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Design and Fabrication of Pneumatic Transplanter

Rozan Manzoor[a], Anupam Anand P[b], Rahul Augustine C J[c] & Prabhu Rahul M[d]

[a,b,c,d]*Student, Department of mechanical engineering , CUFE, Karnataka, India.*

ABSTRACT

Developing countries contribute to about 72% of the total production of vegetables in the world. India, which is one among them, is the second largest producer of vegetables in the world and accounts for about 15% of the production of vegetables in the world. Its production level is over 90Mtons from around 6.2 million hectares. However, the whole cultivation process is done mainly by hand or manually except for the preparation of soil. This manual cultivation involves huge investments in cost, time and labor. In addition to this, hand held transplanters are also used for cultivation purposes. It consists of components like handle, lever, hollow pipe, jaw and jaw operating wire. This implement penetrates into the soil by its self-weight hold with handle, seedling is dropped into the hollow pipe and then the jaw is opened with the lever. The main drawback of the hand held transplanter is that it does not reduce the manpower completely. This gives rise to a need for a transplanter which further reduces manpower. Therefore, this project was focused on the Design, Fabrication, Testing and Evaluation of a Pneumatic Transplanter. This project demonstrates the application of engineering techniques to reduce the labor efforts and time required for transplanting. The designed pneumatic transplanter consists of 2 Pneumatic Cylinders, a compressor, a battery, 2 solenoid valves, a plant feeding pipe, a base plate, a switch board, 3 switches- one for the forward motion, one for the cylinder extension and retraction and one for the opening and closing of valves, tubes- to carry the compressed air, tube fittings, 2 pair of wheels and 4 DC motors. By using pneumatic components, the production process is made more economical since these components are cheap, durable and the cost of repair is significantly lower than other systems.

Keywords *– Cylinder, Transplanter, Hollow Pipe, Pneumatic, Fabrication.*

1. INTRODUCTION

1.1Problem Formulation

A transplanter is an agricultural machine used for transplanting plants to the field. This is very important as it reduces the time taken to transplant plants (when compared to manual transplanting), thus allowing more time for harvesting. Numerous transplanters are accessible in business sector. Be that as it may, all mechanical and hydraulic powered transplanters has its own hindrances like the complexity of the structure, the various components used, space possessed etc. These drawbacks of mechanical and hydraulic transplanters can be overcome by presenting a pneumatic means.

The operation of this machine is discussed as follows.

A portable compressor which is installed on the machine supplies air to the 2 pneumatic cylinders. The machine moves forward by pressing the forward switch. By pressing the extension/retraction switch, the plant feeding hollow pipe which is connected to the plunging cylinder, plunges into the soil as the piston of the plunging cylinder extends which is connected to the 5/2 solenoid valve and is in turn connected to the compressor. After the pipe plunges into the soil, the open/close switch is pressed to extend the releasing cylinder in order to open the jaw of the hollow pipe. As it opens, it displaces the soil from its location. The crop which is to be planted is dropped by hand through the hollow pipe. The pipe is lifted by pressing the extension/retraction switch so that the plunging cylinder retracts and it allows the displaced soil to settle back in its place thus holding the crop in position. The open/close switch is pressed again to retract the releasing cylinder in order to close the jaw of the hollow pipe.

The machine again moves forward by pressing the forward button for planting the next crop. In this way, one person can plant or transplant a host of different crops into prepared seedbeds, all from a standing position.

1.2 Problem Identification

Out of the total number of producers of vegetables in the world, India is the second largest producer. In India, about 175 types of vegetables are grown including 82 field vegetables and 41 root crops. India produces 146.55 million tons (14.5%) of vegetables on 8.5 million hectares (14.9% of world's area) of land. Productivity of vegetables in India is 17.3 tons/hectare and is less than the world's average, which is 18.8 tons/hectare. Most of the vegetables are first sown in nursery beds and later transplanted manually. They use traditional methods of transplanting that is, by hand which is time consuming and increases the labor efforts. Most of the Indian farmers have small land holdings and have a very low standard of living. It is very difficult for them to acquire costly agricultural machinery and equipment. But the development of the Indian agricultural sector depends on the development of farm machinery. There is a need of cheap and easily available farm machinery to reduce human efforts, time consumed and the damage done to crops while transplanting. The already available vegetable transplanters are expensive for the small scale farmers. Due to this, the farmers use traditional methods of vegetable transplanting. In India most of the farmers perform transplanting operation of vegetables using traditional methods. These methods include operations such as making holes in mulching paper and digging out pits on bed and finally transplanting seedlings in each hole manually. Unavailability of labor causes a delay in transplanting operations thus directly affecting the crop production and the economic condition of the farmer. Human workforce contributes substantially to the production of crops in Indian agriculture. Around 220 million workers provide about 8% of all related agricultural activities. Although farm mechanization is increasing rapidly, it is the men whose tasks are predominantly affected. In ancient times only hand tools were used and there has been a gradual improvement in their design, efficient handling, weight and cost in recent times. People still today realize that there are many possibilities to modify these tools for better work efficiency. Hence, to overcome all these problems, the development of machinery and equipment that makes it easy to transplant vegetables, save labor efforts and time consumed are very much crucial.

1.3 Problem Statement and Objectives

The Pneumatic Transplanter has the accompanying destinations:

- To outline, create and adjust the current Transplanter utilized for agricultural purposes by fusing a Pneumatic System.
- To change the Manual Transplanter into a Pneumatic Transplanter keeping in mind the end goal to advance lessen the Labor, Cost and Time.
- To build the generation of vegetables by augmenting the creation level on the current 6.2 million hectares of area in India which is the second biggest maker of vegetables on the planet adding to the 15% of the world's generation of vegetables.
- To decrease the labor and time expended for planting the products which at present is being done physically in India and other creating nations.
- To plant the harvests without bringing on any harm to it.
- To make the creation prepare more practical as the pneumatic parts are shabby, tough and the expense of repair is fundamentally lower than different frameworks in this manner, enhancing the economy of the nation.
- To make mindfulness among the agriculturists about utilizing the programmed Transplanter for the long haul.

1.4 Limitations

Although pneumatic frameworks have a considerable measure of points of interest, they are likewise subject to numerous impediments.

(i) Relatively low precision- As pneumatic frameworks are fuelled by the power gave by packed air; their operation is subject to the volume of the packed air. As the volume of air might change when compacted or warmed, the supply of air to the framework may not be exact, bringing about abatement in the by and large precision of the framework.

(ii) Low stacking- As the chambers of pneumatic segments are not extensive, a pneumatic framework can't drive loads that are too overwhelming.

(iii) Processing required before use- Compacted air must be prepared before use to guarantee the nonappearance of water vapor or dust. Something else, the moving parts of the pneumatic segments might destroy rapidly because of contact.

(iv) Uneven moving velocity- As air can undoubtedly be packed; the moving velocities of the cylinders are moderately uneven.

(v) Noise- Noise will be created when packed air is discharged from the pneumatic segments

2. LITERATURE SURVEY

- This article published by G.V. Prasanna Kumar et al., [1] presents the details of construction of Vegetable Transplanters in addition to recent advances in their development. Performance of Transplanters under actual field conditions was also discussed.
  The low level of mechanization warrants introduction of low cost, efficient machines for planting, inter-culture, spraying, etc. The study done by Pradeep Rajan et al., [2] was focused on to develop a low-cost precision planter to suit vegetables for different agro-climatic regions and production practices in India.
- The work done by Amruta S. Patil et al., [3] was focused on design, development and testing of hand held vegetable transplanter capable to transplant seedling precisely in a straight line with uniform depth in mulch bed. The cost of operation was comparatively less than traditional method of transplanting.
- Ranjeet Kumar et al., [4] studied the performance of a pneumatic planter in both laboratory and actual field conditions using sorghum seeds in context to justify its use in dry land. Pneumatic planter consists of frame, aspirator blower, seed hopper, metering unit, multi-groove metering plate, vacuum retaining plate, furrow opener, pair of ground wheels with power transmission system
- The evaluation of diffusion possibilities of mechanical transplanting method done by Umar Farooq et al., [5] revealed that on economic grounds, although this method is more expensive as compared with the conventional method, however, the yield benefits due to higher population stand makes it profitable to adopt.
- Mohammad Reza Alizadeh et al., [6] conducted a study to evaluate the techno-economic performance of a self-propelled four rows walking-type rice transplanter and to compare it with hand transplanting method in the paddy field.
- H. A. Abd El Mawla et al., [7] devoted to study the application of transplanting cane seedlings including nursery growing and mechanical transplanting to facilitate easy application of the technique. The mechanical transplanting of sugarcane represented applicable technique that facilitated replacing traditional planting method to save more than 1000 LE of production cost.
- To reduce the labour demand and time consumption, power operated transplanters are also available but the poor socio- economic conditions of Indian farmers restrict them to adopt modern technology. Keeping this in view, Pragya Ojha et al., [8] conducted a study to compare the economic cost and the rate of human drudgery among female farm workers, during manual hand transplanting with the power operated eight-row paddy transplanter.

3. OBJECTIVES AND METHODOLOGY

The Automatic Pneumatic Transplanter has got the following objectives:

- ❖ To design, fabricate and modify the existing Transplanter used for agricultural purposes by incorporating a Pneumatic System.

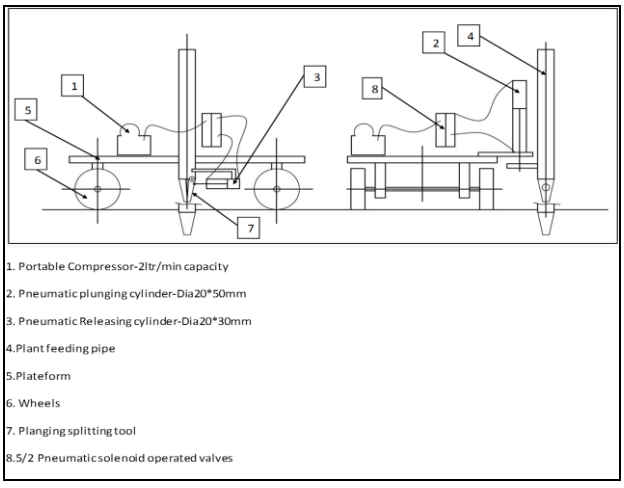

Fig 1: Layout of Automatic Pneumatic Transplanter.

- ❖ To transform the Manual Transplanter into an Automatic Transplanter in order to further reduce the Labour, Cost and Time.
- ❖ To increase the production of agricultural market.
- ❖ To reduce the man power and time consumed for planting the crops which at present is being done

manually in India and other developing countries.

- To plant the crops without causing any damage to it.
- To make the production process more economical as the pneumatic components are cheap, durable and the cost of repair is significantly lower than other systems thus, improving the economy of the country. To create awareness among the farmers about using the automatic Transplanter for the long term.

4. DESIGN CALCULATION

4.1 Cylinder Force Calculation when Cylinder Extends

Cylinders used-Dia 20x100mm
Pressure in Bar 'P'- 4 bar=4kgf/cm^2
D1-Dia in mm – 20mm
A1-area of cylinder (bore area) cm^2- 3.14159 cm2
F-force in Kgf
= P x A1 = 4 x 3.1415
=12.5663Kgf

4.2 Cylinder Force Calculation when Cylinder Retracts

Cylinders used-Dia 20x100mm
Pressure in Bar 'P'- 4 bar=4kgf/cm^2
D1-Dia in mm – 20mm=2cm
D2-Rod area-8mm-0.8cm
A1 bore-area of cylinder (bore area) cm^2 - 3.14159cm^2
A r -rod area-0.50265 cm^2
A1-A r =A2-2.638 cm^2
F-force in Kgf
= P x A2 = 4 x 2.638
= 10.55Kgf.

5. CONCLUSION

The main purpose of this model pneumatic transplanter is to serve the small scale farmers, for them to farm easily and cost effectively for a long period of time. Using the appropriate design calculation pneumatic transplanter force is calculated for both the extend and retract positions.

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