Motorized Wheel Hoe

Madhu. R[1], Veeresh Amaragatti[2], Arkesh Prasad[2], Madhu A[2]

[1]Assistant Prof, Department of Mechanical Engineering, NIE-IT, Mysuru, India
[2]Students, Department of Mechanical Engineering, NIE-IT, Mysuru, India.

Abstract: **India is an agriculture-based country, where 58% of the population is based on agriculture for their livelihood. Indian agriculture sector accounts for 18% of India's gross domestic product (GDP) and provides employment to about 50% of the country's workforce. In most of the developing countries, women constitute as one of the important sources of farm power. Among all agricultural activities, weeding is predominantly the responsibility of women. Weeds are unwanted plants that grow in various fields and gardens, these weeds must be removed for proper cultivation of crops**

Off late, different types of weeders are being developed in India. These weeders are helpful for weeding in agricultural activities. Weeding by manually operated weeders increase the efficiency of workers and the productivity of work. Manual weeding requires huge labor force and accounts for about 25 per cent of the total labor requirement, which is usually 900 to 1200 man-hours/hectare per year (Nag and Dutta, 1979). In India, this operation is mostly performed manually with cutlass or hoe that requires high labor input.

Many weeding implements have been developed, amongst which are the traditional hoes, spades and the cutlasses. Their effectiveness is still very low with high-energy demand. The average energy demand of the traditional tillage hoe ranges from 7 to 9.5kJ/min when compared with 4.5 kJ/min (75 watts) which is optimum limit of continuous energy output of man (Nwuba,1981). In India, the annual loss due to weeds in food grains is about 82 million tons (P. K. Singh, 2013).

A Wheel hoe is a mechanical device used by farmers forplugging, weeding and cultivating. It was invented by a horse farm tools manufacturer Planet, in the year 1890. The aim of our project is to design and develop a semi-automated multipurpose agricultural wheel hoe to use of various agricultural operations in single equipment. Very few Indian farmers have Tractors; but not all the farmers can afford a tractor. An alternative for tractor is the power tillers, which is also expensive. There exists another alternative called wheel hoe. It is manual driven equipment used for agricultural operations.

Moreover, the labor requirement for weeding depends on weed flora, weed intensity, time of weeding, and soil moisture at the time of weeding and efficiency of worker. Behera and Swain (2005) reported that manually operated weeders have found acceptability due to their low cost. The performance of the weeders as well as the operator vastly depends on the design of the weeders. A weeder if designed without considering human capabilities will fail to deliver the desired result and will be finally rejected by the worker.

The possible outcomes of this project are:

- **The working efficiency is set to increase with the reduced power to weight ratio.**
- **Reduced cost with reliable performance output.**
- **People with different physics can be accommodated on this equipment.**
- **Required amount of load can be applied downwards leading to the better plowing of land.**
- **Maximum land is supposed to be ploughed at a single stretch.**

The main aim of our project is to design and fabrication of multipurpose agricultural equipment, we have designed a model running with fuel and also easy to operate for a user. In this equipment we find that we have simply used a sprocket mounted on rear shaft which will carry the loads with other two wheels. Also the assembly consists of 3 wheels out of which 1 is mounted on front and 2 are mounted as guide wheel at rear end. A sprocket is mounted on rear side exactly at the centre of shaft. By pulling the sprocket on shaft that will generate enough torque required. It consists of cultivator, weed remover and a plough.

A plough tool is attached to the bottom of the frame. When we move the complete assembly, ploughing at required distance can be carried out. It helps small scale farmers to save the time and labour. This type of a tadpole configuration gives another feature to add a comfort zone so that a farmer can sit over the engine. This saves much of manpower and the same energy can be utilized to cultivate a larger area in shorter time.

The main intention of transforming conventional wheel hoe to a motorized one is to provide farmers having a low land holding of about 1 to 2 acre the accessibility to carry out agricultural activities at a reduced cost that allows farmers to save on their expenses and add profit to their work. This reduction in expenses would eventually reduce the cost of agricultural products.

Feature of changing the plough distance with respect to required cropping is supported by just fastening the bolts and nuts along with equipment. Cultivating the land by applying no physical efforts by the farmer helps to maintain the health and do more work.

Motorizing is beneficial in both the ways of reduced land cultivation time and quantity of fuel consumption per acre of land. This portable product is designed to its maximum optimal functioning at a very lost cost of 15000 INR this is six times cheaper compared to purchasing of one mini tractor.

Keywords: **Hoe, Weeds, Comfort, Processing speed.**

I. INTRODUCTION

Following are the conventional means of agricultural practices. These are used to find a comparison for a better product development.

The conventional methods of agriculture are mentioned below;

1.1 Wheel Hoe

Weeding is an important but equally labor-intensive agricultural unit operation. Weeding accounts for about 25% of the total labor requirement ranging from 900-1200 man hour/hectare during cultivation season (Nag and Dutta, 1979). Its delay and negligence reduces crop yield from 30 to 60% (Singh, 1988). Weed control has become a highly specialized activity employing thousands of people especially in developing countries. This activity involves industries providing the necessary chemicals (herbicide), and individuals engaging in the practices of weed control. Traditional method of weeding takes longer time for weeding. Women generally adopt squatting and bending posture while doing the activity and maintain it for long hours, which cause musculo-skeletal problems (Sharma, 1999). Off late, different types of weeders are being developed in India. These weeders are helpful for weeding in agricultural activities. Weeding by manually operated weed removers increase the efficiency of workers and the productivity of work. Manual weeding requires huge labor force and accounts for about 25 per cent of the total labor requirement, which is usually 900 to 1200 man-hours/ hectare per year. In India, this operation is mostly performed manually with cutlass or hoe that requires high labor input, very tedious and it is a time-consuming process.

Fig 1.1 Double wheel hoe   Fig 1.2 Single wheel hoe

1.2 Weed Remover

Weed control is the botanical component of pest control, which attempts to stop weeds, especially noxious or injurious weeds, from competing with desired flora and fauna, this includes domesticated plants and livestock, and in natural settings, it includes stopping non local species competing with native, local, species, especially so in reserves and heritage areas.

Weed control is important in agriculture. Many strategies have been developed in order to contain these plants. Methods include hand cultivation with hoes, powered cultivation with cultivators, smothering with mulch, lethal wilting with high heat, burning, and chemical attack with herbicides (weed killers).

Fig. 1.2 Weed Remover

1.3 Cultivator

A cultivator is any of several types of farm implement used for secondary tillage. One sense of the name refers to frames with the teeth (also called shanks) that pierce the soil as they are dragged through it linearly. Another sense refers to machines that use rotary motion of disks or teeth to accomplish a similar result. The rotary tiller is a principal example.

Cultivators stir and pulverize the soil, either before planting (to aerate the soil and prepare a smooth, loose seedbed) or after the crop has begun growing (to kill weeds). Unlike a harrow, which disturbs the entire surface of the soil, cultivators are designed to disturb the soil in careful patterns, sparing the crop plants but disrupting the weeds.

Fig.1.3 Tractor attach cultivator

1.4 Mini Tiller

Mini Tiller is same as that of cultivator.

Fig. 1.4Mini Tiller

II. PROPOSED METHODOLOGY

2.1 Selection of sample:

Twenty non-pregnant women from KVK adopted village Hanumantiya panwar of Neemuch district, Madhya Pradesh, India with normal health without any major illness or cardio-vascular problems in the age range of 25 to 40 years having normal blood pressure and body temperature were selected.

Body height, weight and BMI of each subject were measured. The grading of health status of women based on BMI was done. The BMI scores were interpreted as per the classification given by Garrow (1987).Each respondent was tied the heart rate monitoring machine and was switched on to record the heart rate at every minute. In order to record the resting heart rate, five minutes rest was given. They were then asked to perform the weeding activity for 30 minutes and heart rate was recorded at an interval of 1 minute each and then five minutes rest was given. The heart rate monitor was switched off and removed. The heart rate during rest, work and recovery were recorded while working with traditional as well as single-wheel hoe weeder.

2.2 Assessment of physiological cost of work:

The energy expenditure (KJ/min) was estimated using the following formula proposed by Varghese *et al*. (1994) for Indian homemakers.Circulatory stress was estimated from cardiac cost of work and cardiac cost of recovery. The cardiac cost of recovery is the total number of heartbeats spent above the resting level in order to perform the work. The cardiac cost of recovery is the total number of heartbeats above the resting level occurring between the end of work and return to the pre-activity state (Saha, 1976).

Following formulae were used for calculation of physiological cost of work (PCW) and total cardiac cost of work (TCCW).

Cardiac cost of work = Average heart rate (AHR) x Duration of activity ... (2)

Where,

AHR = Average working heart rate – Average resting heart rate

Classification of workload:

Workload of activity was categorized as per the classification of workload in different occupations proposed by Varghese *et al.* (1994).

2.3 Muscular-skeletal problems:

Incidence of muscular-skeletal problems was identified using the body map (Fig. B) indicating pain in different parts of the body before and just after the completion of theactivity. Five-point scale was used to record the intensity of pain in the various body parts and I for the intensity of pain as very severe, severe, moderate, mild and very mild, respectively.

Weeding is an agro activity where muscular-skeletal problems are very pronounced. The reason being the activity is time bound and performed continuously for prolonged hours. The traditional method employs bending and squatting posture while pulling out weeds with either bare hands or using short handled Kudali or Khurpi.

Muscular-skeletal problems and posture were evaluated by asking the respondents as to where they felt pain in their body after weeding with traditional and improved technology. Table 5 depicts that weeding with traditional tools in strenuous posture caused severe pain in shoulders, upper and mid back and upper arms. The women perceived the task as very heavy. On the contrary using improved weeding tool induced moderate to light discomfort/pain in shoulders, arms, wrist and neck. They were relieved from back pain as improved tool employed standing posture and eliminated back breaking bending and squatting posture. The rating of perceived exertion was also reported as moderately heavy with use of improved tool.

Motorized wheel is technologically upgraded agricultural equipment with a whole thinking over the comfort for farmer to enable the faster agricultural processing such as weed removing, ploughing, cultivating.

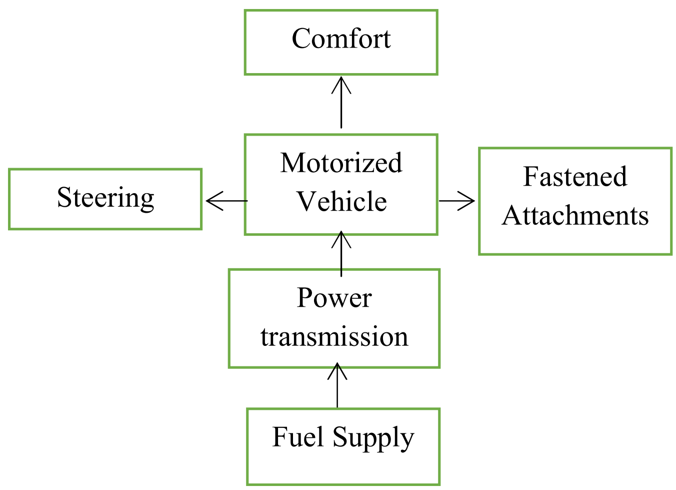


Fig2.3.1 Block diagram of product configuration

A seat is allotted right on top of the engine that is connected to chassis. Ample of foot room is available to adjust the comfort level based on type of agricultural process. The design is robust so enough space is available at the end of vehicle to fasten the equipment's (Plough, Cultivator, Weed remover). The capacity of vehicle is quiet enough to easily process 1 to 2 acers of land each cycle, thereby followed by maintenance.

2.4 Planning Phase

The planning phase begins with corporate strategy and includes assessment of technology development and market objectives. The output of planning phase is project mission statement, which specifies the target market for the product, business goals, key assumptions and constraints. Which also includes the concept development phase, where the needs of target market is identified, alternative product concepts are generated and evaluated, and one or more concepts are selected for further development and testing .A concept is a description of the form, function and features of a product and is usually accompanied by a set of specifications, an analysis of competitive products and an economic justification of the project.

2.5 DO (design) Phase

This phase includes the definition of the product architecture and the decomposition of the product into subsystems and components. The final assembly scheme for the production system is usually defined during this phase as well. The output of this phase usually includes a geometric layout of the product, a functional specification of each of the products subsystems, and a preliminary process flow diagram for the final assembly process.

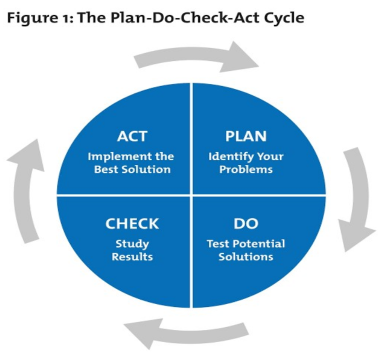


Fig2.4.1 PDCA cycle

- *Detail design*

This phase includes the complete specification of the geometry, materials and tolerances of all of the unique parts in the product and the identification of all of the standard parts to be purchased from suppliers. A process plan is established and tooling designed is designed for each part to be fabricated within the production system. The output of this phase is the control documentation of the product – Drawings or computer files describing the geometry of each part and its production tooling, the specifications of the purchased parts, and the process plans for the fabrication and assembly of the product. Two critical issues addressed in the detail design phase are production cost and robust performance.

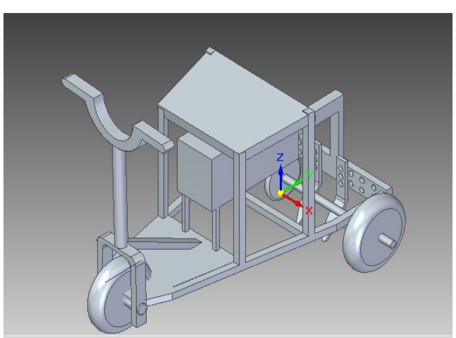


Fig 2.5.1 CAED design of wheel Hoe

2.6 Check (Testing and refinement) Phase

This phase involves the construction and evaluation of multiple preproduction versions of the product. At this stage the equipment is tested in the fields by working for 10 hrs and to determine the performance and other factors. The feedback from the formers is collected later, by testing it in different crop cultivation. The work performances, reliability, load bearing capacity after working through the different crop forming.

2.7 Act Phase

In this phase, the feedback on the developed product is analyzed using the results from testing and any small modification of the product is done if necessary. The purpose of the act phase is to train the work force and to work out any remaining problems in the production processes. Products produced during this phase are sometimes supplied to preferred customers and are carefully evaluated to identify any remaining flaws.

III. PROPOSED DESIGN

The design implemented for this particular activity is calculated. And the design values for the same are derived below

Considerations:

Speed (N)=15Kmph

Mass(human)= 80Kg

Mass(vehicle)= 100Kg} Mass(net)=200Kg

Bending stress= 320/2=160Mpa

Shear stress=

Bending stress/2= 160/2=80Mpa

Power (P)=2KW

$T= \frac{9.55*10^6*P}{n} = \frac{9.55*10^6*2}{108.33}$

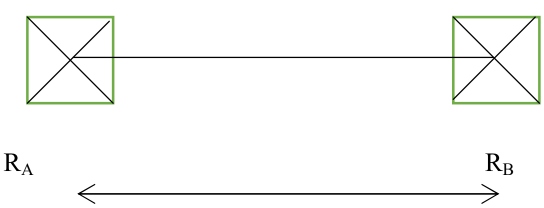
T= 17631.117Nmm

$\tau= \frac{16T}{\pi d^3} = \frac{16*176313.117}{\pi*d^3}$=80Mpa

d=22.390 ̰= 24mm standard diameter

$$\sum Fy = 0$$

$R_{A}+R_{B}=$ 2KN



R_A R_B

50cm

$$\sum Ma = 0$$

$$(2 * 10^3 * 25 * 10^{-2}) = Rb * 50 * 10^{-2}$$

Rb=10KN

Similarly **Ra= 1KN**

$\sigma_{b=}\frac{32}{\pi d^3} = \frac{32*50}{\pi * d^3} = 160$

$$1600 = 502.65d^3$$

$$d^3 = 3.18mm$$

$$\boldsymbol{d = 1.47mm}$$

$\frac{32M}{\pi 24^3}$ =>$\boldsymbol{\sigma_{b = 0.0368Mpa}}$

Hence the shaft diameter is said to be 24mm

Calculation for plate thickness for platform:-

$$\sigma b = \frac{My}{I}$$

I= Moment of inertia

b= Breadth of plate

t= Thickness of plate

M= Mending moment

$\boldsymbol{\sigma_{b=}}$ Bending stress

$$I = \frac{bt^3}{12}$$

$$y = \frac{t}{2}$$

M = 50Nmm

$\boldsymbol{\sigma_{b=}}$ 160mpa

$$160 = \frac{50 * (t/2)}{2t^4/12}$$

$$160 = \frac{50 * 12 * (t/2)}{2t^4}$$

$$320t^4 = 300t$$

$$t^3 = 0.935$$

$$\boldsymbol{t = 0.977 \cong 1mm}$$

Therefore the galvanized plate thickness of 1 mm is selected for platform

IV. HARDWARE DETAILS

The various components used are as follows:

- Chassis
- Engine
- Battery
- Chain drive
- Wheels
- Attachments

4.1Chassis:

A chassis is the framework of an artificial object, which supports the object in its construction and use. An example of a chassis is a vehicle frame, the underpart of a motor vehicle, on which the body is mounted; if the running gearsuch as wheels and transmission, and sometimes even the driver's seat, are included, then the assembly is described as a rolling chassis.

The type of chassis used is a trapezoidal where the leading edge is 12 inch long and trailing edge to be 24 feet.

A space of 24inch * 14inch is rectangular to fit bearing blocks with shaft and gear.

4.2Engine:

The engine selected to suit agricultural activity is HONDA ACTIVA bearing a powerful 100cc 4stoke single cylinder, that produces a power of 7bhp (5.2 kw) along with torque of 8.47 Nm at 300 rpm which can be sufficiently used to plough the land.

Bore and stroke	50 x 55.6
Compression ratio	9.5: 1
Spark Plug	MRC7C-9N
Idle Speed	1700+.100 – 1rpm

Table4.2.1 Engine specification

4.3 Battery:

The battery used is lead acid, having a capacity of 12V and running time of 5 Ah.

4.4 Chain Drive:

Chaindrive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

Most often, the power is conveyed by a roller chain, known as the drivechain or transmissionchain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The teeth ratio of sprocket is 44:14 and sprocket speed (i) being 3.14.

4.5 Wheels:

To roll the whole chassis in desired direction the wheels selected are rubber tiers with a larger wheel grip offset to have a satisfactory traction in slippery agricultural land. The dimensions are standardized to a size of 12 inches each.

Content	Specification
Tire type	Tubeless
Tire size	90/100-10
Diameter	12 inches
Rim size	10inch
Brake type, size	Drum, 130mm

Table 4.5.1 Wheel specifications

4.6 Attachments:

A cultivator is any of several types of farm implement used for secondary tillage. One sense of the name refers to frames with the teeth (also called shanks) that pierce the soil as they are dragged through it linearly. Another sense refers to machines that use rotary motion of disks or teeth to accomplish a similar result. The rotary tiller is a principal example.

Fig 4.6.1 Plough

Fig 4.6.2 Cultivator

Weed control is important in agriculture. Many strategies have been developed in order to contain these plants. Methods include hand cultivation with hoes, powered cultivation with cultivators, smothering with mulch, lethal wilting with high heat, burning, and chemical attack with herbicides (weed killers).

V. TESTING & RESULTS

The machine was tested for its performance. The land was first plowed and was tested for structural stability this was initiated by testing the plough in soil, initially few deflections were found and heat treatment was carried out to overcome this issue.

Testing was carried out to visualize the practical results, after heat treatment no deflections in plow were found. The depth of plow was 3 inches deep that is sufficient for seeding of crops like corn, paddy, tomatoes etc

Sl. No.	Functioning	Depth of dig	Distance adjustment
1	Plough	3 inch	3,6,9 inch
2	cultivator	4 inch	6 inch

Table 5.1 – 1 Summary of test results

VI. BILL OF MATERIALS

Sl. No.	Part Description	Quantity – No’s	Cost
1	Engine	1	5000/-
2	Wheel assembly	2	1, 500/-
3	Chain sprocket	1	500/-
4	Battery	1	1500/-
5	Fork set	1	1000/-
6	Fuel tank	1	100/-
7	Agricultural equipment’s	5	2000/-
8	Fabrication	-	4000/-
Total Manufacturing Cost			**Rs. 15600/-**

Table 6.1 Estimated Costs

VII. CONCLUSIONS

The product developed is able to successfully plough and cultivate the hard agricultural land, It is capable of carrying a human over a chassis with the attachments at the end of vehicle with a 100cc engine.

The main intention of transforming conventional wheel hoe to a motorized one is to provide farmers having a low land holding of about 1 to 2 acre the accessibility to carry out agricultural activities at a reduced cost that allows farmers to save on their expenses and add profit to their work. This reduction in expenses eventually reduces the cost of agricultural products.

VIII. RESULTS

The developed model is capable of performing well at extreme working condition like rocky soil, gravel land. The intention and outcome of this project is practically achieved without any failure in any structural member.

BIBILOGRAPHY

Madhu.R, Assistant Prof, mechanical engineering from NIE-Institute of Technology, Mysuru.

Veeresh Amaragatti, BE in mechanical engineering from NIE-Institute of Technology, Mysuru.

Arkesh Prasad, BE in mechanical engineering from NIE-Institute of Technology, Mysuru.

Madhu A, BE in mechanical engineering from NIE-Institute of Technology, Mysuru.

ACKNOWLEDGEMENTS

This project entitled "Motorized Wheel Hoe" is supported by the institution NIE-IT, Mysuru. We take this opportunity to thank our prof Madhu R, NIE-IT, Mysuru for all their support.

REFERENCES

[1]. ROTARY HOE WHEEL, a paper by *J.F. RUDE ETAL;* Patent no:US2600332
Patent on: June.10, 1952

[2]. Wheeled Long-Handle Weeder *PAPER BY: Silas O. Nkakini, and Abu Husseni*

[3]. MANUALLY OPERATED WEEDER*PAPER BY:SinghNERIST, Nirjuli*

[4]. SEMI AUTOMATED MULTIPURPOSE AGRICULTURE WHEEL HOE*PAPER BY:PRASHANTHA KUMAR S T*

[5]. SINGLE WHEEL HOE IN REDUCING DRUDGERY*Paper by: SHILPI VERMA, SHOBHANAGUPTA AND C.P. PACHAURI*

[6]. Effect of twin wheel hoe on efficiency. Paper By:DeepaliBajpai**.**Patent no: E-ISSN**:** 2278-4136 P-ISSN**:** 2349-8234 Patent on: Sept.07, 2016.

[7]. WHEEL WEEDERPaper By: S, FULLER.Patent no:724,175. Patented on:Mar.31, 1903.