The Pharma Innovation Journal 2023; 12(5): 1087-1089

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(5): 1087-1089

www.thepharmajournal.com
Received: 05-02-2023
Accepted: 16-04-2023

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Development of electric harvester

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Abstract
Harvesting of crop is one of the important agricultural operations, which demands considerable amount of labour. The availability and cost of labour during harvesting season is the serious problem. Therefore, it is essential to adopt the mechanical methods so that the timeliness in harvesting operation could be ensured and field losses could be minimized and consequently productivity and production could be increased. Manual wheat harvesting is done by sickle, which demand considerable amount of labour drudgery, time and cost of harvest which reflect total production cost of the crop. Nowadays, self-propelled reapers are being used in many developing and least developed countries in small scale which is diesel fueled. Combine harvesters are also in use for this purpose but these machines consume diesel fuel. Price of fossil fuels is hiking day by day. Thus, to ensure efficient and timely harvesting operation riding type battery powered tool carrier with reaper attachment was developed, which is very simple in construction, low maintenance and easy to maintain. In present study, only reaeper is attached at front side but at rear side other animal drawn or mini tractor drawn implements can be attached. This machine can be use for different purpouses i.e. seed drilling, interculturing, transportation, etc. Due to its small size it can be boon for remote as well as hilly locations. Its battery pack can be use as power grid in remote areas where continuous electricity is a challange. The machine consists of two DC motors of 1000 W and 750 W, four batteries of 12 V 42 Ah, standard 33" differential, four wheels, crop dividers, cutter bar, conveyor belts, etc. It was able to cut four rows of wheat crop placed at 22.5 cm apart.

Keywords: Harvester, e-reaper, riding type harvester

1. Introduction
Agricultural mechanisation entails the use of various power sources as well as improved farm tools and equipment in order to reduce human and animal drudgery, improve cropping intensity, precision, and timeliness of crop input utilisation, and reduce losses at various stages of crop production.

It is the miracle of soil of India that it provides food to 1.3 billion population with just an average land holding of approximately 1.08 ha. Small and marginal land holdings (< 2.0 ha) contribute to around 86% of total operational land holdings and cover about 47% of total operated area (Department of Agriculture, Cooperation & Farmers Welfare, 2018) [1]. The share of draught animal power is declining in the total farm power. There is a linear relationship between availability of farm power and farm yield. For the year 2020-21, the availability of farm power was 2.76 kW per ha (Singh and Singh, 2021). There is a need to increase the availability of farm power to 4.0 kW per ha by the end of 2030 to deal with the increasing demand of food grains (NABARD, 2018) [2]. Estimates suggest that by 2050, percentage of agricultural workers of the total work force would drop to 25.7 percent from 58.2 percent in 2001 (FICCI Agriculture Division, 2018) [3]. The productivity of food grains has increased from 0.5 MT/ha in 1950-51 to 2.4 MT/ha in 2020-21, while the per capita availability of food grains increased from 144.1 kg/person/year in 1950-51 to feed a population 0.36 Billion then, to 187.1 kg/person/year to feed a population of 1.34 Billion people in 2019-20. This growth in productivity has been driven by better farmers' access to and use of various factors of production. For instance, the percentage of net irrigated area has increased from 20.9 Million hectares in 1950-51 to 69.5 Million hectares in 2019-20 (Anonymous, 2021) [4].

The productivity of agricultural farms depends greatly on the availability and judicious use of farm power by the farmers. Indian agriculture has faced serious challenges like scarcity of agricultural labour, not only in peak working seasons but also in normal time. This is mainly due to increase in nonfarm job opportunities having higher wage, migration of labour force to cities and low status of agricultural labours in the society.

The share of workforce employed in the agriculture sector has declined from 70% in 1951 to 42.3% in 2019 and this will further reduce to 25.7% by 2050 (NITI Aayog, 2018) [5]. Lack of workforce availability and pressing need for improving crop productivity calls for a strong focus on increasing mechanization in agriculture. A substantial increase is found in agriculture mechanization in India. However, the level of farm mechanization is just about 40-45% compared to other countries such as US (95%), Brazil (75%) and China (57%) (FICCI & PwC, 2019).

The need and demand for agricultural equipment caused by increasing world population is more than obvious. Current agricultural equipment has reached its optimization limits in terms of complexity too and efficiency too with respect to current technology. Furthermore advancements in the area of drive technology currently mainly mechanical or hydraulic drives are limited. That's why in future the focus in this area will be on electrical drives. Electrification of implements has the potential for energy savings through more efficient power transfer and savings in operational charges (Hahn, 2008) [6].

The crop harvesting is the important stage in farming. In conventional method of crop harvesting labourers cut the crop manually that is time consuming, so as to minimize the time required for cutting the crop and also to avoid the bending posture of the labour while cutting and health hazard related to long term working in bending posture, A thought has been given to use a machine that cuts the crop with much ease and comfort. It also reduces the operational cost and raise the financial condition of Indian farmers (Ghumadwar and Banker, 2016) [7].

Incorporation of electric drives in agricultural machinery presents advantages in terms of increased energy efficiency and expanded functionalities. Higher efficiency means reduced fuel consumption and therefore subsequent decrease in CO_2 emission. New functionalities result in improved work quality and operator comfort. Major advantages of machinery electrification include speed and torque control, noise reduction, and a much flexible design.

Though agricultural and forestry sector are responsible for significant portion of emissions worldwide, by the usage of diesel engine-based machinery, this sector is also heading towards environmental sustainability. EVs for farming are crucial in these times for sustainable food production and suppressing gas emissions. Magalhaes *et al*. (2017) [8] have described the main research in field of electric tractors highlighting the problems of implementing electric tractors along with suitable solutions. They have mentioned that electrification of tractors is full of challenges. Several national and multinational brands in farm machinery segment are currently developing electric tractors and some of them are already launched which they claim will be on the farm machinery market within a year or two.

Traditional manual harvesting of wheat with sickles is a labour-consuming process and also the shortage of labour as well as unexpected weather change are the barriers for timely harvesting and cause greater loss to the farmers in delaying the harvesting operation. Harvesting is an important operation to perform our job timely to achieve better quality and yield of the crop. Therefore, for timeliness in harvesting operation, it is necessary to adopt mechanical harvesting methods. There are several mechanical methods of harvesting like direct harvesting with combine harvesters, reaping and windrowing with self-propelled reapers or tractor-operated reapers.

2. Materials and Methods

The riding type battery powered tool carrier with reaper attachment was developed by keeping in a view literature review, farming patterns and personal correspondence. Complete line diagram of the developed machine is shown in Fig. 1. Firstly it was thought to have only one motor for the machine but after seeing the drawbacks of that idea two separate motors have been chosen. Because from one motor it could be complex for power transmission to the wheels of the tool carrier and to the reaper. That's why two DC motors have been selected. One for actuating the four wheeled tool carrier and another for propelling the reaper which can be seen in Fig. 1. They got power from the battery pack. Current flows from battery to power controller and from there it goes to motor in specific manner. Accelerator and forward reverse button were connected with power controller to regulate the current so the speed of the machine. At the end a motor was connected to the rear axle and another with the reaper.

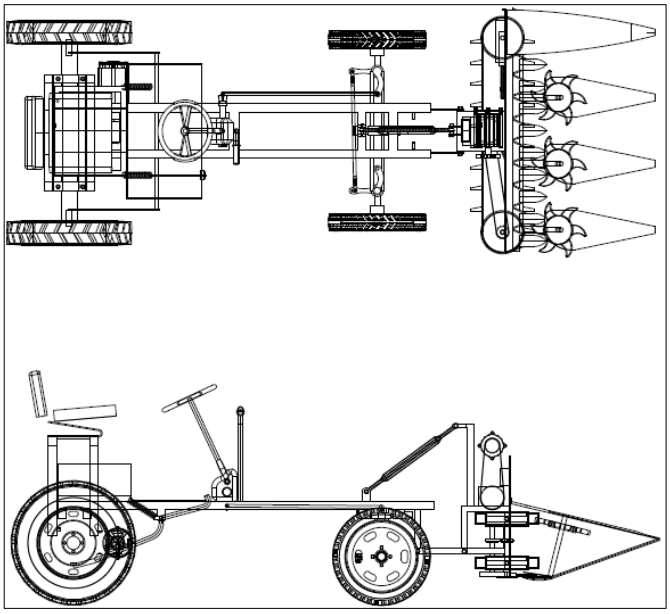

Fig 1: Line diagram of the developed machine

Developed machine can be used for harvesting of the paddy, wheat, jowar, etc. standing crops as well as after detaching the tool carrier it can be useful as mini tractor.

3. Conclusions

In this era of fossil fuels battery powered machineries are being introduced in automobiles likewise in farming it can be introduced widely to minimize the bourdon of fuel prices for the farmers.

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