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An Agricultural Rover for smart agricultural practices

Dr.N.Ramchandra[1], Sameeksha[2], T.Shivani[3], Ch.Bala Bhaskar[4], G.Tarun[5]

[1]*Professor and HOD, Dept of Electrical and Electronics Engineering, St.Martin's Engineering College, Hyderabad, Telangana, India*

[2,3,4,5]*B.Tech Students, St.Martin's Engineering College, Hyderabad, Telangana, India*

Abstract - *Agriculture is the spine of Indian economy and an outsized populace in the country is dependent on agriculture for its livelihood. The objective of this 'Agricultural Rover' is to provide farmers with a complete substitute for the farm tractor and sustain various farm practices. The traditional cultivation in India was based on the use of draught animals. A majority of small scale farmers use bulls and bullocks to drive the plough and other related tools. This rover is designed to replace the long-established and conventional farm machinery. This agricultural rover is driven by an electric motor powered by a suitable battery set. It is equipped to perform nearly all of the major farm practices such as, ploughing, seeding, weeding, fertilizer spraying, watering, etc. The rover is an electro-mechanical vehicle designed to facilitate the farmers with smart machinery and environment friendly farms for better yield. The use of this rover will reduce the manual labor and increase the farmer's efficiency and the crop yield. The problem of evenly spaced sowing of seeds and digging of equally spaced furrows which arose due to the use of draught animals can be overcome by the use of this rover. The seeder of the agricultural rover has the capability of delivering the seeds precisely with uniform depth in the furrow, and also with uniform spacing between the seeds. In a nutshell the agricultural rover will add significantly in the development of smart farms, ebb the farmer's cost of cultivation and boost the income.*

Key Words: Agriculture, farming, brushless dc motor, battery, rover.

1. INTRODUCTION

Agriculture has played a major role in the development of human civilization. The agriculture sector has brought out a fundamental and vibrant change in the world socio-economic situation. Indian economy is long known as an agricultural economy, considering that the country has a rich history of agricultural practice. The history of agriculture in India can be dated back to 9000 BCE, where early cultivation of crops and domestication of plants were known to be practiced. In modern India agriculture comprises of 17-18% of the total GDP of the country. An alarming fact is that; 70% of the rural households are primarily dependent on agriculture for their livelihood. India is the second largest producer of agricultural products in the world. India accounts for 7.39% of the total global agricultural output. It is also the largest exporter of cereals and pulses [1].

The traditional methods and equipments of agriculture are being used in many parts of the country for small scale farming. In India 82% farmers come under the category of small and marginal farmers. They carry out their crop cultivation on an average of 2-3 hectare lands. They are mainly dependent on manual labor or draught animals. They have been using the traditional equipments such as wooden plough, yoke, leveler, harrow, spade, big sickle etc; for farming since a long time. The traditional cultivation in India was based on the use of animal power for 97.6% of the farms. The horse power obtained from one bullock is equivalent to 0.75HP, which is very low and not sufficient for sustainable farming practices [2]. These traditional methods and equipments used by the small scale farmers lead to their huge losses of labor, crop and revenue. They are also hindrance for increased farm productivity and better income for the farmers. Sustainable agriculture requires successful management of resources to satisfy human needs in current times, without endangering the ability of future generations. There has to be an emphasis to consider agriculture sector at par with industrial sector to ensure substantial income from small scale farming. Technological advancement has to be provided to farmers with tools and resources to make farming more handy and sustainable [3]. The need of the hour is to provide farmers with new and sustainable technology to heighten their income and crop production [4].

Crop cultivation involves many stages and practices, which are sequenced so as to obtain quality product. The first stage is that of seed selection, where seeds are selected carefully for maximum yield [5]. Land preparation is the most important aspect of farming, it involves ploughing and digging of furrows for seed sowing. After the process of land preparation, many organic fertilizers are applied to the soil for supplementing nutrients of the soil and protection

from bacteria and fungi. The seeds are treated with fertilizer for removing fungal infections before sowing. Sowing of the seeds is another crucial process in agriculture [6]. Irrigation of the field is the most important aspect of agricultural practices; it is also known as watering. The removal of unwanted plant is known as weeding, and this required for a healthy crop produce. Weeding is also one of the most labor intensive processes of agriculture. When the crop enters in the vegetative and flowering stage the spraying of fertilizers and pesticides is required. The final process of cutting of the crops is known as harvesting, which is followed by many post-harvest processes such as threshing [7-8].

Traditional methods of agriculture are antecedently prevailing in many parts of the country and they are very popular among small scale farmers in India. The conventional tools and equipments are not very efficient and are incompetent in supplying to the increasing demand of the growing population [9]. Cultivation process using these tools is very cumbersome and an enormous amount of manpower is required. For the basic process of ploughing, weeding and watering many laborers are necessary and the farmer is dependent on them. The process of manure application and fertilizer spraying is also very feeble and results in an unhealthy crop, when done manually. The need of the hour is to produce a good quantity of crop with the best quality, in the land available. For the accomplishment of sustainable agriculture it is mandatory to adopt new technologies and methods of farming; and let go the conventional practices [10].

Our aim of designing this Agricultural Rover is to completely replace the bulls and bullocks and provide farmers with easy to use, safe and a very efficient machine; which will avail all the needs of the farm. This machine is premeditated keeping in mind small scale farmers and their financial conditions. It is a well-known fact that small scale farmers in India cannot afford to buy large farm tractors, hence our vehicle will serve as a complete replacement of the farm tractor. It is equipped to support all agricultural process such as; land preparation, application of manure and fertilizers, seed sowing and weeding of unwanted plants. The problem of unavailability of labor and inefficiency will also be solved by our agricultural rover. Our vehicle is an electric vehicle driven by electric motors which is the most significant feature of the prototype. The use of electricity as a source of energy is very important to irradiate air pollution caused by diesel tractors in the agricultural fields. Laconically this agricultural rover will be a complete one man army, to fulfill all the requirements of small scale farmers.

2. EQUIPMENT DESIGN

The agricultural rover is an electric vehicle to which farm tools are attached to solve the purpose of a farm tractor. The machine is thoughtfully designed keeping in mind the literacy rates of small scale farmers and their financial conditions. The agricultural rover is divided into two parts; the locomotive part is called the rover and to this rover the farm tools or equipments are attached. The rover is an electric vehicle designed for sustainable agriculture and for pollution free farms.

The attachments for the farm practices include the following:

- Plough
- Groove Driller
- Seed sowing tool
- Fertilizer and pesticide sprayer
- Unwanted plants removal Weeder

2.1 Plough:

The Plough is a traditional tool which is used for land preparation. Ploughing of the land is one of the most crucial aspects of farming. The main purpose of this plough is for loosening of the soil and whirling of the soil. This is done to make sure the nutrients in the lower layer of the soil come to the above layer and can the utilized by the next crop. The plough designed by us is made of mild steel. This plough is attached to the rover.

Fig1. 3D Design of head of the ploug

2.2 Groove driller:

The groove driller can also be called the furrow; it is used to make rows of furrows in the land after the process of ploughing. These rows are made to plant the seeds also they are important for equally spaced plants to grow. The groove driller is also made of mild steel.

Fig2. 3D Model of a furrow opener

2.3 Seed sowing tool:

Sowing of seeds in the right way is a key aspect of healthy crops. Our seeder is designed such that it not only delivers the seed to the furrow but also places the seeds at the right place. The seeds are delivered such that they are equally spaced. The apparatus of our seeder is such that; the seeds are collected and delivered by a succession of uniformly spaced cells present on the border of a globular plate or wheel. This ensures proper sowing of seeds. The seeder is also made of mild steel and the storage tank of the seeds is made of plastic. A heavy metal cylinder is also provided behind the seeder, to cover the soil after the sowing of seeds. This is also made of mild steel.

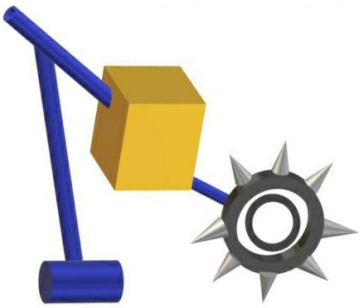

Fig3. Seeder equipment 3D Model

2.4 Fertilizer and pesticide sprayer:

Application of fertilizer is done after the process of digging of furrows, before sowing of seeds. This is done to ensure that the soil has enough nutrients for the growth of a healthy crop. The process of pesticide spraying is necessary for the eradication of unwanted bacterial and fungal infection in the vegetative and flowering stage of the crop. The equipment designed for this purpose consists of the following:

- Storage tank made of plastic
- Spin wheel with spikes
- DC motor inside the tank
- Sprayer

The DC motor is powered by a battery attached to the rover of the machine. The sprayer is used to spray pesticides on the vegetative parts of the crop. This equipment is mainly made of mild steel.

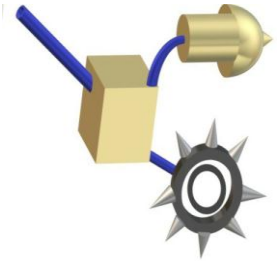

Fig4. Fertilizer and pesticide sprayer 3D model

2.5 Weeder:

A weeder is a tool used for the removal of unwanted plants. It is necessary as unwanted plants occupy space and take up the nutrients from the soil. This results in depletion of nutrients for the main crop. Thus, removal of weeds is important. The weeder design particularly premeditated for maximum removal of weeds. The design also consists of a heavy leveler blade which covers the soil after the removal of unwanted weeds. This equipment is made of mild steel.

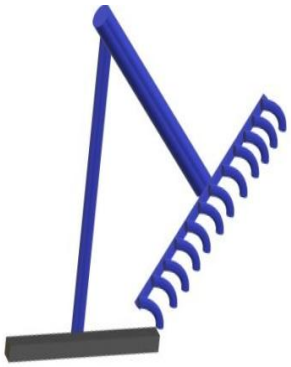

Fig5. Weeder 3D Model

3. FABRICATION OF THE ROVER:

The locomotive part of the agricultural machine is named as rover, as it drives all the tools required for farming. The rover is a three wheeled electric vehicle. We have designed the rover with three wheels instead of four wheels as; it occupies less space and can easily move between the rows of plants in an agricultural field. A well-known fact is that, the tilting system of three wheeled vehicle provides better maneuverability during large steering angles. The frame of this rover is made of mild steel. The rover is controlled by using two paddles and a single differential gear box is used to convert electric power to mechanical power. The frame is the back bone of the rover. It is made of mild steel. All the sub-parts in the rover are mounted in the shaft. It is the rigid structure that forms a skeleton to hold all the major parts together.

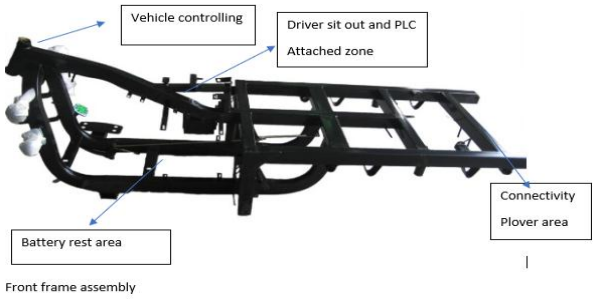

Fig6. Frame design

The rover is given provision for the attachment of the agricultural tools in the rear end of the vehicle as well as the front end. Most of the equipment is attached to the rear end of the rover as, the process of ploughing and seeding is very efficient when carried out from the rear end. The tools are attached using a beam. The beam helps in maintaining necessary posture of the tools and helps in proper spacing. In this agricultural rover we are using a 9 feet long beam. The length of the beam is decided considering safe distance for carrying out farming activities.

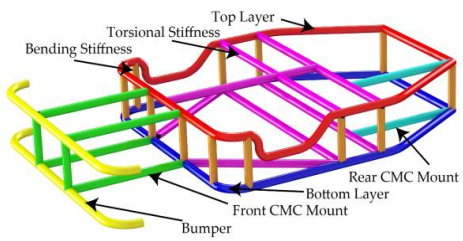

Fig7. Framed chassis design for the electrical vehicle

The power to the rover is supplied by a 48V lithium ion battery. This is the most distinctive feature of our design as; the use of electric vehicle in farming is very rare. The battery set is a pack of 4 sealed Li-ion batteries, each of 12V joined in a series connection (12*4=48V). The maximum current supplied is 26A. This battery is used to supply a brush less DC motor. The power of the DC motor is 1Kwatt, the voltage rating is 48V and the current rating is 24A. The motor is sufficient for pulling a load of 400-500Kgs. The use of a brushless DC motor is done so that the maintenance of the equipment is very low. The battery is provided by a charger set, which contains a step down transformer for stepping down the AC voltage from the supply mains. A rectifier is also provided to convert the AC- DC; this is followed by a filter for removal of ripples and a controller to control. This process of power supply is fabricated such that the safety of the motor is ensured.

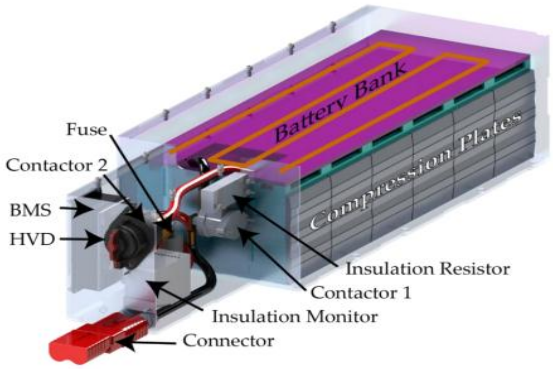

Fig8. Battery pack design for bottom mounting

The rear wheels of the rover have a differential gear box which is used to deliver the rotational power of the motor as linear movement to the wheels. Two paddles are provided near the leg rest area of the driver's seat for the control of the vehicle. One is used for acceleration and the other for braking. A steering wheel is attached to the rear wheel for the free and efficient turning movements.

Utmost care is taken to make the rover compact in size such that it can efficiently work in a farm. The height of the rover is 4 feet with a ground clearance of 2 feet and the length is also 4 feet; the width being 3 feet. Enough care is taken to provide sufficient space for the driver. This Agricultural rover is completely fueled by electricity, making it very environment friendly and very efficient in sustainable agriculture.

4. FUNCTIONALITY AND UTILITY OF THE AGRICULTURAL ROVER:

The mechanization of processes plays a key role in several areas such as manufacturing; medical, military applications etc. The use of vehicles has progressively amassed the efficiency in cultivation in many parts of the world. The major shortcomings of Indian agriculture being; low availability of skilled labor and lack of knowledge of latest technological innovations; lead to the increased cost of crop production and debts of farmers. Thus, this agricultural rover is the answer to many problems of the small scale farmers. We have strived to develop this vehicle to satisfy the needs of the farmers and to increase the efficiency of crop production.

4.1 Working of the agricultural rover:

The agricultural rover can be divided into two parts; one is the locomotive part and it is called the rover. The other part is the farm tools such as the plough, seeder, weeder and fertilizer sprayer. The locomotive or the rover is an electric vehicle, which is powered by a battery and driven by a BLDC motor. This is used to attach the farm tools and perform the farm operations. The farm tools can be attached both at the front and rear end of the rover. A driver will drive the rover with the help of the two paddles and a steering wheel. The vehicle can run for 3-4hrs constantly at fully charged condition. When the farm equipment is attached to the rover it can easily move in the fields. The plough is customarily attached at the rear end of the locomotive. The weeder and fertilizer sprayer can be selectively attached either to the front end or the rear end. The furrow digger is generally attached to the rear end of the rover. In the first stage of farming i.e., land preparation ploughing is done using the plough attached to the rover. Then the groove driller is attached to rover for the process of making furrows. With the help of the fertilizer spraying tools, manure is applied to the field for the nourishment of the crops. Then the seeder is used for sowing of the seeds. As the crop reaches the vegetative and flowering stage the fertilizer sprayer and the weeder can be used as and when required. The agriculture rover is equipped to serve the farmers in every stage of the crop cultivation. It is a complete all in one machine which is the solution to many farm problems. The 3D model of the agricultural rover is shown below.

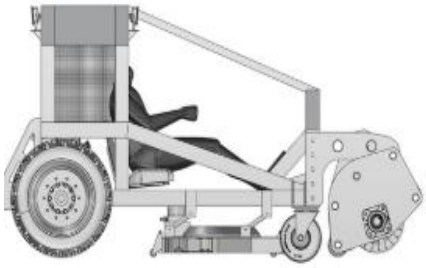

Fig10. Side angle view of the Agricultural rover along with the farm tool attached

Fig11. Top and Back view of the agricultural rover

4.2 Future scope:

- The agricultural rover is currently dependent of the supply of electricity for the charging of its batter. In future a solar panel can be installed for uninterrupted supply of power to the rover and the subsidiary tools.
- By increasing the equipment strength and quality to its peak, we can have multipurpose agricultural equipment for life time usage.
- The battery unit could be enhanced in order to generate more prolonged electric supply. A motor with greater efficiency could be used
- More equipment like soil testing tasks could be added to this project.
- The use of Internet of things for the driver free application and running of the machine can also be designed. This will make the equipment fully automated.
- Cameras of high quality can be placed at the front and rear ends of the rover for better monitoring of the farm processes. This will also be an added advantage for crop health monitoring.
- On an overall basis the next versions of the agricultural rover have good scope of improvement and improvisation.

5. CONCLUSIONS

Market-oriented farmers need to look at their profitability and efficiency in order to be competitive in farming. These are critical dimensions of the performance of the farm business. It is therefore vital for market oriented farmers to benchmark profitability and efficiency as a starting point in better management of their farms. This agricultural rover will provide a complete replacement of a farm tractor. It will increase the farm's productivity and reduce the cost of crop production. This machine is designed keeping in view the farmers literacy rate and is made such that it is very easy to use. The aim of the project is to provide a semi-automated all-purpose machine for the various agricultural practices. Based on the overall performance of the machine we can definitely say that the project will satisfy the need of small-scale farmer, because they are not able to purchase costly agricultural equipment. By designing a derived vehicle with low cost and high strength in the material the final design results are simulated to check the performance of vehicle. The machine requires less man power and less time compared to traditional methods, so if we manufacture it on a large scale its cost gets significantly reduce and we hope this will satisfy the partial thrust of Indian agriculture. So in this way we can overcome the labor problem that is the need of today's farming in IndiaBy implementing this project in the field of agriculture we can help the farmers in the initial stage of agriculture i.e. during the seeding and fertilizing. Our ultimate motto is to make this agricultural rover a very popular means of agricultural practices among the small scale farmers, leading to their increased income. The self-manufacturing of the agricultural rover on large scale in India will lead us one step closer to self-reliance or '*Aatmanirbhar Bharat'.*

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