International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume –05, Issue – 03, March 2020, PP – 19-30

Design and Fabrication of Multipurpose Agriculture Vehicle

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Abstract: Cultivation of any crop involves various steps like seed selection, field preparation, fertilizing, sowing, irrigation, weed removal, pesticide spraying. Farmer has to use various agricultural equipment and labors for caring out those steps, our purpose is to combine all the individual tools to provide farmers with multipurpose equipment which implements all the scientific farming techniques and specifications and suitable for all type of seed to seed cultivation with as minimum cost as possible. This project work is focused on the design and fabrication of multipurpose agriculture vehicle which is used for land preparation, sowing, fertilizing, leveling and weed removal process.

Keywords: Agriculture, Weeder, Sprayer, Seed sower, Multipurpose components.

I. INTRODUCTION

Agriculture has been the backbone of the Indian economy and it will continue to remain so for a long time. A man without food for three days will quarrel, for a week will fight and for a month or so will die. Agriculture is a branch of applied science. Agriculture is the science and art of farming including cultivating the soil, producing crops and raising livestock. It is the most important enterprise in the world. Over the years, agricultural practices have been carried out by small-holders cultivating between 2 to 3 hectare, using human labor and traditional tools such as wooden plough, yoke, leveler, harrow, mallot, spade, big sikle etc. These tools are used in land preparation, for sowing of seeds, weeding and harvesting. Modem agricultural techniques and equipment's are not used by small land holders because the equipment's are too expensive and difficult to acquire. By adopting scientific farming methods, we can get maximum yield and good quality crops which can save a farmer from going bankrupt but majority of farmers still uses primitive method of farming techniques due to lack of knowledge or lack of investment for utilizing modern equipment.

The use of hand tools for land cultivation is still predominant in India because tractors require resources that many Indian farmers do not have easy access to. The need for agricultural mechanization in India must therefore be assessed with a deeper understanding of the small holder farmer's activities. There is huge gap in technology adoption and Implement used with small and marginal farmers. Sustainable improvement in the livelihoods of poor farmers in developing countries depends largely on the adoption of improved resource conserving cropping systems. While most of the necessary components already exist, information on the availability and performance of equipment is lacking and effective communication between farmers and agricultural research and development department is unsuccessful

II. HEADINGS

1. Agriculture

Agriculture is the art and underlying science in production and improvement of field crops with the efficient use of soil fertility, water, labor and other factors related to crop production. It is the most important enterprise in the world. About 70% of Indian populations are either farmers or involved in some agricultural related activities

1.1 Main Features of Indian Agriculture

- **Source of Livelihood:** Agriculture is the main occupation. It provides employment to nearly 61% persons of total population. It contributes 25% to national income.
- **Dependence on Monsoon:** Agriculture in India mainly depends on monsoon. If monsoon is good, the production will be more and if monsoon is less than average then the crops fail. As irrigation facilities are quite inadequate, the agriculture depends on monsoon.

- **Labor Intensive Cultivation:** Due to increase in population the pressure on land holding increased. Land holdings get fragmented and subdivided and become uneconomical. Machinery and equipment cannot be used on such farms.
- **Under Employment:** Due to inadequate irrigation facilities and uncertain rainfall, the production of agriculture is less; farmers find work a few months in the year. Their capacity of work cannot be properly utilized. In agriculture there is under employment as well as disguised unemployment.
- **Small Size of Holdings:** Due to large scale sub-division and fragmentation of holdings, land holding size is quite small. Average size of land holding was 2 to 3 hectares in India while in Australia it was 1993 hectares and in USA it was 158 hectares.
- **Traditional Methods of Production:** In India methods of production of crops along with equipment are traditional. It is due to poverty and illiteracy of people. Traditional technology is the main cause of low production.

1.2 Major Challenges Faced by Indian Agriculture

- **Stagnation in Production of Major Crops:** Production of some of the major staple food crops like rice and wheat has been stagnating for quite some time. This is a situation which is worrying our agricultural scientists, planners and policy makers. If this trend continues, there would be a huge gap between the demand of ever growing population and the production.
- **High Cost of Farm Inputs:** Over the years rates of farm inputs have increased. Farm inputs include fertilizer, insecticide, pesticides, HYV seeds, farm labour cost etc. Such an increase puts low and medium land holding farmers at a disadvantage.
- **Soil Exhaustion:** Soil exhaustion means loss of nutrients in the soil from farming the same crop over and over again. This usually happens in the rain forest.
- **Depletion of Fresh Ground Water:** Most of the irrigation in dry areas of Punjab, Haryana and Western Uttar Pradesh was carried out by excessive use of the water. Today fresh ground water situation in these states is alarming. In the coming few years if this type of farming practice continues, these states are going to face water famine.
- **Adverse Impact of Global Climatic Change:** Among various challenges, global climatic change is the recent one. It is predicted that due to climate change, temperature would increase from 2°C to 3°C, there would be increase in sea level, more intense cyclones, unpredictable rainfall etc These changes would adversely affect the production of crops.
- **Impact of Globalization:** You can see the effect of globalization on the farm sector in India. All developing countries have been affected by it. The most evident effect is the squeeze on farmer‘s income and the threat to the viability of cultivation in India. This is due to the rising input costs and falling output prices. This reflects the combination of reduced subsidy and protection to farmers.

1.3 Steps Involved in Agriculture

Seed Selection

Among varieties of crops, a suitable crop has to be selected for cultivation is as shown in the Fig. 1.1

Fig. 1.1 Selection of Seeds

Land Preparation

It involves tilling, ploughing and furrows and ridges formation is as shown in the Fig. 1.2 and Fig. 1.3.

Fig. 1.2 Ploughing

Fig. 1.3 Forming Ridges and Furrows

Fertilizer Application

Organic fertilizer is applied during ploughing, chemical fertilizer is applied before sowing and during vegetative stage as shown in the Fig.1.4

Fig. 1.4 Fertilizer Application

Seed Preparation

Seeds are treated with fungicides like carbendazim before sowing as shown in the Fig. 1.5.

Fig. 1.5 Seed Preparation

Sowing

Seeding or sowing is an art of placing seeds in the soil to have good germination in the field as shown in the Fig. 1.6.

Fig. 1.6Sowing

Irrigation

Watering the crops for its growth and development as shown in the Fig. 1.7

- Surface irrigation.
- Drip irrigation.
- Sprinkler irrigation.
- Rain dependent irrigation.

Fig. 1.7 Irrigation

Germination

seed develops into a two leaf stage, tiny plant as shown in the Fig. 1.8.

Fig. 1.8 Germination

Thinning

Only one plant is retained in each pit by plucking the excess seeding. One healthy seeding is left and other seeding is plucked to support the complete resources of water, fertilizer and spacing for single plant as shown in the Fig. 1.9.

Fig. 1.9 Thinning

Filling

If there is no germination in some pits; when some seeds fail to germinate, then seedling is plucked from where it is excess and planted at the empty space.

Weeding

The process of removing the unwanted plants in the field to ensure complete utilization of resources only to the crop.

- Manual weeding (once in 3 weeks).
- Before sowing, field has to be ploughed well to remove all weeds.
- After germination tiny weeds area removed using weeding blade.
- After vegetative stage weedicides are sprayed. Chemical weeding
- Spraying of weedicides like "pendimethalin" of 1 liter is mixed with 200 liters of water for one hectare

Pesticides spraying

When the crops are infested with pests use pesticides as shown in the Fig. 1.10.

Fig. 1.10 Pesticide Spraying

Harvesting stage

Separating crop from soil as shown in the Fig. 1.11

Fig. 1.11 Harvesting

2. Literature Review

Sheikh Mohd Shahid Mohd Sadik and Hussai [1], Agriculture being one of the major occupation in India, Agriculture plays a vital role in the Indian economy. Indian agriculture has registered impressive growth over last few decades. It is very essential to discover and implement new idea in this field, though lot of work has been done in this area. It is unfortunate that, these ideas are not being implemented properly in actual field. This is due to high cost and is complicated for rural people. Multipurpose agriculture or farming machine is basic and major machine involved in agriculture for maximum yielding.

Durga Sowjanya et al. [2], More than 40 percent of the population in the world chooses agriculture as the primary occupation. In recent years, increased interest has grown for the development of the autonomous vehicles like robots in the agriculture. The existing agricultural robot performs basic elementary functions like harvesting, planting and spreading the pesticides. The Proposed system aims at designing multipurpose autonomous agricultural robotic vehicle which can be controlled through Bluetooth for ploughing, seeding and irrigation systems.

Hani Hagras et al. [3], In this paper we will introduce the application of our newly patented double hierarchical Fuzzy-Genetic system (British patent 99-10539.7) to produce an intelligent autonomous outdoor agricultural mobile robot capable of learning and calibrating its controller online in a short time interval and implementing a lifelong learning strategy. The online and lifelong learning strategy allow the outdoor robots to increase their experience and adapt their controllers in the face of the changing and dynamic unstructured outdoor agricultural environments.

Azogu [4], In order to meet with the challenge of ensuring food security, the Federal Government of Nigeria realized that the use of appropriate levels of technology to improve the production of farm works is inevitable. One of those types of technologies is Agricultural Mechanization Technology. In order to facilitate the mechanization of Nigerian agricultural production system, the government established the National Centre for Agricultural Mechanization (NCAM) about two decades ago. This paper presents an overview of the centre and its role in mechanizing Nigerian agriculture. The Centre has over the years developed technologies that have impacted positively towards the use of land tools, animal traction and engine powered mechanization technology in Nigeria.

David Wilson and John Lumkes [5], A multipurpose agricultural vehicle, known as the Practical Utility Platform (PUP), was developed by Purdue University in partnership with the African Centre for Renewable

Energy and Sustainable Technology (ACREST), a local Non-Governmental Organization (NGO) in Bangang, Cameroon. The practical and simple vehicle is designed to haul 900 kg loads, be a platform to power auxiliary equipment, and pull ground engaging implements. After several design iterations, a vehicle design was developed that is functional, affordable, easy to manufacture, and adaptable for use in a variety of applications. In addition to the vehicle, a simple maize grinder, two-row planter, 3-point hitch caddy, and water pump were designed and tested with the PUP.

Vishal et al. [6], India is an agricultural country cultivating more number of ground nuts, corns, cereals etc., in the village sides of the country. The available automatic machines are imported from foreign countries. The imported machines are not only bulk in size but also cost is also high. In this project an attempt has been made for the design and fabrication of multipurpose agricultural equipment exclusively for small farmers at cost not exceeding rupees around 15000 per unit. A study has been carried out to develop multipurpose agriculture equipment for performing major agricultural operations like goods carrying, spraying pesticides, sowing, seeding, weeding and cutting operations to increase the efficiency and reduce land preparation and handling cost.

3. Objectives

The main objective of the project is

- To design and fabricate a multipurpose agricultural vehicle which is affordable by lower and creamy layered farming community.
- To reduce the time consumption required for multiple farming operation by using a single equipment.
- To decrease the labour cost required for various operations.

4. Working Principle

- Initially the seeding unit and spraying unit are loaded with deserved seeds and the fluids manually at the base station.
- As the transmission initiates the vehicle starts moving in the desired direction, also the accessories like drum/disc rotates with respect to the transmission system, thus allows the seeds to fall on the path created by the ploughing accessory at the bottom.
- In the meantime the ploughing accessory also acts as a weeder and removes any weeds on the path specified for sowing the seeds. Further it covers the soil inclusive of the removed weed by converting it as a natural fertilizer in the later stages of the crop development.
- At the same transmission stage even the spraying unit also activates with the slider crank chain mechanism to accomplish spraying the desired fluids.

5. Working Methodology

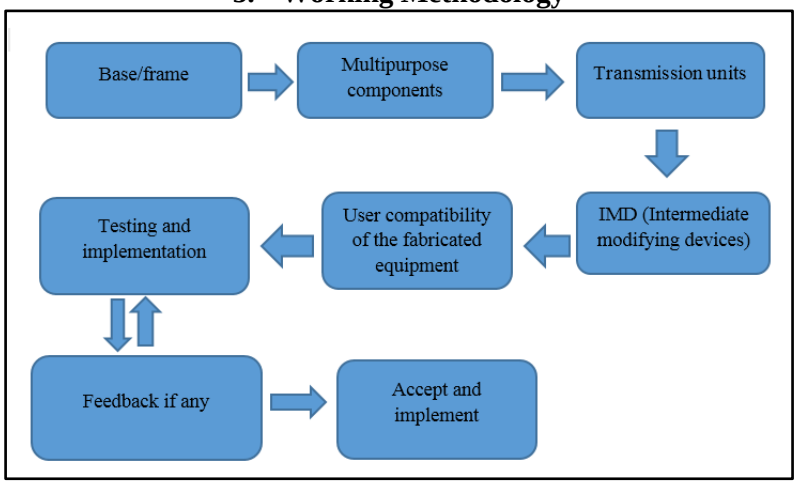

Fig. 5.1 Methodology Adapted for the Project

The methodology as shown in the Fig. 5.1 which is adopted for the project is explained below,

- **Base/Frame**

First of all the base frame materials like handle, base, iron rods were collected depending on the properties of materials and the dimensions.

- **Multipurpose Components**

Multipurpose agriculture vehicle consists of multipurpose components like seed sowing drum, fertilizer spraying drums with sprayer which was collected after base

- **Transmission Units**

Transmission units basically consists of chain sprockets, bush, wheels, and a slider crank chain mechanism which was generally for transmission of motion.

- **IMD (Intermediate Modifying Devices)**

The intermediate modifying devices consists of the parts that is to be modified according to our convenient. After all the above parts were collected n modified then assembly was done by staying on the methodology of the project and after the work was over finally the testing was done and after the result are as per the expectation, we can finally implement the multipurpose vehicle to do the various operation like seed sowing, fertilizer or water spraying and weed removal.

6. Components Used

Spraying Unit: Fig. 6.1 and Fig. 6.2 shows the spraying unit components which mainly consists of spraying pump and a reservoir drum fitted with a nozzle in it.

Fig. 6.1 Spraying Pump

Fig. 6.2 Reservoir with Nozzle

Transmission Unit: As show in the Fig. 6.3 transmission units basically contains a component like Chain Sprocket, Bearings, Shaft and Wheel.

Fig. 6.3 Transmission Unit

- **Chain Sprocket:** A sprocket or sprocket-wheel is a profiled wheel with teeth, cogs,or even sprockets that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. Fig. 6.4 shows the Chain sprocket used in Project.

Fig. 6.4 Chain Sprocket

- **Bearing:** A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts as shown in Fig. 6.5.

Fig. 6.5 Bearing

- **Shaft:** shaft is a mechanical component for transmitting torque and rotation, usually used to connect other components of a drive train that cannot be connected directly because of distance or the need to allow for relative movement between them. As torque carriers, drive shafts are subject to torsion and shear stress, equivalent to the difference between the input torque and the load. They must therefore be strong enough to bear the stress, while avoiding too much additional weight as that would in turn increase their inertia. Fig. 6.6 shows the shaft used in project.

Fig. 6.6 Shaft

- **Frame**
  Frame is made from the mild steel and the operation involved is welding as shown in Fig. 6.7.

Fig. 6.7 Frame

- **PVC Pipe**
  PVC pipe of length 2 m is used which is used to carry water, insecticides and pesticides.

- **Wheels**
  Wheels are made in such a way by welding and grinding as shown in Fig. 6.8 that it contains extensions which helps it to move properly in the soil.

Fig. 6.8 Wheels

Seed Sowing Unit: Seed sowing unit contains the seed sowing drum as shown in the Fig. 6.9.

Fig. 6.9 Seed sowing drum

Weeder: It is used to remove the extra unnecessary weeds that comes across the seed sowing machine so that it might not bring obstacle in seed sowing as well as seed flourishing. Fig. 6.10 shows the weeder.

Fig. 6.10 Weeder

III. CALCULATIONS AND RESULT

The overall dimensions of the vehicle is shown in Table 7.1 where all the respective values required for the calculation is taken from the same table.

Table 7.1 Dimensions of Vehicle

Particulars	Dimensions
Total length of the Vehicle (L)	1.7 m
Width of the Vehicle (B)	0.55 m
Total Weight of the Vehicle (W)	30 kg
Weight at the Front End (WF)	17 kg
Weight at the Rear End (WR)	13 kg
No. of Bearings	6
No. of Chain Sprocket	3
Capacity of Water Drum Reservoir (Q)	16 ltr
Height of the Vehicle at Rear End (h_1)	0.55 m
Height of the Vehicle at Front End (h_2)	0.42 m
Handle Length (l_1)	0.85 m
Handle width (b_1)	0.35 m
Wheels Diameter (D)	0.24 m
Length of Crank Rod (l)	0.87 m
Diameter of Disk (d)	0.24 m
No. of holes in Seed Reservoir Drum (n)	6

Calculation

The center of gravity of the vehicle is calculated by the Eq. (7.1) and the Volume of the water reservoir drum is calculated by the Eq. (7.2).

- **Center of Gravity Calculation**

Weight of the vehicle (W) = 30 kg = 30× 9.81 = 294.3 N
Weight Distribution: 17:13 (F: R)
Weight acts on the front side (WF) = 166.7 N,
Weight acts on the rear side (WR) = 127.52 N
Total length of the vehicle (L) = 1.7 m
Total width of the vehicle (B) = 0.55 m

b = (WR × □) / W **…(7.1)**

= (127.52 × 1.7) / 294.3= 0.73 m

Center of gravity lies at 0.73 m from front end.
Centroid along the length of the vehicle = 1.7 / 2 = 0.85 m.
Centroid along the width of the vehicle = 0.55 / 2 = 0.275 m.

- **Capacity of Water Reservoir Drum**

Length of the drum (l) = 0.4 m
Breadth of the drum (b) = 0.16 m
Height of the drum (h) = 0.25 m

Total volume of the drum= l × b × h **…(7.2)**

= 0.4×0.16×0.25
= 0.016 m^3

- **Pumping Cycle per Rotation of the Wheel**

1 complete rotation of wheel= 2 rotation of disk
Therefore, one rotation of wheel equals to 2 pumping cycle.

Result: The total weight of a vehicle is 30 kg where 17 kg is at the front and 13 kg at the rear end and the centroid long the length of the vehicle is 0.85 m and centroid along the width is 0.275 m and 2 pumping cycle takes place at 1 rotation of the wheel where center of gravity lies at 0.73 meter from the front end.

IV. CONCLUSION

Practically our multipurpose agricultural vehicle can be used for fertilizing, sowing and for weed removal purposes. All the parts are connected in such a way that in every stage of agriculture the equipment can be rearranged or easily assembled to required length and specifications of field operation. Our team has successfully combined many ideas from various fields of mechanical engineering and agricultural knowledge to improve the yield and by reducing the labor effort and expenses. The whole idea of multipurpose equipment is a new concept, patentable and can be successfully implement in real life situations. A multipurpose agricultural vehicle is designed and fabricated for farmers for their comfort and improve their productivity which will be suitable for spraying, sowing seeds and weeding at minimum cost for the farmer so that they can afford it. The equipment results in more beneficial when it is subjected to moist soil for weeding purpose, due to moist soil the weeder can effectively remove the unnecessary grasses and hence will easily accomplish the weeding process, the performance of the vehicle will also increase when it operates on the smooth surface or less uneven surface.

Scope for Future Work

By increasing the equipment strength and quality to its peak, we can have multipurpose agricultural vehicle for life time usage and can be improvised manual into automatic by using a motor and gears assembly with minor adjustments.

Advantages

The advantages of the multipurpose agriculture vehicle is given below,

- The Simple in construction and operation.
- Economical.
- Less time consumption for spraying and seed sowing.
- More suitable for small agricultural farms.
- Optimized spraying efficiency and seed sowing.
- Reduced human effort.

Disadvantages

The disadvantages of the vehicle is given below,

- Not suitable for un ploughed lands.
- Not effective for large production.

Applications

The multipurpose vehicle is basically used in the field for agricultural purposes such as

- Seed sowing.
- Weed removal and leveling.
- Water, insecticides or fertilizer spraying.

Acknowledgements

The successful completion of any task would be incomplete without mentioning the people who made it possible with constant guidance and encouragement leading to success.

Guidance and deadlines play a very important role in successful completion of the project on time. We are grateful to Project Guide and Coordinator **Mr. Arunkumar S M**, Assistant Professor, Department of Mechanical Engineering, for his kind support, guidance and motivation extended for our project work.

We expressed our gratitude to **Dr. R Bala Sundar Rao,** H.O.D, Department of Mechanical Engineering, for his unfailing encouragement and suggestions given to us, in course of our project work.

We take this opportunity to express my gratitude to the Principal **Dr. H S Nanda** for his constant support and encouragement.

We express our gratitude to founder chairman late **Dr. Rame Gowda,** president **Dr. A Prabhakara Reddy** and secretary **Sri. C L Gowda** for providing us a great infrastructure and well-furnished labs.

Finally a note of thanks to the Department of Mechanical Engineering, both teaching and non-teaching staffs for their cooperation extended to us.

Last but not least, we acknowledge the support and the feedback of our parents and our friends of all time.

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