interactive systems. https://www.iso.org/standard/77520.html

Kalpakjian, S., & Schmid, S. R. (2014). Manufacturing engineering and technology (7th ed.). Pearson Education.

Karwowski, W. (2006). The discipline of ergonomics and human factors. CRC Press.

Kaur, B., Mansi, N., Dimri, S., Singh, J., Mishra, S., Chauhan, N., Kukreti, T., Sharma, B., Singh, S. P., Arora, S., Uniyal, D., Agrawal, Y., Akhtar, S., Rather, M. A., Naik, B., Kumar, V., Gupta, A. K., Rustagi, S., & Preet, M. S. (2023). Insights into the harvesting tools and equipment for horticultural crops: From then to now. Journal of Agriculture and Food Research, 14, 100814. https://doi.org/10.1016/j.jafr.2023.100814

Matthews, G. A. (2008). Pesticide application methods (3rd ed.). Wiley-Blackwell.

Nevala, N., Pehkonen, I., Koskela, I., & Anttila, H. (2017). Workplace ergonomics interventions to prevent musculoskeletal disorders. Cochrane Database of Systematic Reviews, 2017(9). https://doi.org/10.1002/14651858.CD008570.pub3

Norman, D. A. (2013). The design of everyday things: Revised and expanded edition. Basic Books.

Osorio, J., Amaral, F., & Goncalves, M. (2019). Ergonomic evaluation of agricultural tools: A case study. Applied Ergonomics, 74, 1-8. https://doi.org/10.1016/j.apergo.2018.07.002

Philippine Statistics Authority. (2024). Selected statistics on agriculture. https://psa.gov.ph

Purdue Extension. (2019). Sprayer calibration and pesticide application practices. Purdue University Extension.

Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.

Verma, S. R. (2006). Impact of agricultural mechanization on production, productivity, cropping intensity, income generation, and employment of labor. https://www.researchgate.net/publication/237801065

Wilson, J. (2000). Fundamentals of ergonomics in theory and practice. Applied Ergonomics, 31(6), 557-567. https://doi.org/10.1016/S0003-6870(00)00034-X