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RESEARCH ARTICLE

MULTIPURPOSE MANUAL AGRO EQUIPMENT

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Abstract

Design and Development of machines in field of agriculture has shown some drastic improvement in past few years. Farmers are opting for Heavy machines and accessories for farming to acquire better performances thus saving time and effort. The purpose behind this plan is to design equipment for the farmers in order to amplify their efficiency. This equipment designed here can perform multiple functions sequentially. Taking in consideration of all the parameters following feature is designed; Ploughing is one of the first steps in farming. During this process the land is cultivated and it is primed to disseminate the seeds. The next process is Seed Sowing and Fertilizing where the seeds and fertilizers are laid on the ground at regular intervals and are pitched accordingly. Finally, the T-shape leveler levels the soil once the processes are completed. In a traditional method, farmers usually perform the entire task separately which requires more effort and time thus may lead to weariness. Henceforth, by initiating this multipurpose farming tool farmers will be able to perform their task easily.

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Introduction:-

The Indian economy is backed by the Agricultural sector and it will continue to endure for a long time. Due to liberalization and globalization agriculture sector is changing the socio – economic environment of the population. 75% of people living in the rural area are still dependent on agriculture and 43% of geographical area is utilized for agricultural activities by the people of the nation. Due to the growth of Indian population exponentially, the demand for producing crop per hector is also increasing; this requires well-equipped high capacity machines with better efficiency. So, adapting to the way of mechanization in agriculture industry plays an important role in Indian economy. The operation performed by the Multipurpose Manual Agro-Equipment is to plough the soil, sow the seed, fertilizer the land and level it so that the seeds and fertilizers are mixed into the soil properly. The seeds are spread evenly on the ground thus, saves time and money. The equipment aims to help each and every small-scale farmer who can't afford automatic machineries. This eventually helps the farmers in many ways and also reduces their efforts. Thus, the proposed idea implements the tool to perform every task sequentially. These functions can be integrated into single equipment for efficient performance.

Motivation:-

When the farmers worked on the fields cultivating crops back in those days had many processes for different activities, which were done at regular intervals and not simultaneously. In earlier times farming was done by harrowing the field with the help of animals such as bullocks which were tiring and time consuming. Process of

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Sowing and fertilizing was completed by spreading the seeds and a fertilizer with hands, which again was time squandering and was arduous for them. Fertilizing the soil with the help of hands may cause health issues as the fertilizers consist of chemicals. Due to the aid of advance technology, there are equipment which helps farmers to carry out their processes simultaneously with ease and better performance. Farming in today's time has become much uncomplicated with the mean of automatic machines. Motive behind the project is to help the farmers to buy the equipment which is affordable and effectively sufficient.

Litrature Review:-

Sheikh Mohd. ShahidMohd. Sadik, H.A. Hussain [1] have designed and manufactured Multipurpose Farming Machine which can perform four tasks namely; ploughing, seed sowing, irrigation and transportation. The mechanism is divided into two parts; Part 1 and Part2. Part 1 of the machine is used for the agricultural activities on the farms and part 2 is used for transportation of farming goods on roads which is driven by a 100cc engine. It has come to the conclusion that this machine can be used for the increase of the productivity of the crops. RautMadhuri, Pawar Ganesh, PatilShubham, Patil Nikhil [2] have designed Multipurpose Seed Sowing Machine which executes two operation; Seed Sowing and Fertilizing. Fertilizing is done with the help of sprayer. Slider crank chain mechanism is used for spraying the fertilizers by mixing it with water. It indicates that the machine can solve the problem of farmers of carrying the fertilizer on their back and thus increase their efficiency of producing the crops. Rashmi S. Chimote [3] have studied and designed Multipurpose Farm Machine. This equipment performs four operations i.e. digging, sowing, cultivation and spraying. Two of the operation which is sowing and cultivation are performed manually while the rest of two are automated process. A 24cc engine is used for digging operation and 12V battery is used for the purpose of spraying fertilizer. A concept of using automation can aid to save time and also help the farmers economically. Prashanth S.R., Punith S, Ashoka Raja, Mukhtar Nadeem, Harish A [4] have designed and fabricated Multipurpose Agro Machine which perform three tasks; Seed Sowing, fertilizer spreading and pesticide spraying. First two tasks are operated mechanically using solar power with the help of 20W solar panel which further charges a 12Ah battery to power 2W & 4W DC motor. The third task is performed manually. It is found that the presence of solar panel reduces the efforts on farmers. ChinmayKadam, HaiderGazge, Rahul Dagia, Nikhil Kalpund [5] have designed and manufactured Agricultural Sprayer Vehicle with Router Weeder and Seed Sower which performs Pesticide spraying, routing arrangement, weeder arrangement & seed sowing arrangement. Spraying of pesticide is done with the help of crank gear which drives the connecting rod further helping the connecting link to swing around the hinge. The engagement between the connecting link and the piston of the sprayer pump assist the pump action by moving it forward and backward thus, spraying the pesticide properly. It is concluded that efforts are reduced on farmers as they don't need to carry any backpack of pesticide.

Methodology: -

The equipment works manually due the forced applied by the farmer. The equipment is made such that when the farmer applies the force on the handle, the wheel rotates and the axle connected to wheels also rotate, thus rotating the sprocket mounted on the axle which leads to the transmission of power to the shaft with the help of a chain drive mechanism. There are two hoppers wherein seeds and fertilizers are stored separately. Seeds and fertilizers descend on the gear which is mounted inside the hopper in a calculated manner with the help of flapper. After the seeds and fertilizers pass through gears, they are directed into the soil through the pipes which are connected to the digger. The digger is mounted on a main body frame which digs the soil and later the soil is levelled by T shape leveller. Thus, multiple operations are performed sequentially with help of this manualequipment. Given below are the steps to be followed

Ploughing

Plunging is executed by digging the soil. During the process, essential supplements gradually come up from the soil further nurturing the soil very well. Conventionally, animals such as bullocks and horses were used but now the old method has been replaced by a tool.

Digging

Digging is executed with the help of Digger tool. Digger itself is used as digging tool. Digger is connected to the frame by means of nut bolt and is made adjustable in order to perform on any land with better efficiency.

Seed Sowing

Once the soil is harrowed, the sowing of seeds is implemented. Seeds along with the fertilizer are stored in a hopper. The hopper is compartmentalized into two sections for seeds and fertilizers because, if these when mixed can cause to stop germination of seeds, thus jeopardizing the processes. The seed is then plunged into the soil through a hose.

Fertilizing

Soil does not contain enough nutrients to nurture it in order to grow thus, fertilizers are used to provide balanced amount of nutrients to the soil. Fertilizers are generally categorized for different plantation in the form of N-P-K ratio, where N stands for Nitrogen, P- Phosphorous, K- Potassium. The N-P-K ratio in the fertilizer determines the available nutrients by weight. Many sources of fertilizer exist such as natural and industrial made also known as synthetic fertilizers.

Leveling

Leveler is an important equipment that is used for farming with a purpose to level the land. Levelling is important to cover the soil in order to get adequate amount of nutrients from it. This further helps in the growth of crops.

Calculations

Selection of material is an important aspect in the field of engineering as there are various factors that are needed to be considered. The specific properties of material play a prime factor during manufacturing in order to resist the load and work systematically. Thus, the table of selection of material is shown below:

Table.1: -Selection of Material.

Sr.No.	Components	Materials
1	Wheels	Stainless Steel
2	Trolley Wheel	Nylon
3	Pedestal Bearings	Cast Iron
4	Gears	Acrylic
5	Shaft	Stainless Steel
6	Sprockets	Cast Iron
7	Chain	Cast Iron
8	Handle	Stainless Steel
9	Hopper	Stainless Steel
10	Digger	Stainless Steel
11	T-Shape Leveler	Stainless Steel
12	Chassis	Stainless Steel
13	Nut & Bolts	Steel

Design of wheel

Radius of wheel = 200mm = 0.2 m

Distance = 16 m

Time= 25 seconds = 0.42 mins

Speed = $\frac{\text{Distance}}{\text{Time}} = \frac{16}{0.42} = 38.09 \text{ m/min}$

RPM = $\frac{\text{speed}}{\text{circumference}} = \frac{38.09}{2\pi r} = 30.31 \text{ rpm}$

Design of shaft**Material:-****Stainless steel**

T = 17.69 KN-mm

P = 5.5 KW

$\sigma = 215 \text{ MPa} = 215 \text{ N/mm}^2$

$\tau = \frac{\sigma}{\text{FOS}} = \frac{215}{5} = 43 \text{ N/mm}^2$

$$[\tau] = 0.5 \cdot \frac{\sigma}{\text{FOS}} = 0.5 \cdot 43 = 21.5 \text{ N/mm}^2$$

$$[\tau] = 21.5 \text{ N/mm}^2$$

$$T = \frac{\pi}{16} \cdot \tau \cdot d^3$$

$$d = 16 \text{ mm}$$

Design of bearing

Material: UCP 204 (Pillow block bearing)

Dynamic Bearing Capacity = 12843 N = 1284.3 Kgf

Static Bearing Capacity = 6668 N = 666.8 Kgf

Assuming,

$$P_{\text{min}} = 0.02 \cdot \text{Dynamic Bearing capacity}$$

$$P_{\text{min}} = 0.02 \cdot 1284.3$$

$$P_{\text{min}} = 25.686 \text{ kgf} = 256.86 \text{ N}$$

$$L_{90} = \left(\frac{12843}{256.86} \right)^{3.33} = 460.5 \cdot 10^3 \text{ hr}$$

$$L_{90} = \frac{\text{Lhours} \cdot 60 \cdot N}{10^6}$$

$$460.5 \cdot 10^3 = \frac{\text{Lhours} \cdot 60 \cdot N}{10^6}$$

$$\text{Lhours} = 255.83 \cdot 10^6 \text{ hrs}$$

Design of bolt

Permissible shear stress $\tau = 40 \text{ N/mm}^2$

Total load on bolt = 140 N

$$d_c = 10.09 \text{ mm}$$

Diameter of bolt = 10.00 mm

Shear strength of bolt = resisting area * shear stress

$$140 = \frac{\pi}{4} \cdot d_c^2 \cdot \tau$$

$$140 = \frac{\pi}{4} \cdot 10^2 \cdot \tau$$

$$\tau = 1.7825 \text{ N/mm}^2$$

As the induced shear stress is very less than permissible shear stress. Hence, design of bolt is very safe.

When equipment is not in working condition, the total load on bolt is only 140 N.

When the equipment is in the working condition, considering the soil resistance, the impact load on bolt may go up to 3000 N

Thus, the bolt is selected to a greater value.

Design of hopper

Considering the volume of 2-3 kgs of seeds and fertilisers & allowances for bending following dimensions are selected.

Thickness = 1.6 mm

Total height of hopper = 190.5 mm

Total length of hopper = 152.4 mm

Total width of hopper = 152.4 mm

Base structure for frame = 490 mm

Axial length for frame = 632 mm

Design of seed and fertiliser gear

Diameter of wheel = 140 mm

Bore diameter = 25 mm

According to the size of various seeds, suitable dimensions for slot is selected.

With these dimensions, the result is as required. Thus, these dimensions are selected.

Design of digger

For proper digging and to overcome soil resistance and considering the depth of the dig, dimensions of tool are as follows

The angle can be adjusted according to the digging required.

Total length of tool = 140mm

Width of the tool = 50mm

As result obtained from the above dimensions are suitable. Thus, selected dimensions are correct.

Design of trolley wheel

Material: Nylon

Diameter: 102mm

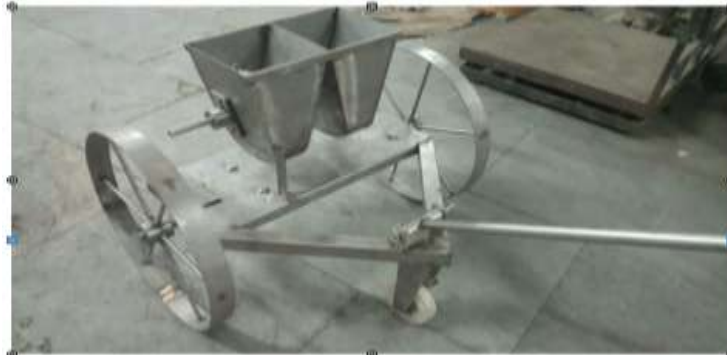


Fig.1:- Multipurpose manual agro equipment.

Results:-

1. Improvement in planning efficiency
2. Increase in crop yield and cropping reliability.
3. Increase in cropping frequency.
4. Also increases seed/fertilizer placement accuracy.
5. It is made durable and affordable for small scale peasant farmers.
6. Lesser maintenance cost.
7. Plant germination is also improved
8. Requirement of Labour decreases.
9. Due to trolley wheel, 360-degree rotation is possible

Conclusion:-

This multipurpose manual- agro equipment has considerable potential to greatly increase productivity. The need of a poor and small land farmer has fulfilled by the manual operated equipment and they can easily and effectively plant their seed in the field by this equipment.

Future scope:

The equipment can be used on a larger scale by providing some changes into it. Manual machine can be changed to automatic by adjoining Engines and DC motor to it further used as a tractor powered machine. Also, by modifying the design of hopper and other farming tool it can be made more impactful. During the rainy season hydraulic arrangement's equipment can be made in order to perform better efficiency on muddy land.

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