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Field Performance Evaluation of Power Weeder for Paddy Crop

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Abstract

Weeds are the main significant constraints in paddy production. Weed eradication by using herbicides and weedicides pronounced simple and fast method but is restricted due to its adverse effects on both environment as well as human beings. To overcome these limitations, mechanical weeding can be selected as appropriate weed control measure. Based on this, a modified power weeder was tested for weed control in upland paddy at 20 and 45 days after sowing (DAS) and the performance was compared with traditional hand weeding and manual operated mechanical weeder (*Ambika* paddy weeder). The modified power weeder show well prominence in weeding for up land paddy at 20 and 45 DAS and fuel efficient (0.63 to 073 l/h). The power weeder was found at par with the *Ambika* paddy weeder with a weeding efficiency of 74.22 % and 86% at 20 and 45 DAS respectively. There was no significant variation in field efficiency for Ambika paddy weeder at 20 & 45 DAS, but the highest field efficiency was shown by paddy power weeder as 70% for 45 DAS. The energy consumption was more in paddy power weeder than *Ambika* paddy weeder as 493.64 and 452.40 MJ/ha at20 and 45DAS respectively. The cost of operation per hectare with power weeder amounted to ₹928/-and ₹850/-against *Ambika* paddy weeder as ₹2,617/- and ₹2,346/- for 20 and 45 DAS respectively. The machine also depicted the energy-cost as 1.88 and 1.87 at 20 and 45 DAS respectively. Whereas the hand weeding showed the highest values in weeding efficiency and field efficiency at 20 and 45 DAS as it was an ideal method of weed control except for the cost of operation.

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Introduction

Paddy is the main cereal crop produced and consumed all around the world. Weeds are the main constraint in paddy production and a direct determinant for crop yield reduction. Weeds reduce the yield from 40% to 65% and its eradication is the

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most important challenge faced by the farmers.[1] It can be eradicated by hand weeding, chemical means, by using herbicides or by mechanical weeders. Hand weeding is the most efficient method in weeding but is not well suited due to more time consumption coupled with labour intensive operation and expenditure. Chemical method, show promising results in weed eradications but restricted due to its ill-effect on human beings and environment. Mechanical weeding promotes the plant growth as a result of increased soil aeration, root length and better tiller production. This may be done by traditional hand aided weeding tool; manual operated mechanical weeder and power weeders.

As a recommendation to control weeds, many studies were conducted by researchers by comparing traditional weeding methods with mechanical weeder.

A power weeder was developed, evaluated and performance was compared with conventional manual weeding with hoe and manually operated dry land weeder.[2] The field capacity of weeder was 0.04 ha/h with a weeding efficiency of 93%. The operational cost of the power weeder amounted to be `250/ha as against `490/ha by dry land weeder and `720 by manual weeding with hoe. Saving in time and cost was 93% and 65% respectively. As a recommendation to control weed,an engine operated rotary weeder with "L" shaped cutting blades system for wet land paddy was designed and developed.[3] This machine showed satisfactory result with field capacity ranges from 0.04 to 0.06 ha/h, field efficiency (71%) and weeding efficiency of 90.5%.

For the replacement of human labour with mechanical means, an engine operated weeder was designed, developed and tested.[4] This machine recorded field capacity (0.10ha/h), field efficiency (85.71%), weeding efficiency (85.85%), cost of operation (`580/ha) with fuel efficiency of 0.60 to 0.75 litres of kerosene per hour.

As a contribution to eradicate weeds, a rotory paddy power weeder with 1.4 hp petrol start kerosene run engine was designed, developed and fabricated.[5] A belt and pulley systems were used for power transmission from engine to traction wheel and to the cutting units. For weeding operation,"L" shaped blades fitted on a rotary shaft were provided. This machine depicted, weeding efficiency (91%), field efficiency (60%) and operational cost as `808.42/ha. Under the light of these research recommendations, it reveals that, mechanized weeding is the appropriate measure to eradicate weeds in short time. As a contribution to this, a power weeder was designed to eradicate weeds from line sown paddy crop. The study intends in the replacement of human labour by machine by reducing the weeding operational time and as an evident to achieve the productivity of the crop.

Materials and Methods

A power weeder for line sown upland paddy was modified at Swami Vivekanand College of Agricultural Engineering Technology & Research Station, Raipur in 2014-15. An empirical comparative analysis of this power weeder was done at 20 and 45 days after sowing (DAS) in test plots (26m × 5m) as 3 treatments; hand weeding (Treatment T_1), mechanical weeder (*Ambika paddy weeder*, (Treatment T_2) and paddy power weeder (Treatment T_3) with 5 replications at 28% and 30% moisture content (db) in Alphisol soil. The weeding efficiency, field efficiency, energy consumption, cost of operation and energy-cost ratios are the parameters of this comparative study. The technical specification of the modified paddy power weeder is depicted in Table1.

Weeding Efficiency

The weeding efficiency was determined by square quadrant of 1m×1m at randomly selected spots in the field.[6] It articulates as the ratio between the numbers of weeds removed to the numbers of weeds present in a unit area and is expressed in percentage.[4]

$$n_w = \frac{w_1 - w_2}{w_1} \times 100$$

Where, w_1 and w_2 are the number of weeds present per unit area at before and after the weeding operation.

Field Efficiency

It is the ratio of effective field capacity to the theoretical field capacity and is expressed in percentage.[7]

$$n_w = \frac{EFC}{TFC} \times 100$$

Where, η_F = Field efficiency (%), EFC = Effective field capacity (ha/h), TFC = Theoretical field capacity (ha/h)

Fuel Consumption

It is measured by topfill method; the fuel tank was filled to full capacity before the testing at levelled surface. After completion of test operation, amount of fuel required to topfill again is the fuel consumption and is expressed in litre per hour.[8]

Table 1: Technical specification of the modified paddy power weeder

Sl. No.	Particulars	Specifications
1.	Name and type	Paddy power weeder, 3 row walk behind type
2.	Make and model	Prototype
3.	Power source	1.4 hp, single cylinder, Petrol start kerosene run, Air cooled engine
4.	Over all dimensions	1900x700x900 mm
5.	Weight	98 kg
6.	Cutting unit and Blade type	Rotary type, "L" shaped blade
7.	Number of blades	12 Nos.(3 rowsx4 blades per row)
8.	Blade cutting length	50 mm
9.	Wheels	Two ground wheel and one gauge wheel at front end
10.	Cost of machine	` 30,875/-

Energy Consumption

The energy consumption of each treatment is based on total time taken during the weeding operation, weight of the implement and number of labours required for operation. For hand weeding, only man power was required and for paddy power weeder, the total fuel consumption was also taken into account. Data collected on weeding operations was multiplied by respective energy conversion coefficient for determining the energy consumption.[9] The human energy consumed, machine energy (Me), fuel energy and total energy consumption are expressed in MJ/ha and are determined as.[5]

Human Energy = Operation time (h/ha) × Energy equivalent × Number of labours required

Machine energy (Me) = $(W_{mc} \times E_{cm} \times T_r) \div (AWH \times L)$

Where, Me = Machine energy(MJ/ha), W_{mc} = Weight of the machine(Kg), E_{cm}= energy coefficient of machinery (MJ/kg), T_r= Time required (h/ha), AWH= Annual working hour(h), L= Useful life (years)

Fuel energy = Fuel consumption x Energy equivalent of fuel

The total energy consumed by the power weeder is the summation of human energy, machine energy and fuel energy.[9]

Operational Cost

The cost of operation was determined by straight line method with two heads known as fixed cost and variable cost. In fixed cost; depreciation, interest, tax and insurance, housing cost are taken as determinant. Whereas in variable cost; repair and maintenance cost, fuel and lubricant cost, wages of operator are considered.[10] The fixed cost is independent of operational use while variable cost varies proportionally with the amount of use. The total cost of weeding is determined by summation of total fixed cost per hour with total variable cost per hour.[5]

Energy - Cost

It is the ratio of cost of operation (`/ha) to the input energy (MJ/ha) required for the operation.[11] It is expressed in`/MJ.

E/C = Cost of operation/Input energy

Result and Discussion

The traditional method of weed management practice such as, hand weeding and mechanical weeder (*Ambika paddy weeder*) is compared with modified power weeder for controlling weeds.The performance in terms of weeding efficiency, field efficiency, energy consumption, cost of operation and energy cost ratio are evaluated in modified power weeder and other different weed management practices.

Weeding Efficiency

At 20 DAS, the intensity of the weed in test plots was higher, this may be due to, after land preparation with adequate soil moisture content, the weed seeds got the favourable condition for emergence and due to their greater competitive ability started growing more rapidly than the crop. Weeding efficiency for different weeding operations for 20 DAS and 45 DAS are depicted in Table2.The weeding efficiency for both 20 DAS and 45 DAS was highest as 88.53% and 95.67% respectively in treatment T^1 (Hand weeding) as the weeds were removed manually by farm labourers in which all weeds can be removed. The weeding operation was done in between intra rows only in case of treatment T_2 (*Ambika paddy weeder*) and T_3 (Paddy power weeder), hence the weeds in inter rows were difficult to be removed. This may be the manifestation of less weeding efficiency for treatment T_2 (63.04%) and T_3 (74.22%) as compared to treatment T_1 for 20 DAS. The treatment T_3 (Paddy power weeder) worked satisfactorily by cutting and removing the weeds though it works due to engine power, as a result, T_3 (paddy power weeder) showed highest result (74.22% and 86.00%) as compared to the T_2(*Ambika paddy weeder*) for 20 and 45 DAS.The influence of first weeding in 20 DAS triggered the reduction in weed population for 45 DAS. As a result, the weeding efficiency for 45 DAS was found to be more than 20 DAS for both T_2(*Ambika paddy weeder*) and T_3(paddy power weeder). Figure1 shows the weeding efficiency for different treatments.

Table 2: Weed population and weeding efficiency for different treatments at 20 and 45 DAS

Sl. No.	Treatments	Weed population for 20 DAS(No./m^2)		Weeding Efficiency for 20 DAS ηw(%)	Weed population for 45 DAS(No./m^2)		Weeding Efficiency for 45 DAS ηw(%)
		Before weeding (Average of) 5 values	After weeding (Average of 5 values)		Before weeding (Average of 5 values)	After weeding (Average of 5 values)	
1	T1	253.00	29.00	88.53	185.00	8.00	95.67
2	T2	138.00	51.00	63.04	108.00	28.00	74.00
3	T3	194.00	50.00	74.22	157.00	22.00	86.00

The soil moisture content can also influence the weeding efficiency. As the moisture content decreases, the weeds cannot be uprooted be removed completely by uprooting. Instead of, it may break above the ground level and allow the root portion under the soil. This may further grow and its eradication may also an impediment in future. As the moisture content increases, there will be slippage between the soil and traction device (wheels) of the weeder. Hence the weeding efficiency is affected. In this study, the moisture content was about 28 to 30%. As a result, the weeding efficiency was depicted as 74 to 86 % for treatment T_2 (*Ambika paddy weeder*) and treatment T_3 (Paddy power weeder). Whereas, in case of treatment T_1(Hand weeding), the human labour removes the weeds completely. Hence the efficiency of weeding was highest. The result of paddy power weeder for weeding efficiency was reported as 85.85% by 4. Whereas for manual operated mechanical weeder, the result reported by 12 was same as the current study.

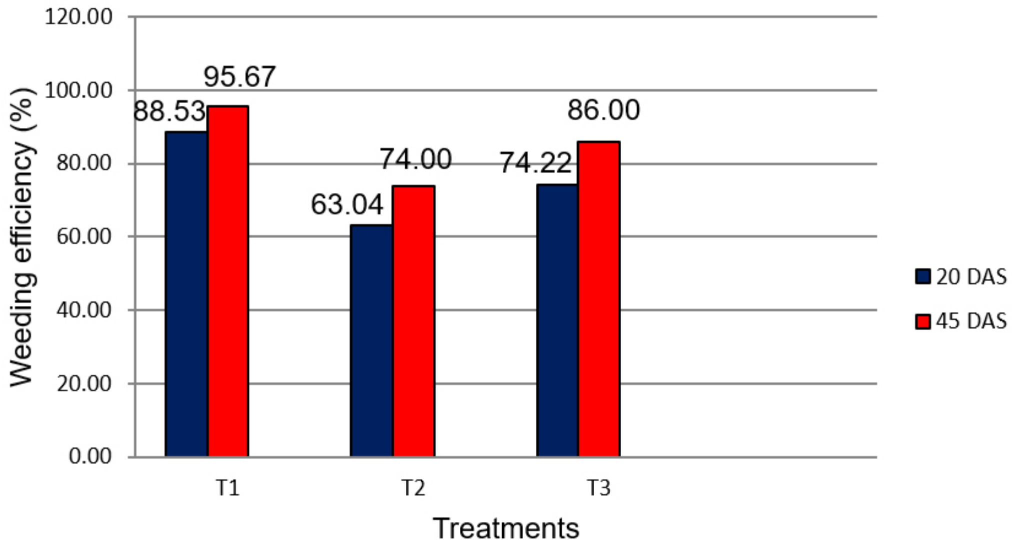

Fig. 1: Weeding Efficiency (%) for differents Treatments

Field Efficiency

The highest field efficiency, for 20 DAS was 66.20% for treatment T_2 (*Ambika paddy weeder*) and 64.00% for T_3 (Paddy power weeder). It was also observed that, for 45 DAS, the treatment T_3 (Paddy power weeder) depicted the maximum field efficiency as 70.00% followed by treatment T_2 (*Ambika paddy weeder*) as 65.00%. The treatment T_1 (Hand weeding) is regarded as more ideal method in which no machine parameter are included and weeds were removed by hand, so this method of weeding regarded as 100% efficient which depends on the efficiency of the farm labourers. But it is more time consumable and labour intensive. The field efficiency for different treatments at 20 and 45 DAS are shown in Table 3. Similar results were reports by 3 and 5 for field efficiency.

Table 3: Field efficiency for different treatments at 20 and 45 DAS

		Different Treatments	
		T_2	T_3
Effective field capacity (ha/h)	20 DAS	0.010	0.065
	45 DAS	0.011	0.071
Field efficiency (%)	20 DAS	66.20	64.00
	45 DAS	65.00	70.00

Energy Consumption

The energy consumed during weeding operation for different treatments are delineated in Table4. It depicts that the maximum energy consumed (493.64 MJ/ha and 452.40 MJ/ha)was recorded for treatment T_3 (Paddy power weeder) in operations on 20 and 45 DAS respectively. The treatment T_1 (Hand weeding) consumed the energy of 457.00MJ/ha and 424.60 MJ/ha for 20 and 45 DAS respectively. The main reason for this may be, treatment T^1 required more time for weeding operation and as a result the energy consumption for this operation may also increase.

The treatment T_3 (Paddy power weeder) consist of machine energy, human energy and fuel energy and the energy consumed for the operation was maximum and recorded as 493.64 and 452.40 MJ/ha for 20 and 45 DAS respectively. The reason for this may be; paddy power weeder runs by kerosene dependent prime mover which has higher energy coefficient and the weight of the machine is also high. The machine also showed a fuel consumption rate of 0.63 to 0.7l/h. As a result the energy consumption contributes higher in terms of machine energy and fuel energy in addition with human energy contribution. Even though the energy consumption is much more in treatment T_3 (power weeder) than treatment T_1 (hand weeding), but treatment T_3 (power weeder) show high prominence in less labour requirement and timeliness of operation.

Table 4: Energy consumption for different treatments at 20 and 45 DAS

Energy used		Different Treatments T_1	T_2	T_3
Man hours	20 DAS	233.00	100.00	15.40
(h/ha)	45 DAS	216.00	90.00	14.10
Human energy (MJ/ha)	20 DAS	457.00	197.40	30.15
	45 DAS	424.60	176.90	27.60
Machine energy	20 DAS	-	5.00	15.71
(MJ/ha)	45 DAS	-	4.50	14.40
Fuel energy	20 DAS	-	-	447.78
(MJ/ha)	45 DAS	-	-	410.40
Total energy used (MJ/ha)	20 DAS	457.00	202.40	493.64
	45 DAS	424.60	181.40	452.40

The treatment T_2 (*Ambika paddy weeder*) consumed 202.40 and 181.40 MJ/ha energy for 20 and 45 DAS. The main reason for this less energy consumption may be, Ambika paddy weeder is light weight as compare to paddy power weeder and not require fuel for its operation. As a result, machine energy is less and human energy is mainly contributed as energy consumption.

Cost of Operation

The total cost of weeding is gained from machine operation cost and labour cost for weeding. Whereas in hand weeding, the total cost of operation is just related to labour cost only. The highest operational cost per hectare (`5,979) was in $T_1$ (Hand weeding) and lowest operational cost (`928) was for T_3 (Paddy power weeder) for 20 DAS.

At 45 DAS the cost of operation per hectare for treatment T_2 depicted as`2,346/- and for treatment $T_3$ as`850. But in case of treatment T_1 the cost of operation was`5,552/- per hectare. During hand weeding (Treatment T_1) the time required for the work is more; as a result, the wages for the labourers will also increases whereas in paddy power weeder (Treatment T_3) and *Ambika paddy weeder* (Treatment T_2), the time engagement for the work is less and as a result the operational cost are also reduced. The cost of operation for different treatments for 20 and 45 DAS are shown in Table 5. However, for power weeder ; different results were reported by 4, 5 and 8 for cost of operation.

In energy – cost, there was no significant difference between the treatments T_1 (hand weeding) and treatment T_2 (*Ambika paddy weeder*) for weeding at 20 and 45 DAS. The minimum energy- cost was depicted by treatment T_3 (Paddy power weeder) and it was1.88 and 1.87`/MJ for 20 and 45 DAS respectively.

Table 5: Cost of operation for different treatments for 20 and 45 DAS

		Different Treatments		
		T_1	T_2	T_3
Man hours (h/ha)	20 DAS	233.00	100.00	15.40
	45 DAS	216.00	90.00	14.10
Total energy used (MJ/ha)	20 DAS	457.00	202.40	493.60
	45 DAS	424.60	181.40	452.50
Cost of operation (`/ha)	20 DAS	5,979	2,617	928.00
	45 DAS	5,552	2,346	850.00
Energy –cost (`/MJ)	20 DAS	13.08	12.92	1.88
	45 DAS	13.07	12.93	1.87

Conclusion

Though paddy is the main cereal crop, it is more vulnerable to weeds. It is imperative to mechanise the weed management for high production for small and medium farmers for the commercial paddy cultivation. The modified paddy power weeder is more appropriate for the weed management than *Ambika paddy weeder* with higher weeding efficiency at 20 and 45 DAS. Though the paddy power weeder and *Ambika paddy weeder* shows not much significant variation in field efficiency but is in case of operational cost, paddy power weeder is much more feasible than *Ambika paddy weeder*. Traditional hand weeding eradicates weeds better than other treatments but the affordability and adjustability of the mechanical weeder in connection with operational cost and energy consumption promotes the necessity of mechanized weeding.

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References

1. Sharma H. C., Singh H. B., Fires on G. H. Competition from weeds and their control in direct seeded rice. *Weed Research.*1977; 17(2):103-108.
2. Rangasamy K., Balasubramanian M., Swaminathan K. R., Evaluation of power weeder performance. *AMA.*1993;24(4): 16-18.
3. Victor V. M., Verma A. Design and development of power-operated rotary weeder for wetland paddy. *AMA.*2003;34(4):27-29.
4. Tajuddin A., Design. development and testing of engine operated weeder. *Agril. Engg.Today.* 2006;30(5, 6):25 – 29.
5. Mahilang K. K. S., Kumar K., Kanwar G. R. Design and development of power operated rotary weeder for rice. B. Tech. Thesis.Indira Gandhi Krishi Vishwa Vidyalaya, Raipur, Chattisgargh. 2013.
6. ISS: 7927- 1976. Method of field testing for manually operated paddy weeder
7. Kepner R. A., Bainer R., Barger E. L. Principles of farm machinery. 3rd edition. New Delhi: CBS Publications and Distributors. 1978.
8. Padole Y. B. Performance evaluation of rotory power weeder. *Agril.Engg.Today*.2007; 31(3, 4):30 – 33.

9. Singh S, Mittal J. P. Energy in production Agriculture. New Delhi: Mittal Publications. 1992.
10. Kamboj P., Khurana R., Dixit A. Farm machinery services provided by selected cooperative societies. Agricultural Engineering International:*CIGR Journal.*2012;14(4):123.
11. Jogdand S.V. Investigation of energy requirement in agriculture and application of energy audit principles to optimize man and machine energy contribution.Ph.D. thesis, Guru Ghasidas University, Bilaspur, Chattisgargh. 2007.
12. Shiru J. J. Design and development of push-pull mechanical weeder for farmer's use. *The Nigerian Academic Forum.*2011;21(1).