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Concept Design and Analysis of Multipurpose Farm Equipment

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Abstract- All trades of village artisanship in black-smith carpentry, stone etc. contributed to the design of development of farm tools through artisan's ingenuity. Carpentry made the counterpoise to lift the water from wells to irrigate crops. Big size of earthenware was made by potters to store grains for month to be safe from insects and pest's cobblers used whole skins of animals to carry water to irrigate horticultural crops besides entering dust roads. Farming is the backbone of Indian economy. In this agriculture sector there is a lot of field work, such as weeding, reaping, sowing etc. Apart from these operations, spraying is also an important operation to be performed by the farmer to protect the cultivated crops from insects, pests, funguses and diseases for which various insecticides, pesticides, fungicides and nutrients are sprayed on crops for protection. As agriculture was the mainstay of the population, farmer required hand tools to do work, improve labor productivity and quality of work, therefore the results in poor productivity and obtain low yield MAE(Multipurpose Agriculture Equipment) was developed. We have developed agriculture needs to find new ways to improve efficiency. One approach is to utilize available information technologies in the form of more intelligent machines to reduce and target energy inputs in more effective ways than in the past. The advent of new concept gives the opportunity to develop a complete new range of agricultural equipment based on small smart machines that can do the right thing, in the right place, at the right time in the right way.

Keywords- MAE(Multipurpose Agriculture Equipment)

I. INTRODUCTION

Farming has undergone a great evolution in last 50 years. Out of the various reasons involved for this evolution is control of various diseases on crops. During initial days there was only hand spraying people use to do. Then slowly there has been development of various methods to spray out chemicals and dusts. Though these devices were highly efficient, there is a need to have certain changes. Chemicals are widely used for controlling disease, insects and weeds in the crops. They are able to save a crop from pest attack only when applied in time. They need to be applied on plants and soil in the form of spray, dust or mist. The chemicals are costly; therefore equipment for uniform and effective application is essential. Dusters and sprayers are generally used for applying chemical. The application of pesticide is one of the most frequently used methods to protect crops and trees against diseases and insects in agriculture. In the modern agriculture, the usage of pesticides is still increasing, moreover the 90% of these pesticides are being applied in the form of liquid spray and mostly by using the pressure gained from direct energy sources like electrical energy and chemical energy. Increasing public concern about the potential damage of chemical and electrical inputs in agricultural spraying systems has challenged industry to develop new and effective methods of spraying which will maintain environment friendly approach.

II. DIFFERENT OPERATIONS

A. *Sowing and Fertilizer*

It is used for line sowing and fertilizing of cereals and other crops. It is a low cost line-sowing device in which seed metering is done manually by the operator by dropping the seeds in the funnel provided for the purpose.

B. *Inter Cultivation*

It is used for leveling of beds, crushing of clods, and collection of uprooted weeds and aeration of soil. It is a long handled tool and consists of spikes, welded to a Z shaped frame made from joining two pieces of angle to connect with body by fasteners.

C. *Spraying*

Designing of spraying mechanism which is driven by the chain and sprocket by the front wheel of the unit.

D. *Objective's of the Present study*

The following are the objectives of this project work:

- It is the best and economic to farmers in today's world without any huge investments and it can be worked without any external source like (electrical, solar energy) and we can contribute today's world without air pollution and water pollution. And it can accessed by any kind of farmer at low cost. The recommended drown to row spacing seeds rate, seed to seeds spacing and depth of seed placement vary from crop to crop and for different agro-climatic conditions to achieve optimum yields.

- To improve the soil conditions by reducing evaporation from the soil surface, improve infiltration of rain or surface water; reduce runoff to maintain ridges or beds on which the crop is grown and to reduce competition of weeds for light, nutrients and water.
- Chemicals are widely used for controlling disease, in sects and weeds in the crops. They are able to save a crop from pest attack only when applied in time. They need to be applied on plants and soil in the form of spray, dust or mist. The chemicals are costly. Therefore, Equipment for uniform and effective application is essential. so to adopt new method of applying chemicals, by using chemical sprayer equipment.

III. CONCEPT DEVELOPMENT

A. *Introduction*

The different kinds of problems faced in traditional method of using individual equipments for agriculture field are mentioned below. We are using three concepts and are developed for multipurpose agriculture equipment and the best concept is selected using bi cycle.

B. *Need Analysis*

1. Gathering raw data from the customers.
2. Interpreting the raw data in terms of customer needs.
3. Organizing the needs into primary, secondary and tertiary needs.
4. Establishing relative importance of needs.

C. *Concept Generation*

Concept 1: The first concept developed for MAE is shown in the below fig 1, the frame is in cubic shape and the attachment like sprayer, flow pipe of fertilizers and sowing were assembled closed cubic, and the inter cultivator placed at the bottom side. The front wheel having snipers which helps in easy flow in wet land, and there are two rear wheel which is supporting to the cubic, cutter can also be adjusted by the handle provide to it, the sprayer is driven by the front wheel drive. The cubic structure is bulky and it's not such easy to operate by the operator and also it's not economical.

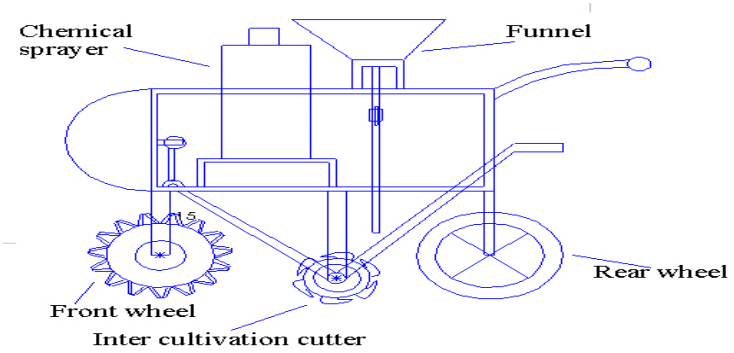

Fig. 1 Schematic of multipurpose agricultural equipment Concept 1

Concept 2: In this concept as shown in fig 2, a single frame is used to mount all the equipments like chemical sprayer at the front side of the wheel and the cylinder to maintain the chemical in liquid form at the middle of the frame. The shape of the Hooper is V and is placed near to handle of the operator since it will be easy to operate the flow of seeds and fertilizers. Inter cultivation is placed at the rear side of the frame base.

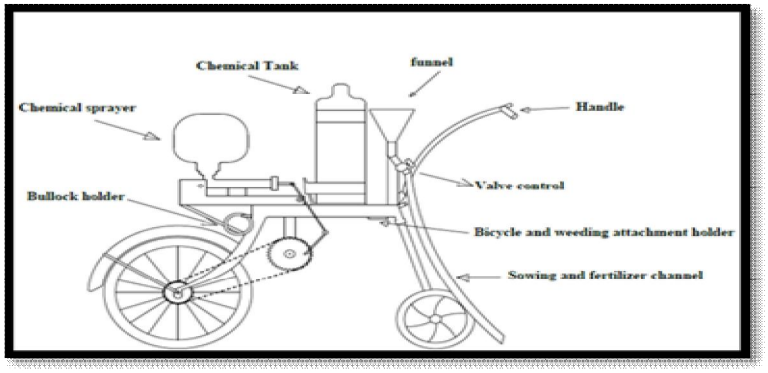

Fig. 2 Schematic of multipurpose agricultural equipment Concept 2

Concept 3: In this concept as shown in fig 3, a single frame is used to mount all the equipments like chemical sprayer at the front side of the wheel and the cylinder to maintain the chemical in liquid form at the middle of the frame. The shape of the Hooper is V and is placed near to handle of the operator since it will be easy to operate the flow of seeds and fertilizers. Inter cultivation is placed at the rear side of the frame base. Using single frame and single attachment of bicycle results in reduction in space, cost, and also helps in local transportation 3

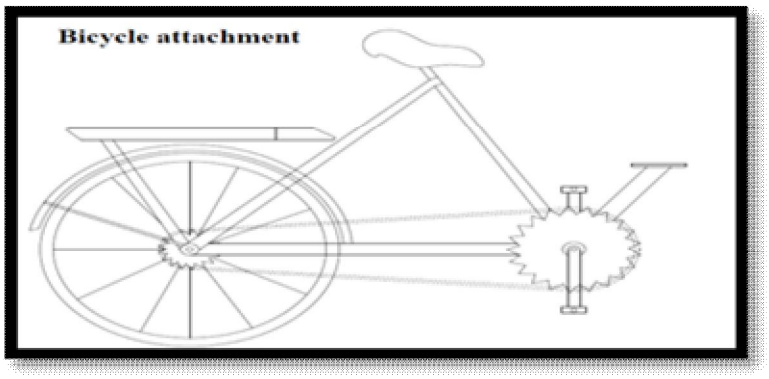

Fig. 3: Schematic of multipurpose farm equipment Concept 3

D. Concept selection

TABLE 1 - PUGH MATRIX SELECTION CRITERIA FOR THE MULTIPURPOSE FARM EQUIPMENT

KEY CRITERIA	CONCEPT 1	CONCEPT 2	CONCEPT 3
EASE OF DESIGN	-	+	0
SAFETY	+	+	0
EASE OF FUNCTION	+	0	0
EASE OF MANUFACTURE	-	-	+
EASE OF USE	-	+	+
SUM OF POSITIVES(+'S)	2	3	2
SUM OF ZEROS(0'S)	0	1	3
SUM OF NEGATIVES(-'S)	3	1	0
NET SCORE	-1	3	5
RANK	3	2	1

Concept 1: Gear mechanism results in difficulties in fabrication.
Concept 2: Chain and sprocket arrangement increases the complexity of manufacturing.
Concept 3: Due to design simplicity and cost effectiveness, this concept is selected.

IV. DESIGN AND DEVELOPMENT

A.Plan – Layout of the model

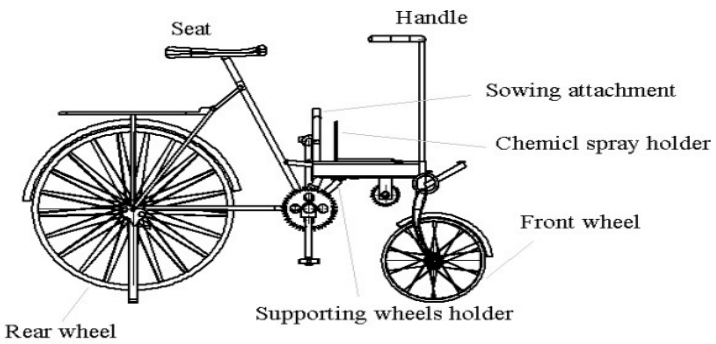

Fig. 4 Bicycle assembly as multipurpose agriculture equipment

The attachments like inter cultivation sowing and feeding and chemical sprayer can be replaced on the final assembly for specific functions. Any one of the attachments must be fixed on the bicycle assembly of multipurpose agricultural equipment.

B. Sowing and Fertilizer

Fig. 5 supporting rear wheels attachment and Sowing and fertilizer with control values

C. Chemical Sprayer

Fig. 1 Chemical sprayer having front wheel has its driver with sprocket and kinematic links

D. Inter Cultivation

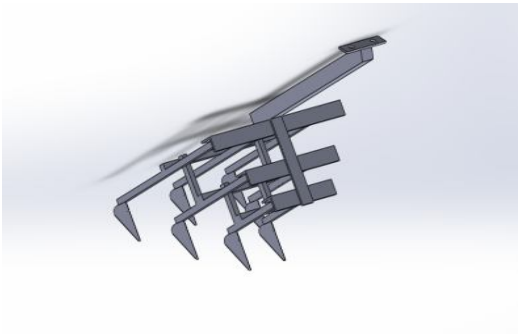

Fig. 7 Weeding and Inter Cultivation

E. Design of various parts

1) Rear wheel axle shaft Design

For a main shaft which is a power generator, power is given as,

P=FxV---------- (1)

Our whole assembly will have weight approximately equal to 60kilograms.Thus total force acting will be on 5 wheels. Out of those 4 wheels we have maximum load acting on rear wheels mounted on shaft. This shaft is subjected to approximately 50 kilograms of load. So force acting on shaft is given by,

F=mxg---------- (2)

Putting m=50kg

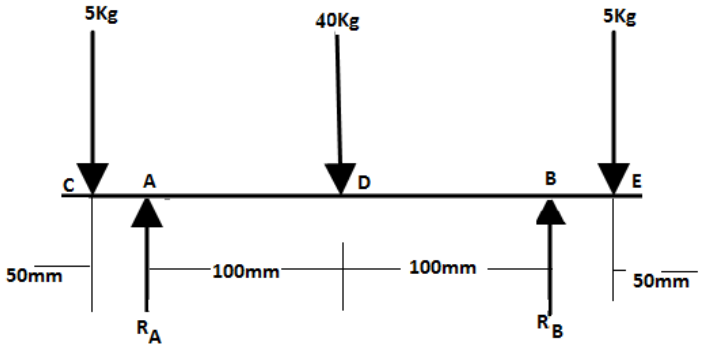

Fig. 8 Free body diagram

g = 9.81 m/s2
Thus
F = 50 × 9.81 = 490.5 N
Velocity is found out to be 10 cm/s i.e. V = 0.10 m/s
Thus
Power, P = 490.5x0.10 = 40.05 watts
We know that torque is given as, T = Px60/ (2πn)
Assuming No. of Revolution, n=50rpm
Thus, we have Torque, T = 49.05x60/ (2πx25)

$= 9.36 \times 10^3$N-mm

For a given shaft we have from diagram,
Vertical reactions at wheels i.e. fixed supports,
$R_A = R_B = (5+40+5) / 2$
$= 25$ kg
$= 25 \times 9.81 = 245.25$ N

From bending moment diagram, maximum bending moment is found to be M = 1750 Kg-mm = 17.167×10^3 N-mm

The resultant moment on a given shaft is given as
$M_R = (M + T)^{1/2}$
$= ((17.167 \times 10^3)^2 + (9.36 \times 10^3)^2)^{½}$
$= 19.552 \times 10^3$N-mm
Also we know that shaft diameter is given as,
$d = [(M_R x16)/ (\pi x\tau)]^{1/3}$

TABLE 2
SHEAR STRESS VALUES

Service Condition	τ, (MPa)
Heavily loaded short shafts carrying no axial load	48-106
Multiple bearing long shafts carrying no axial load	13-22
Axially loaded shafts (bevel gear drive or helical gear drive)	8-10
Shafts working under heavy overloads (stone crushers, etc.)	4.5-5.3

Consider shear stress, τ = 50Mpa
$d = [((19.552 \times 10^3) x16)/ (\pi x50)]^{1/3}$
d = 12.581 mm

This is ideal diameter of shaft which is needed. Since a shaft may be subjected to extra load as it has to work in rough conditions and from availability point of view, we chose a safe diameter from DDHB (Table 3.5a) of standard shaft diameter of 15 mm.

Thus diameter of shaft, d = 15 mm

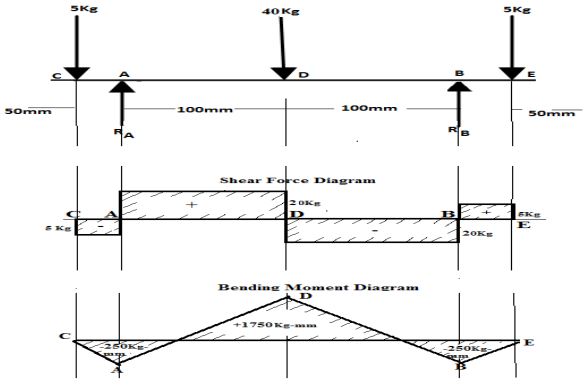

Fig. 9 Bending Moment and Shear Force Diagram

V. STATIC ANALYSIS

A. *Introduction*

Engineering analysis of mechanical systems have been addressed by deriving differential equations relating the variables of through basic physical principles such as equilibrium, conservation of energy, conservation of mass, the laws of thermodynamics, Maxwell's equations and Newton's laws of motion. However, once formulated, solving the resulting mathematical models is often impossible, especially when the resulting models are nonlinear partial differential equations. Only very simple problems of regular geometry such as a rectangular of a circle with the simplest boundary conditions were tractable.

B. *Mesh*

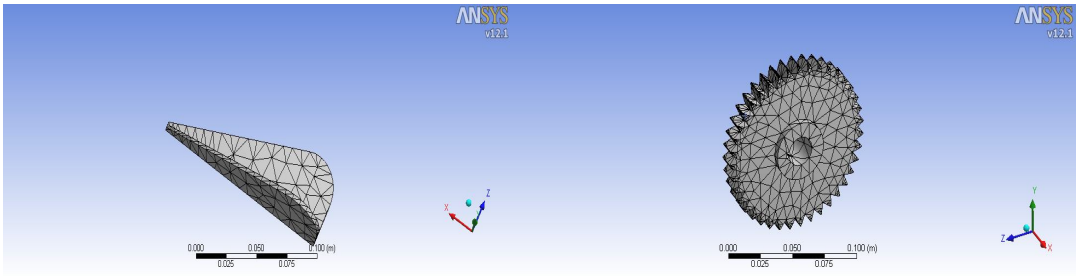

Fig. 10 Meshing of Weeding and Intercultivating blade and sprocket

VI. COST ESTIMATION

TABLE 3 - COST ESTIMATION TABLE

COMPONENT	COST (RS)
BICYCLE	3000
INTER CULTIVATING AND PLOUGH ATTACHMENT	6000
CHEMICAL SPRAYER	2900
SEED SOWING EQUIPMENT AND ATTACHMENTS	7200
TOTAL COST	**19100**

Fabrication and labor cost = Rs 5,000

Total cost = Component cost + Fabrication and Labor Cost

= 19,100 + 5,000

= Rs 24,000/-

VII. CONCLUSION

A. Conclusions

- The various components required for building the multipurpose agricultural equipment has been designed as planned.
- MAE is single system which can perform multi operations like Sowing, fertilizer Chemical sprayer, Weeding and inter cultivation.
- It can also be used for local transportation purpose as a bicycle.
- MAE will reduce external charges like fuels; electricity etc.and this will be helpful for poor farmers.
- MAE is a single system which contains multi attachments and can be easily assembled and dismantled comfortably. All the fasteners used in the equipment are of the same size.
- The equipment weight is around 8 to 10 kg (Excluding bicycle attachment) thus it can be carried easily in farmland.
- The equipment can do the work of 4 labors a day which reduces the labor cost of the farmer.

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