

# **MULCH BED IMPLEMENT ATTACHED TO HAND TRACTOR**

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## TABLE OF CONTENTS

	PAGE
LIST OF TABLES	xii
LIST OF FIGURES	xiii
LIST OF APPENDICES	xv
LIST OF APPENDIX TABLES	xv
LIST OF APPENDIX FIGURES	xv
ABSTRACT	xix
INTRODUCTION	
Background of the Study	1
Statement of the Problem	3
Objectives of the Study	3
Significance of the Study	4
Scope and Limitation of the Study	5
Time and Place of the Study	5
REVIEW OF RELATED LITERATURE	
Vegetable Production in the Philippines (Crops and Area)	6
Mulching Practices in the Philippines	6
Traditional Materials used	6
Traditional way of Laying Technique	7
Mechanize Laying of Plastic Mulch	8
Bed and mulch	9
Limitation of Mechanized Plastic Mulch Laying	12
Hand Tractor	12

Machines for Plastic Mulch Laying	13
Designs	15
Economic Importance of Mulching	18

## METHODOLOGY

Conceptualization of the study	20
Conceptual Framework	20
Flowchart of Activities	21
Design Parameters and Considerations	22
Conceptual Design	22
Principle of Operation	23
Fabrication	24
Components	25
Tools and Equipment	25
Test Preparation	33
Test instruments and Materials	33
Performance Evaluation	33
Preliminary testing	33
Final testing	34
Experimental design	35
Data gathering	36
Performance Parameters	37
Field capacity and field efficiency of the implement	37
Field capacity	37
Field efficiency	37
Procedure in determining efficiency	38
Criteria for laying plastic mulch properly	40

Criteria for not properly lay	41
Statistical Data Analysis	41
Cost Analysis	43
RESULTS AND DISCUSSION	49
SUMMARY, CONCLUSION AND RECOMMENDATION	66
LITERATURE CITED	71
APPENDICES	74

## LIST OF TABLES

TABLE		PAGES
1	Suggested plants spacing for vegetables grown on plastic mulch	12
2	Components	25
3	Tools and equipments	25
4	Instruments and materials	33
5	Specifications of mulch laying implement attached to hand tractor	51
6	Mean bed width produced by the mulch bed implement	53
7	Mean soil width cover of the mulch bed implement	55
8	Mean time of laying of the mulch bed implement	57
9	The actual field capacity at different speeds of combinations	59
10	The efficiency of bed width forming with the mulch bed implement	60
11	Efficiency of soil width cover together with the different treatments	61
12	Efficiency of time in laying plastic mulch	62
13	Criteria for laying the plastic mulch	64
14	Summary of cost analysis	64

## LIST OF FIGURES

FIGURE		PAGES
1	Traditional laying of mulch	8
2	Bed and mulch terminology	9
3	Mulch laying equipment driven by tractor	14
4	3D Model of mulch laying machine	14
5	Components of the machine	15
6	Auto-CAD design of animal drawn plastic mulch laying machine	16
7	3-D Solid projection of developed animal drawn plastic mulch laying machine	17
8	Conceptual view of plastic mulch laying machine	17
9	Conceptual framework	20
10	Flowchart activities	21
11	Conceptual design	23
12	Elevation view of the proposed machine	27
13	Detailed drawing of furrow openers	28
14	Detailed drawing of the press wheel	29
15	Exploded view of mulch laying unit and press roller	30
16	Details of the soil covering unit	32

17	Experimental Field Layout	36
18	Field Experimental Layout	42
19	Final design with adjustments and modifications	49

## LIST OF APPENDICES

APPENDIX		PAGES
I	APPENDIX TABLES	75
II	APPENDIX FIGURES	84

## LIST OF APPENDIX TABLES

TABLE		PAGES
1	Analysis of Variance Completely Randomized Design	75
2	Bill of materials	76
3	ANOVA of bed width	77
4	Post Hoc Comparisons of speed in bed width	77
5	Post Hoc Comparisons of soil cover depth in bed width	78
6	ANOVA of soil width cover	78
7	Post Hoc Comparisons of speed in soil width cover	79
8	ANOVA of time in laying plastic mulch	79
9	Post Hoc Comparisons of speed in time	79
10	Post Hoc Comparisons of soil cover depth in time	80
11	Marginal mean of speed in soil cover width	80
12	Marginal mean speed in bed width	80
13	Marginal mean of soil cover depth in bed width	81
14	Marginal mean of speed in time of laying plastic mulch	81
15	Marginal mean of soil cover depth in time of laying plastic mulch	81
16	ANOVA of capacity in speed	82

17	Post Hoc Comparisons of capacity in speed	82
18	ANOVA of capacity in furrow depth	82
19	Post Hoc Comparisons of capacity in furrow depth	82
20	ANOVA of capacity in soil covering depth	83
21	Post Hoc Comparisons of capacity in soil covering depth	83
22	Post Hoc Comparisons of capacity in speed Marginal Means	83
23	Post Hoc Comparisons of capacity in furrow depth Marginal Means	83
24	Post Hoc Comparisons of capacity in soil cover depth Marginal Means	84
25	Summary of the computation in Cost Analysis	84

## LIST OF APPENDIX FIGURES

FIGURE		PAGES
1	Rear view	85
2	Left view	85
3	Right view	86
4	Front view	86
5	Isometric view	87
6	Preliminary field testing of the implement	87
7	Design for preliminary testing without modifications	88
8	Design for final testing with added modifications	88
9	Pre-testing evaluation of the implement	89
10	Trial phase of the implement	91
11	Assembly of the implements' final design adjustments and modifications	92
12	Testing phase of the Final Design	93
13	Preliminary testing in the field	93
14	Final testing	94

## **ABSTRACT**

**GALLANO, ISSA MARIE T. and VERGARA, NOLITO G. JR.,** Department of Agricultural and Biosystems Engineering, College of Engineering, **June 2023,**  
**MULCH BED IMPLEMENT ATTACHED TO HAND TRACTOR**

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The use of plastic mulch in vegetable production in the Philippines has shown significant benefits, including faster crop development, higher yields, and improved fruit quality. The application of plastic mulch remains tedious and laborious despite the availability of machinery of such purposes. The adoption of mulch bed implements attached to hand tractors may help farmers reduce labor and time required for mulching, enhancing efficiency and crop outcomes. The specific objectives of this study hence for to design a plastic mulch laying implement that can be attached to a commercial hand tractor, fabricate the implement using local materials and shop skills, evaluate the plastic mulch laying implement in terms of capacity and efficiency, and determine the relative cost of using the developed tool. The implement was designed and fabricated based on the approved design plans, considerations and specifications. It was fabricated from local materials using basic tools. The components of the implement include the frame, mulch laying unit, press wheel, press roller, opener (furrower), soil covering unit, and hitch.

The study found that a forward speed of 5 km/hr, furrow depths of either 10 cm or 14 cm, and a soil covering depth of 16 cm produced the best results, achieving the highest actual field capacity (AFC) of 0.38 ha/hr. The performance indicators in the study focused on evaluating the machine's field capacity and efficiency using different speeds of the hand tractor (low and high), different depths of opener operation, and different depths of soil

covering operation. A total of 8 combinations/treatments were tested, with three replicates each, resulting in 24 plots. The results indicated that both speed and soil covering significantly influenced the implement's performance.

In terms of bed width efficiency, the combination of 5 km/hr (A2), 10 cm (B1), and 16 cm (C2) stood out with the highest efficiency of 99.91%. For soil width cover efficiency, two combinations stood out: 5 km/hr (A2), 10 cm (B1), and 14 cm (C1), and 5 km/hr (A2), 12 cm (B2), and 14 cm (C1), both achieving an efficiency of 99.75%. In terms of time efficiency for laying plastic mulch, the combination of 3 km/hr (A1), 10 cm (B1), and 16 cm (C2) was the most effective, with an efficiency score of 90.28%.

The adoption of mulch bed implements combined with hand tractors for plastic mulch implement proves economically advantageous, with a short payback period of 2.6 months and a break-even point at 1.71 hectares per year. This approach not only ensures a quick return on investment but also indicates the potential for sustainable financial gains when covering a larger land area.

## LITERATURE CITED

- Abdelsamia Meselhy, A. (2020). Development the Wide Ridges Machine for Laying Drip Irrigation Tubes and Plastic Mulch in Ras Sudr-South of Sinai. *International Journal of Applied Agricultural Sciences*, 6(5), 135. <https://doi.org/10.11648/j.ijaas.20200605.15>
- Amin, S., Dixit, J., & Muzamil, M. (2022). Integrated plastic mulch laying machine: A viable technology for sustainable agricultural production. *Poljoprivredna Tehnika*, 47(1), 56–78. <https://doi.org/10.5937/poljtch2201066>
- Balli, S., Sajjan, S. C., Balli, S. R., & Shetty, P. (2020). *Design and Development of Tractor Operated Plastic Mulch Laying Machine Influence of Moonpool shapes on vessel response View project Mechanical Ox Replacing Tractors View project Design and Development of Tractor Operated Plastic Mulch Laying Machine*. <https://doi.org/10.5281/zenodo.3773814>
- BED & MULCH CONFIGURATIONS*. (n.d.).
- Dewangan, K. N., & Tewari, V. K. (2009). Vibration energy absorption in the hand-arm system of hand tractor operator. *Biosystems Engineering*, 103(4). <https://doi.org/10.1016/j.biosystemseng.2009.06.001>
- Dimensions and Costs of Polyethylene, Paper and Biodegradable Plastic Mulch*. (n.d.).
- Hanna, G. B., Maksoud, S. E. A., & Wahab, M. K. A. (1979). Effect of field size on machine field efficiency and ploughing costs [Land holdings in Egypt, mechanization]. In *AMA, agricultural mechanization in Asia: Vol. v. 10*.
- Hochmuth, G., Hochmuth, R., & Olson, S. (n.d.). *New Technologies in Mulching for Vegetable Production in Florida I*. <http://nfrec-sv.ifas.ufl.edu>.
- Holmer, R. J., & Drescher, A. W. (n.d.). *Empowering Urban Poor Communities through Integrated Vegetable Production in Allotment Gardens: The Case of Cagayan de Oro City, Philippines*.
- In, & Hod. (2016). "Design and Fabrication of Mini Tiller" *BACHELOR OF ENGINEERING Project Guide Head of the Department*.
- Iqbal, R., Raza, M. A. S., Valipour, M., Saleem, M. F., Zaheer, M. S., Ahmad, S., Toleikiene, M., Haider, I., Aslam, M. U., & Nazar, M. A. (2020). Potential agricultural and environmental benefits of mulches—a review. *Bulletin of the National Research Centre*, 44(1). <https://doi.org/10.1186/s42269-020-00290-3>
- Karthik T. (n.d.). *Fabrication of Agro Plastic Sheet Spreader*. [www.ijert.org](http://www.ijert.org)

- Kerketta, A. K., Moses, S. C., Khandai, S., & Pal, S. (2018). Performance Evaluation and Economic Analysis of Developed Manual Mulch Laying Machine. *International Journal of Current Microbiology and Applied Sciences*, 7(12), 2482–2487. <https://doi.org/10.20546/ijcmas.2018.712.282>
- Lament, W. J. (2018). Plastic Mulches for the Production of Vegetable Crops. *HortTechnology*, 3(1). <https://doi.org/10.21273/horttech.3.1.35>
- Lamont, W. J. (2017). Plastic Mulches for the Production of Vegetable Crops. *A Guide to the Manufacture, Performance, and Potential of Plastics in Agriculture*, 45–60. <https://doi.org/10.1016/B978-0-08-102170-5.00003-8>
- Marie Amongo, R. C., Amongo, L. D., & Victoria Larona, M. L. (n.d.). *Mechanizing Philippine Agriculture for Food Sufficiency 1*. [www.unapcaem.org](http://www.unapcaem.org)
- Maughan, T., & Drost, D. (2016). *Use of Plastic Mulch for Vegetable Production*.
- Mehta, C. R., Tiwari, P. S., & Varshney, A. C. (1997). Ride vibrations on a 7.5 kW rotary power tiller. *Journal of Agricultural and Engineering Research*, 66(3). <https://doi.org/10.1006/jaer.1996.0131>
- Miso, A. (n.d.). *A city-wide ecosan concept for Cagayan de Oro, Philippines*. <https://doi.org/10.13140/2.1.4695.8889>
- Nangare, K. R., Otari, A. A., Patil, G. I., Humbe, D. B., Chougule, J. B., & Sutar, U. P. (2020). Design and Development of Agricultural Mulching Paper and Drip Laying Machine. *International Journal of Innovative Research in Science, Engineering and Technology*. [www.ijirset.com](http://www.ijirset.com)
- Necessito Agusan del Sur (Philippines)), C. T. (Provincial A. O. (2002). Use of plastic mulch in vegetable production. In *PCARRD Highlights 2001 (Philippines): Vol. v. p. 123*.
- Omprabha, ., Victor, V. M., Chandraker, A. K., & Bhutia, N. P. (2020). Energetics and Cost Economics of Laying Plastic Mulch in Vegetable Cultivation. *Current Journal of Applied Science and Technology*, 20–25. <https://doi.org/10.9734/cjast/2020/v39i4831193>
- Palden Bhutia, N., Singh, S., Scholar, P., Verma, N., Omprabha, V. M., Victor, P., Bhutia, S., & Singh, P. (2022). Design and development of animal drawn plastic mulch laying machine. ~ 881 ~ *The Pharma Innovation Journal*, 5, 881–884. [www.thepharmajournal.com](http://www.thepharmajournal.com)

Patel, A. (2020). *Benefits of Power Tiller Operated Farm Machinery in Small / Marginal Farmers Conservation Agriculture View project Small agricultural machinery View project*. <https://www.researchgate.net/publication/350755399>

*Plastic Mulch for Vegetable Production FARMING*. (2019). [www.aces.edu/directory](http://www.aces.edu/directory).

Pradhan, P. L., Mishra, J. N., Paul, J. C., & Nanda, S. K. (2011). Development and evaluation of a power tiller operated planter for Maize. *AMA, Agricultural Mechanization in Asia, Africa and Latin America*, 42(4).

*PRINCIPLES OF FARM MACHINERY Third Edition*. (n.d.).

Pollard, S., & Morris, J. (1978). Economic aspects of the introduction of small tractors in developing countries towards a philosophy for small tractor development. In *J Proc Inst Agric Eng Lond*.

Sarian, Z. (2019). Plastic Mulching Made Easy. *January*. <https://www.agriculture.com.ph/2019/01/10/in-growing-various-crops-especially-vegetables-has-become-very-popular-with-farmers-these-days-this-is-the-use-of-a-plastic-sheet-installed-atop-the-planting-bed-the-usual-dimensions-of-those-on-t/>

Shashidhar, S., Rajesh, B., Seele, A., & Nived, M. (2020). Design and Fabrication of Plastic Mulching Machine for Agricultural Application.

TECA-Technologies and Practices for Small Agricultural Producers. 2015. Mulching in organic Agriculture.

Victor, V., & Gautam, A. (2019). Performance evaluation of animal drawn plastic mulch laying machine. ~ 280 ~ *Journal of Pharmacognosy and Phytochemistry*, 2, 280–283.

Viluan, M. P., (2021). Push-type Hole maker for mulch bed, Undergraduate Thesis CLSU, Munoz, Nueva Ecija