DEVELOPMENT AND PERFORMANCE EVALUATION OF SELF-PROPELLED PADDY SEEDER

BY

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TAVANUR – 679573, MALAPPURAM KERALA, INDIA

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PROJECT REPORT

Submitted in partial fulfilment of the requirement for the degree of

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DEPARTMENT OF FARM MACHINERY AND POWER ENGINEERING

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
TAVANUR-679573, MALAPPURAM
KERALA, INDIA

2023

DECLARATION

We hereby declare that this project entitled **"DEVELOPMENT AND PERFORMANCE EVALUATION OF SELF- PROPELLED PADDY SEEDER"** is a bonafide record of project work done by us during the course of study and that the report has not previously formed the basis for the award to us of any degree, diploma, associate ship, fellowship or other similar title of another university or society.

Place: Tavanur

Date: 25-05-2023

Fathima Rana T (2019-02-018)

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Anusree S Kumar (2019-02-048)

CERTIFICATE

Certified that this project report entitled **"DEVELOPMENT AND PERFORMANCE EVALUATION OF SELF-PROPELLED PADDY SEEDER"** is a record of project work done jointly by **Ms. FATHIMA RANA T, Mr. AARIFF.S, Ms. NADHIYA C and Ms.ANUSREE S KUMAR** under my guidance and supervision and that it has not previously formedthe basis for any degree, diploma, fellowship or associateship or other similar title of another University or Society.

Place: Tavanur

Date: 25-05-2023

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SYMBOLS AND ABBREVIATION

Abbreviation/Notation	Description
/	Per
%	Percentage
CDS	Conical drum seeder
cm	Centimeter(s)
cm^2	Square centimeter(s)
cm^3	Cubic centimeter(s)
DS	Direct seeding
et al.	And others
fig.	Figure
etc.	et cetera
°C	Degree centigrade
g	Gram(s)
ha	Hectare
ha/hr	Hectare per Hour
kg	Kilogram(s)
kg/m^3	Kilogram per cubic meter
km/hr	Kilometer per hour
l	Liter(s)
m	Meter(s)
m/s	Meter per second
mm	Millimeter(s)
N	Newton
Nm	Newton meter
rpm	Revolution per minute
s	Second(s)
Viz	Namely

DEDICATED TO OUR FAMILY AND PROFESSION

INTRODUCTION

CHAPTER I

INTRODUCTION

Agriculture is the ancient and indispensable practice of cultivating plants and raising animals to produce food, fiber, and various other products. Throughout history, it has served as a vital human activity, ensuring sustenance for populations. This encompassing field entails a multitude of tasks such as soil preparation, crop planting, livestock care, harvesting, and the processing of goods for consumption or trade. Over time, agriculture has become increasingly complex and sophisticated, incorporating new technologies and scientific advancements to increase efficiency and sustainability. Today, agriculture is a critical industry that provides food and raw materials to support global populations and economies. However, the modern agricultural industry also faces numerous challenges, including climate change, resource depletion, and the need to meet increasing demands for food while minimizing environmental impact. Meeting these challenges will require continued innovation and investment in sustainable agriculture practices, as well as cooperation and collaboration across the agricultural sector.

Rice (Oryza sativa), is the world's most important cereal crop and is the staple food for more than half of the world's population. India is the second largest producer of rice in world. Rice is one of the major staple diets in India. The total production of rice is estimated to be 122.27 million tonnes in 2020-21, which is higher by 9.83 million tonnes as compared to the last five years of average rice production of 112.44 million tonnes (Anon, 2022).

In Kerala, rice is an inevitable part of their life. In Kerala, the rice production is 6.33 lakh tones from paddy cultivation area of 2.05 lakh hectares. And it occupies 7.66 percent of the total cropped area of the state (Anon, 2022).

Also, the rice is ranked third in world cereal crop production after wheat and maize. About 90% of the world's rice (146.7 million ha of area with a production of 673.6 million tons of paddy) was cultivated and produced in Asia. India is the second largest producer of rice with 156 MT after China having 205.5 MT rice among countries in the world. Above facts revealed that rice is one of the most important crops in India and occupies 24% of gross cropped area of thecountry, with 45 million ha of cultivated area. (Anon, 2014).

Generally paddy is propagated through direct seeding of dry seeds manually or with a seed drill, broadcasting or line sowing of dry seed/ pre-germinated seed or transplanting the seedling from nursery either manually or by mechanical means. In India, manual transplanting of 3–4 weeks old nursery seedlings is the most commonly used conventional rice cultivation practice. Though manual transplanting is a pre-dominant practice in almost all the paddy growing areas, it has very high labour demands. During the transplanting season, the labour requirement for transplanting, including nursery raising, varies from 50–1000 man-h per ha in different country regions. (Manoj Kumar *et al.,*2021) The shortage of labour during the peak season of transplanting creates uncertainty and delays in the operation, ultimately reducing crop yields.

Nevertheless, Paddy cultivation is too laborious, burdensome, and has many expenses on raising, settling, and transplanting nursery. Additionally, transplanting has other disadvantages, such as stress on seedlings when pulled out from nursery and the time taken and the laborious process of raising nurseries and the delayed growth compared with direct seeding. The transplanting method deteriorates soil's physical properties, adversely affects the performance of succeeding upland crops, and contributes to methane emissions. These problems have compelled engineers, researchers, farmers, and scientists to replace conventional paddy transplanting methods.

Several studies have been conducted in many countries on the direct seeding of rice as an alternative to rice transplanting. Most field experiments and on-farm researches have established that direct-seeded rice can yield as high as transplanted rice if adequately managed. Some studies found that direct paddy seeding is the best alternate cropping technique, which requires less water and labour than the transplanted rice. In the direct seeding method of paddy cultivation, the pulling, transporting, and transplanting of seedlings are avoided, so plants are not exposed to strains like being dragged from the field and then re-establishing seedlings. A study conducted by on direct seeding reduced the cost of cultivation by Rs. 9166 per ha by avoiding nursery and transplanting costs (Manoj Kumar *et al.,*2021). The grain yield of dry direct-seeded rice was identical to the transplanted-flooded rice. However, dry direct-seeded rice increased nitrogen use efficiency by 20.3 percent. The direct sown paddy saves about 25 percent of irrigation water as it avoids puddling andenhanced irrigation intervals. There was a net saving of Rs. 13,000/ha in crop establishment due todirect-sown paddy as against the conventional puddled transplanted rice. (Manoj Kumar *et al.,*2021)

The unavailability of efficient direct seeding machines is one of the major problems in practicing direct seeding rice cultivation. The drum seeder may also face challenges in achieving consistent and accurate seed placement, which can lead to uneven plant emergence and reduced crop uniformity and it is also laborious to pull the seeder in the puddle field. With the above facts, the project entitled "Development and performance evaluation of self-propelled paddy seeder" aimed with the following objectives:

- To study the seed parameters for the design of a self-propelled paddy seeder.
- To develop the components of a self-propelled paddy seeder.
- To test and evaluate the performance of paddy seeder.

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

2.1. INTRODUCTION

The review of previous research works related to direct seeding of rice, DSR machines and seed metering mechanism are mentioned below.

2.2. DIRECT SEEDING OF RICE

Direct seeding is a crop establishment system wherein rice seeds are sown directly into the field, as opposed to the traditional method of growing seedlings in a nursery, then transplanting into flooded fields.

W.M.W. Weerakoon *et al.* (2014) studied about, Direct-seeded rice culture in Sri Lanka. The survey revealed that smaller land holding size, non-adherence to the optimum time of farm activity initiation, less efficient use of rain water, higher seed rate and higher cost of production are a few reasons for the existing yield gap. Location-specific technologies for different agroecological zones of Sri Lanka should be developed to reduce the cost of production and to increase resource-use efficiency and should be transferred to the farmers to achieve sustainable optimum direct-seeded rice yield. The farmer’s survey described in the present study identified several short to long-term measures to enhance the productivity and production needed to meet the growing demand of next 20–30 years. Growing shortages of labor and water dictate the needof major changes in the way direct-seeding is practiced in Sri Lanka.

Marasini *et al*. (2016) reported that direct seeded rice is a resource conservation technology which can reduce water and labour by 50 %. As compared to conventional method of transplanting, the methane gas emission is lower for direct seeded rice. The directed seeded rice includes the sowing of pre-germinated seeds into puddled soil (wet seeding), in standing water or dry seeding.

Hossain *et al.* (2016) stated that the weeds are the major constraints to DSR systems and its management is a fundamental practice. Integrated approaches, such as the use of clean certified seeds, higher seeding densities, cultivation of competitive variety, seed invigoration, stale seed bed preparation, crop rotation, water and fertilizer management along with rotation of herbicides with different mode of actions followed by manual weeding are suggested for sustainable weed control in DSR.

Gulshan *et al.* (2018) showed that the adoption of DSR has reduced the cost of cultivation by 29 per cent on an average. The farmers who adopted DSR received higher profits in comparison with the conventional transplanted rice cultivation, because of reduced labour costs for crop establishment and also higher yields obtained in DSR. Also, adoption of DSR has allowed an earlier harvest of the crop. The findings confirm the positive impacts of DSR and the results support promoting DSR as a strategy to enhance profitability of farmers and also as a water saving technology in the face of depleting water resources for agriculture in general and rice in particular.

Balkaran Singh Sandhu (2019) explained that overall direct seeding is a labour-saving technology but soil type, weed flora are important factor for its success. In new rice growing area it should be avoided and preference should be given to transplanted. Happy Seeder technology is a good option against burning of rice residue. This technology is also time savings because the happy Seeder can be brought into the field immediately after the rice harvest and is environment friendly. Among the different planting methods maximum seed yield was obtained with the conventional and happy seeder without loose straw as compared to happy seeder with loose straw, zero tillage and conventional method with mulching. Whereas, higher B:C ratio was obtained by happy seeder with and without loose straw as compared to zero tillage method and conventional due to its lesser cost of cultivation as compared to conventional method of sowing.

Singh *et al.* (2019) studied that direct seeding of rice resulted in higher seed yield compared to traditional transplanting methods. The study also noted that direct seeding reduced water consumption and labour costs. Direct seeding alternative establishment method of aerobic rice and relatively less water requirement compared to transplanted rice. Direct seeded rice avoidsrepeated puddling, preventing soil degradation and plough-pan formation. It facilitates timely establishment of rice and succeeding crops as crop matures 10-15 days earlier. It saves water by 35-40% and reduces production cost by Rs 3000 ha-1with an increase in yields by 10%. In general,a total of 1382 mm to 1838 mm water is required for the rice-wheat system accounting more than80% for the rice growing season. In addition to higher economic returns, DSR crops are faster andeasier to plant, having shorter duration, less labour intensive, consume less water, conducive to mechanization, have less methane emissions and hence offer an opportunity for farmers to earn from carbon credits than TPR system.

Radhika *et al.* (2020), the direct sowing can be done either by manually or by drum seeder using pre germinated rice under the puddled field condition. The direct seeded rice method requires only 34 % of total labour costs and 29 % of cost of transplanting

Manish Kumar *et al.* (2022) direct seeded rice has a 10% yield advantage compared with mechanically transplanted rice. The results show that DSR technology has the potential to protect against up to 70% of crop lodging in adverse climatic conditions. DSR helps in advancing the planting dates of succeeding rabi crops, by at least 7–10 days, by saving the land preparation time. The DSR option is cost effective and environmentally friendly compared with the puddled transplanted rice system. DSR allows crop seeding in dry conditions. Traditional methods, however, require intensive tillage, puddling, and submergence conditions. The DSR method has various benefits over the traditional puddled transplanted rice planting systems. Meanwhile, the DSR crop will have a 10–14-day advantage in maturity in comparison with the traditional planting method. The DSR crops have higher nutrients and are water and carbon efficient. Puddled transplanted rice enhances greenhouse gas emissions.

2.3 DSR MACHINERIES

R.M. Chandima Ratnayake and B.M.C.P. Balasoriya (2013) re-designed and developed manual conical drum seeder. The work was undertaken to re-design and develop a manually operated mechanical drum seeder, which can be used for sowing pre-germinated paddy rice, by taking into consideration currently available drum seeder designs and their drawbacks. To design a mechanical drum seeder for direct seeding of pre-germinated paddy seeds and evaluate its performance in relation to manual broadcasting. The theoretical and effective field capacity, field efficiency, and missing hill percentage were observed to be 0.22 ha/h, 0.18 ha/h, 81% and 3.70% respectively. The saving of pre-germinated paddy rice seed was about 75% and increase in yield was about 37% in CDS as compared to manual broadcasting.

R. Jaya prakash et al. (2015) developed a 4-row drum seeder with 25 and 30 spacing. Based on the experimental results, from the calibration of drum seeder the seed rate of 37.99 and 33.33 kg/ha was achieved with the 25 and 30 cm row spacing's respectively. The field capacity of 25cm row spacing was observed that 0.07 kg/ha with the field efficiency of 77.41 per cent at the seed rate of 38 kg/ha whereas the field capacity of 30 cm row spacing was 0.08 ha/h with the field efficiency of 76.16 per cent at the seed rate of 33.85 kg/ha. Maximum tillers of 561/ m^2 and panicles of 509 / m^2were recorded with 30 cm spacing whereas the tillers of 491/ m^2 and panicles of 440/m^2 were recorded for 25 cm row spacing. From the results, 30 cm row spacing has got more yield and less operating cost which is more economical and suitable for farmers.

Baolong Wang *et al.* (2018) designed and evaluated a hill-drop pneumatic central cylinder direct-seeding machine for hybrid rice. A series of orthogonal experiments were conducted to investigate the performance of the cylinder seeder. The influences of the hole diameters, degree of vacuum, and rotational speed of the cylinder were tested on JPS-12 computer-vision seeding test platform, and the rotational speed of 10-50 r/min, diameter of 135 mm and a negative pressure of 1.0-2.0 kPa were employed. Test results showed that the optimal parameter combination was a vacuum of 2.0 kPa and a hole diameter of 2.0 mm (straight hole), with a rotational speed of 30 r/min. The probability of (2±1) seeds in each hole was 95.3%, while the probability of seed-missing hole was 2.0%. A series of field experiments were then conducted to test the seeder performance according to China National Standard Test Methods, and the field test results showed that for the hill-drop pneumatic central cylinder direct-seeding machine, the probability of (2±1) seeds in each hill was 91.6%, while the probability of seed-missing hill was 2.7%.

Tian Liquan *et al.* (2021) designed and tested a direct seed metering device for rice hill. To meet the requirements of rice field precision direct seeding in rows and hills, a spiral grooved seed metering device is designed. The test results show that when the spiral groove rise angle is 71.0°, the spiral groove length is 10.8mm, and the working speed of the metering wheel is 23.2r/min, the qualified rate of hill diameter, qualified rate of hill seeds and miss-seeding rate are 91.06%, 94.64% and 3.64% respectively. The seeding performance meets the agronomic requirements of rice field seeding.

2.4 RICE METERING MECHANISMS

Different types of metering mechanisms are used in drills and planters for regulating and controlling the rate or number of seeds dropped per rotation of the mechanism to achieve recommended seed rate of the crop sown. The devices used for metering the seeds for distributing in lines in the field are of volume basis. The common devices are fluted roller, inclined plate, roller and disc cell types, hole and agitator types etc., which functions on volume basis. However, the pneumatic and electronic devices meters seeds on the basis of number of seeds fills or picked by the cells.

Emrah *et al.* (2014) studied that seeds used in crop production are very different from each other in terms of shapes and sizes. The metering devices with fluted roller can be used for seeds with different size and shape especially in case of using the appropriate flute diameters along with helical angle of flute and revolution speed of feed shaft. The metering devices with fluted roller which are cheaper and more common than other metering devices should be tested with seeds with different size and shape for obtaining of a sufficient accuracy of flow. The results this study showed that the metering devices of the fluted roller can be used for dry bean seed in a sufficient accuracy of flow.

V. K. Garg and R. K. Pachauri (2015) designed and developed a motorized seed feeder for precision agriculture. This study proposed a motorized seed feeder for precision agriculture that utilizes a cell feed mechanism to accurately distribute seeds. The researchers tested their device with wheat and found that it significantly improved seed distribution compared to manualmethods.

A. K. Das and S. K. Roy (2017) designed, developed and evaluated a Pneumatic Cell Type Seed Metering Device for a Precision Planter. The researchers found that their device had a high level of accuracy and consistency in seed distribution.

Y. H. Park and S. H. Park (2018) developed a Cell-Type Seed Metering Device for a Precision Planter. This study proposed a cell-type seed metering device that utilizes a rotary feeder and adjustable cell size to achieve precise seed distribution. The researchers found that their device was highly accurate and could be easily adjusted for different seed types.

Rakesh, N (2018) developed and evaluated a small tractor drawn seed planter with battery operated seed metering mechanism. All tractor operated seed planter with battery drive metering mechanism evaluated for its performance, results shown that the field capacity, field efficiency of the planter, fuel consumption, seed to seed spacing, depth of sowing and germination of seed was 0.30 ha/h, 66.17 %, 1.87 lit/h, 23.2 cm, 5.4 cm and 97 % respectively.

M. K. Yadav et al. (2019) designed and developed a seed drill machine with cell feed mechanism. This seed drill machine with cell feed mechanism can plant seeds at a high speed with accurate distribution. The researchers tested their device with maize and found that it had a high level of efficiency and reliability.

Jorge W Cortez (2020) Seed metering system and tractor-seeder forward speed are factors that affect sowing. Therefore, this study aimed to evaluate sowing and agronomic components of corn as a function of seed metering mechanism and tractor-seeder forward speed, in addition to evaluating the yield data obtained from a harvester with a yield monitor. Seed metering system and tractor-seeder forward speed are factors that affect sowing. Therefore, this study aimed to evaluate sowing and agronomic components of corn as a function of seed metering mechanism and tractor-seeder forward speed, in addition to evaluating the yield data obtained from a harvester with a yield monitor.

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

In this chapter the data collected for the development of machine functionalities and study of different varieties of paddy seeds and machine parameters are explained. Development and performance evaluation of a self-propelled paddy seeder was done considering paddy varieties and various machine parameters. The machine was developed for different paddy seed varieties to place the seeds precisely at recommended uniform spacing and up to 4 rows. The predominant varieties of paddy seeds such as Neeraja, Jyothi, Sreyas,Uma,Mattatriveni,Ponmani,Athira, Makara, Kanchana, Supriya, Swetha and Jaya were collected from RARS, Pattambi to determine the physical and engineering properties.

3.1. PHYSICAL AND ENGINEERING PROPERTIES

The physical and engineering properties of seeds such as size, shape, bulk density, angle of repose and thousand seed weight plays a vital role in the development of seed metering mechanism. The size parameter helped in designing groove dimensions to accommodate the number of seeds in the groove. The shape property described the uniform free flow of paddy seeds from the groove surface. Bulk density values helped in development of seed hopper. Angle of repose was determined to develop the required slope of seedhopper for free flow of paddy seeds from the hopper. The physical properties were determined as follows.

3.1.1. Physical properties

3.1.1.1. Size and shape

The size and shape of paddy seeds were the two important factors that helped in deciding dimensions of seed metering unit. Paddy seeds had a three-dimensional shape which could be measured as the length, breadth and thickness. The predominant varieties of paddy seeds are collected and the size along three directional axis was measured as length, breadth and thickness. Geometric mean size and sphericity were determined based on the dimensions of the paddy seeds.

Geometric mean size of paddy seed affects the groove size. A sample of 100 seeds of each variety was taken and geometric mean was determined by the following relationship.

$$\text{Geometrical mean} = \sqrt[3]{l \times b \times t}$$

Where,

l = length of paddy, mm

b = breadth of paddy, mm

t = thickness of paddy, mm

Sphericity(ø) affects the uniform free flow of paddy seeds from the metering roller groove surface. In order to define the shape of seeds, sphericity (ø) was calculated by utilizing the values of physical dimensions of seed using the following relationship.

Sphericity(ø)= $(\sqrt[3]{l \times b \times t}) \div (l)$

Where, l = length of paddy, mm

b = breadth of paddy, mm

t = thickness of paddy, mm

3.1.1.2 Thousand seed weight

The thousand seed weight is an important factor in deciding the desired seed rate. One thousand seeds were randomly selected from the seed samples of different varieties and weighed using an electronic balance having an accuracy of 1 mg and mean weight was determined.

3.1.1.3 Bulk density

Bulk density, also called apparent density or volumetric density. Bulk density is used to determine the capacity of seed hopper. Bulk density was determined using a measuring beaker of diameter 4 cm and height 6 cm.Initially the beaker was weighed. The beaker was filled with paddy seeds, and then the beaker was weighed again. The weight of seeds(w) was calculated. The bulk density was determined as the ratio of weight ofthe seeds and volume of beaker following relationship

$$\text{Bulk density, } \rho = \frac{w}{v}$$

Where ρ =bulk density, g/cm^3

w = weight of seed, g

v = volume of the beaker, cm^3

3.1.1.4 Moisture content

The given sample was dried in electric oven at a temperature of 105°C for 24 hours and weighed by using a weighing balance of accuracy 1mg.Three replicas of each variety was taken and its mean value was considered as the moisture content. The moisture content of the sample in percent dry basis was determined by the following formula.

$$\text{Moisture content (\%)} = \frac{wi-wd}{w_d} \times 100$$

Where,

w_i = Initial weight of the sample, g

w_d = Final weight of the sample, g

3.1.2 Engineering properties

3.1.2.1 Angle of repose

The angle of repose is the angle between the base and the slope of the cone formed on a free vertical of the granular material to a horizontal plane. The angle of repose was measured by using a wooden frame full of paddy seed sample is placed on a tilting top drafting table. The table top is tilted so that the seed starts moving downwards over the inclined surface. The angle of inclination was measured, which is the angle of repose of the paddy seed sample.

$$\text{Angle of repose } (\theta) = tan^{-1}\left(\frac{2h}{d}\right)$$

Where,

h = height of the heap, cm

d = diameter of heap, cm

3.2 MACHINE PARAMETERS

3.2.1 Spacing

Spacing is an important consideration as it directly affects the distribution and placement of seeds. Proper spacing ensures uniform coverage and optimal growth conditions for the plants. Spacing is also an important parameter in developing seeder for direct seeded rice cultivation because of the need of weeding. Weeding is an important intercultural operation in direct seeded rice cultivation. The weeds that are grown in the germination period and initial growth of paddy seed is to be removed precisely using any weeders. In order to allow weeding, the spacing should be precise. The optimum spacing is also important for the yield and it varies with varieties. In this development row to row and hill to hill spacing of 24 cm x24 cm is provided.

3.2.2 Number of seeds per hill

The number of seeds per hill can have both positive and negative effects on paddy cultivation, depending on the specific conditions of the field and the management practices used. The optimal number of seeds per hill can vary depending on factors such as soil fertility, irrigation, and pest and disease. The number of seeds per hill affects the way the plant utilizes the available resources such as water, nutrients, and sunlight. A higher number of seeds per hill can suppress the growth of weeds by reducing the available space for weeds to grow. Generally, 3-4 seeds per hill is used for better performance (Indian council of agriculture research).

3.2.3 Seed rate

The number of seeds in each 24 cm x 24 cm square multiplied by the thousand seed weight equates to the estimated seed rate (kg per ha). Seed required for direct seeded rice cultivation is around 12-18 kg/ha with drum seeder, and it varies with number of seeds per hill and spacing of seed.

3.3 DEVELOPMENT OF PADDY SEEDER

The range of walking speed of the human operating a self-propelled machine in the clayey soil is in the range of 0.35-0.75 m/s. In order to select the engine, the average walking speed is selected as 0.5m/s. Assumed the diameter of the paddle wheel (D) as 500 mm and thickness of the annular ring of the paddle wheel as 10 mm. The calculated perimeter and speed of the paddle wheel are 1.6014 m and 20 rpm respectively. The calculation is given in the Appendix-I.

Seed metering roller was developed based on the physical and engineering property of paddy seed varieties. The paddy seeder essentially consists of engine, gear box, wheel, wheel shaft, chain and sprockets, seed metering roller and shaft. The selection and development details of different components of the machine are explained below in different sub headings.

3.3.1 Selection of engine

3.3.2 Selection of clutch

3.3.3 Selection of speed reduction gear box

3.3.4 Development of paddle wheel

3.3.5 Development of seed metering mechanism

3.3.6 Development of frame

3.3.7 Selection of float

3.3.1. Selection of Engine

The engine is the power source of the machine for the forward movement and the seed metering mechanism. Since the development is for a light weight machine, petrol engine with low torque, high speed was selected. The selection of engine was done based on the speed of the paddle wheel and the reduction gear box available to match the velocity ratio. The engine used for the development of the machine was the engine of 'MARUYAMA 420' brush cutter. The calculation of engine speed and torque at the paddle wheel is shown in the Appendix-II. The illustration and specification of the engine is given in the Plate 3.1 and Table 3.1 respectively.

Plate 3.1. Two stroke spark ignition engine

Table 3.1 Specification of the selected engine

Engine	AE420
Type	2-stroke
Fuel	petrol
Ignition	Spark ignition
Displacement	41.5cc
Maximum power (kW/rpm)	1.51 kW/7000rpm
Maximum torque (Nm/rpm)	2.30 Nm/5000rpm
Fuel tank capacity	2.3L

3.3.2 Selection of clutch

Clutch is a device which engage and disengage the drive from the engine to the rest of transmission system. The clutch used for the development of self-propelled paddy seeder is centrifugal clutch. The centrifugal clutch engages the drive after the drive reaching on a threshold rpm which uses centrifugal force to operate.

Plate 3.2: Centrifugal clutch

3.3.3 Selection of speed reduction gear box

A gear box having two pairs of spur gears and a set of worm gear is selected for the transmission of drive from the engine to paddle wheels.

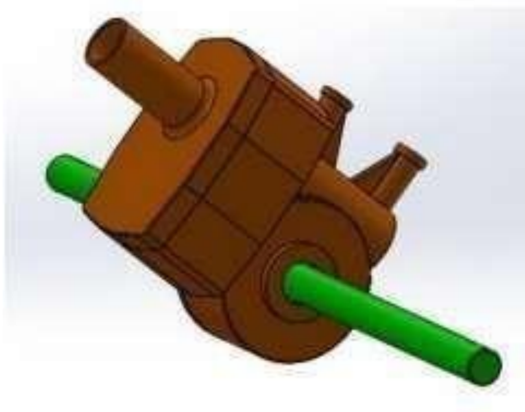


Fig 3.1 Speed reduction gear box

The velocity ratio of the first spur gear set and the second gear set is 2.5625 and that of the worm gear box is 36. So, the total speed reduction of the gear box is 236.4. The overall efficiency of the transmission gear box is assumed as 94%. The calculation is given in the Appendix – III.

3.3.4 Development of paddle wheel

The wheels are the part which enables the forward motion of the vehicle. The major problem of wheels while moving through the wetlands is slipping. In order to overcome this problem, the paddle wheels are used. It works with less slippage and requires high torque. The high torque is attained by speed reduction gear box. The developed wheel has a diameter of 510 mm and perimeter 1601mm.

The paddle wheel was developed by forming annular ring with diameter of 50mm and thickness 10mm in which four support rods are provided at an angle of 90°. Eight number of paddle plates are welded at the periphery of the annular ring at equidistance. The material for each component of the paddle wheel is selected a AISI 1020. The wheel hub provided at the centre has a hole diameter of Ø22 mm. Two paddle wheels are provided for the machine to propel.

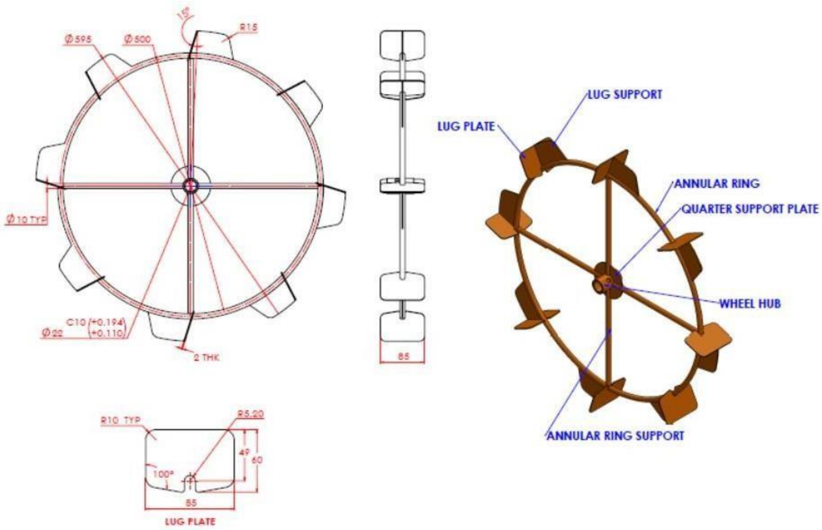


Fig. 3.2 Design of Paddle wheel

Plate 3.3 Developed Paddle Wheel

3.3.4 Development of seed metering mechanism

Seed metering mechanism plays a crucial role in the paddy seeder. It refers to the system or device used to control the flow of seeds from the seed hopper to the metering roller. It consists of four seed hoppers, seed metering shaft, seed metering rollers. The drive from the paddle wheel is transferred to the seed metering mechanism through chain and sprocket. The category of chain selected for the drive system as per DIN standard was 06B-1.

3.3.4.1. Seed hopper

Seed hopper is the part where the seeds are stored during operation. It should be capable of carrying enough number of seeds for continuous sowing. The commercially available light weight boxes of low cost and having sufficient capacity are selected.

The seed hopper is made of fiber with a thickness of 2 mm. The seed hopper consists of four seed boxes. The hopper has a trapezoidal shape with square bottom 130 mm × 130 mm having a height of 155 mm and square top 185 mm × 185 mm. The angle of repose of the selectedseed hopper is greater than that of the paddy seeds. Seeds used were of Sreyas variety having an angle of repose 40.3°. So, the seed hopper having an angle of repose 80° was selected.

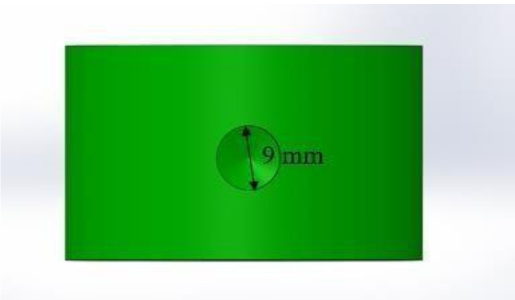
Plate 3.4 Seed hopper

3.3.4.2 Seed metering shaft & rollers.

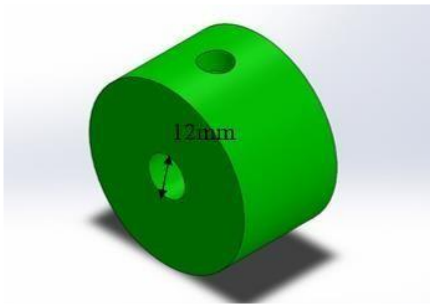
For hill dropping paddy seeds, a roller type cell mechanism was selected. The roller cell was designed based on the paddy dimensions. Three to four number of paddy seeds were to be picked up by cell type roller per dropping cycle. The groove size was determined as per the seed length 7.2 mm - 9.3 mm and thickness 2 mm - 2.3 mm. A vertical cell type metering roller was developed for paddy seeds. The seed metering roller was developed using 30 mm thickness and 50 mm diameter nylon rod. Two hemisphere shaped grooves were made on the roller. The hemisphere shaped cell has a diameter of 9 mm and depth of 6 mm.

The vertical cell metering roller was mounted on a shaft of diameter 12 mm and is supported by bearings of number SKF 6001. The bearings are placed inside the metallic flanges of 5 cm length, 3 cm width and 1 cm thickness. The four are interconnected using couplers. The seeds from the seed hopper flows into the metering mechanism. The metering roller shaft rotates by the power from engine through the shafts, chain drives and gear box device.

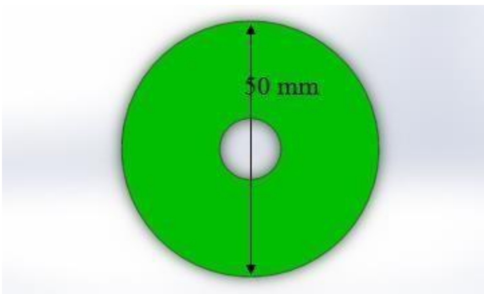
Plate 3.5 Bearing supported inside flanges



(a) Top view



(b) Isometric view



(C) Side view

Fig 3.3 Metering roller

3.3.4.3 Drive for seed metering mechanism

The drive transmission mechanism consists of paddle wheel, sprocket-chain assembly and a driven shaft that carry the seed picking cells. The paddle wheel rotates when the power from engine is transmitted to gear box through the shaft. A sprocket of 45 teeth is fixed on the paddle wheel shaft and it rotates along with paddle when throttled. This sprocket drives an intermediate shaft which has a sprocket of 18 teeth. Thus, there is a step up in the rpm of intermediate shaft. From the intermediate shaft drive is provided to the metering roller shaft through a pair of sprocketsof 18 teeth each. Calculation of step-up ratio is provided on appendix IV.

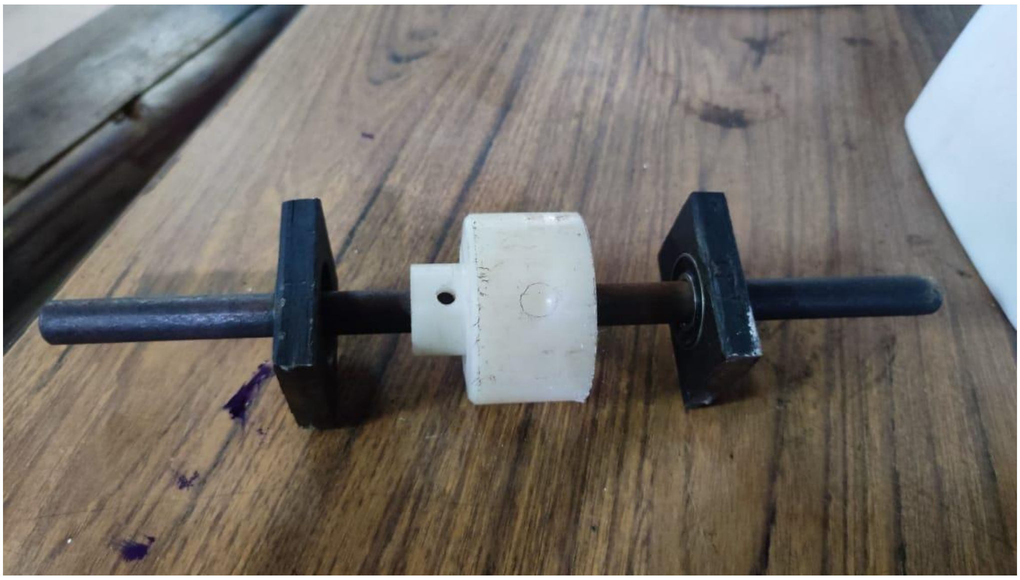


Plate 3.6 Drive transmission mechanism

3.3.5. Float

The floats are the main component of machine which slides over the puddled soil. The float gives support to the main frame of the unit and takes the partial weight of the machine. It serves as a base for the easy movement of the machine. The float controls the working depth of the machine and also prevents the machine from sinking in puddled soil. The machine consists of a pair of floats made of fiber material fixed on the bottom side of the machine. The float was 570 mm long, 140 mm wide. In front of the float a curved MS sheet is provided to enhance the motion of machine over the puddled field.

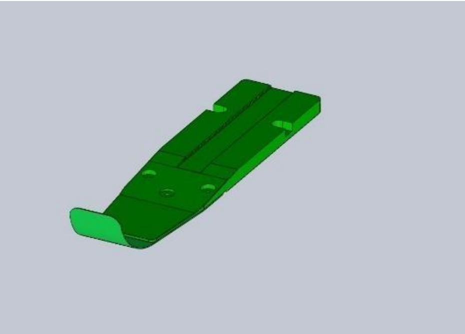


Fig 3.4 Float **Plate 3.7 Float**

3.3.6. Frame

It is the part of seeder where all the other components such as engine, reduction gear box, chain and sprockets, handle, and drive wheels are attached. The main frame was made of mild steel pipe of dimension of diameter Ø 28 mm and thickness of 2 mm. A pipe is bent in the form of a rectangular shape to work as a handle of the machine.

The supporting frame was made of GI Square pipe of size 19.05mm. The dimension of the supporting frame was 960 mm x 130 mm x 130 mm. A connection between the frame and other components of the seeder was made using appropriate sizes of flat clamps, bolts and nuts. The dimension of the frame was based on the design loads of components to be mounted on it.

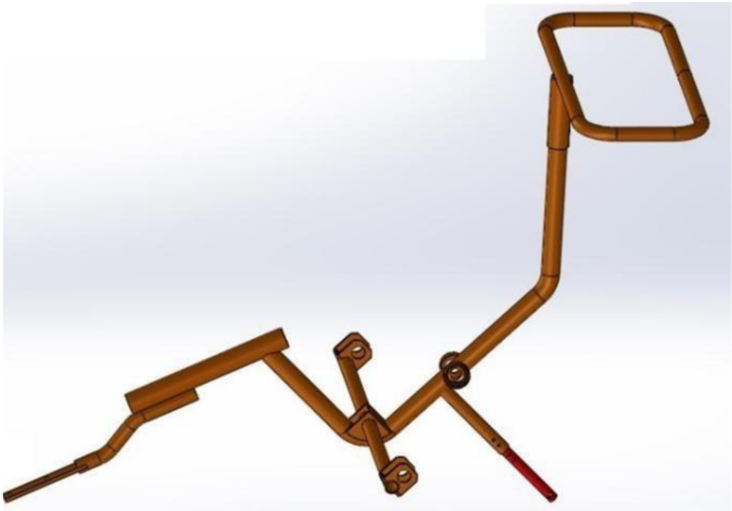


Fig 3.5 Frame

3.4. TESTING AND PERFORMANCE EVALUATION

The performance parameters such as mean spacing, multiple index , miss index, quality of feed index, number of seeds per hill and seed rate were recorded.

3.4.1 Calibration of unit

The developed self-propelled seeder was calibrated in the laboratory to observe the seed rate. The seeder was jacked up so that the paddle wheel of self-propelled unit turns freely. A mark was made on the paddle wheel and a corresponding mark at a convenient place on the body of the paddy seeder to help in counting the revolutions of the ground wheel. The hopper was filled to three fourth to half of its capacity. The paddle wheel rotated for 10 revolutionsand a seed dropped from the metering unit was collected in the tray. The quantity of seeds collectedwas weighed. Calibration was done for three replications.

3.4.2. Test parameter

3.4.2.1. Mean hill spacing

To calculate the mean hill spacing, need to measure the distance between individual hills or clusters of seeds that were collected from the outlets of paddy seeder. By calculating the average of these distances, mean hill spacing can be determined.

3.4.2.1 Miss Index

Miss index (I_{miss}) is an indicator of how often the paddy seed skips the desired spacing. It is the percentage of spacing greater than 1.5 times the theoretical spacing S in mm.

$$I_{miss} = \frac{n_1}{N}$$

Where,

n_1 = Number of spacing in the region > 1.5 S

N = Total number of observations

3.4.2.1. Multiple Index

The multiple indices (I_{mult}) are an indicator of seeds dropped more than once within desired spacing.It is the percentage of spacing that are less than or equal to half of the theoretical spacing S in mm.

$$I_{mult} = \frac{n_2}{N}$$

Where,

n_2 = Number of spacing in the region ≤ 0.5 S

N = Total number of observations

3.4.2.3 Quality of feed index

The quality of feed index (I_{fq}) is the measure of how often the spacing is close to the theoretical spacing. It is the percentage of spacing that are more than half but not more than 1.5 times the theoretical spacing S in mm. The quality of feed index is mathematically expressed as follows.

$$I_{fq} = 100 - (I_{miss} + I_{mult})$$

Where,

I_{miss} - Miss index

I_{mult} - Multiple index

3.4.2.5 Number of seeds per hill

Number of seeds dropped in each hill in the entire row. The values were recorded in the field at five different locations randomly to determine number of seeds per hill.

3.4.2.6 Row to row spacing

While conducting the field trials of the paddy seeder, the spacing between two adjacent rows (cm) was measured with the help of steel tape. The row to row spacing was measured in the field at five different random locations. Dependent parameters

3.4.3.1. Fuel Consumption

Fuel tank is filled to its full capacity before and after test. The quantity of fuel filled at the end of test divided by total hours of operation will give hourly fuel consumption(l/hr).

3.4.3.2 Theoretical Field Capacity(ha/hr)

It is the rate of field coverage that would be obtained if the machine were performing its function 100 per cent of the time at rated forward speed and always covered 100 per cent of its rated width.

$$\text{Theoretical field capacity, ha/hr} = \frac{ws}{10}$$

Where,

s = speed of machine, km/hr

w = rated width of the machine, m

3.4.3.3. Effective Field Capacity

It is defined as the ratio of area covered by the machine to the total working time. It indicates the actual rate of coverage of the field by the machine. It is expressed as:

$$\text{Effective field capacity, ha/hr} = \frac{A}{T_P + T_L}$$

Where,

A = area covered in ha

T_P = productive time, hr

T_L = Non-productive time, hr

3.4.3.4 Field efficiency (%)

This gives an indication of the time lost in the field and failure to utilize the full working width of the machine. It varies according to the shape and size of the field, the type and size of machine, the skill of the operator and other similar factors.

$$\text{Field efficiency, \%} = \frac{Actual\ field\ capacity\ \left(\frac{ha}{hr}\right)}{Theoretical\ field\ capacity\ \left(\frac{ha}{hr}\right)} \times 100$$

3.4.3.5 Forward speed (km/hr)

The speed of the machine is noted during the field operation. A particular distance say,16 m is noted in the field. The time required to cover the 16 m distance is also noted down. The speed of travel of the machine is calculated using the following formula,

$$\text{Forward speed (km/hr)} = \frac{Distance\ travelled(km)}{Time\ taken(hr)}$$

3.4.3.6 Wheel slip (%)

It is expressed as a percentage. Initially a point is marked on the wheel to find the number of revolutions of the wheel required to travel. The machine is allowed to move through a known distance (actual distance). Theoretical distance is found out by multiplying the number of revolutions of wheel and perimeter of wheel.

The slippage of driving wheels is calculated by following formula

$$\text{Slippage (\%)} = \frac{D1 - D2}{D_1}$$

Where ,

D_1 = Theoretical distance, m

D_2 = Actual distance, m

RESULT AND DISCUSSION

CHAPTER IV

RESULT AND DISCUSSION

Introduction

The physical and engineering properties of selected paddy varieties for determining design parameters of paddy seeder for direct paddy seeding were determined. Parameters such as hill spacing, row spacing, seed rate, miss index, multiple index, fuel consumption, field capacity, wheel slip were determined during performance evaluation.

4.1 PHYSICAL AND ENGINEERING PROPERTIES

The physical and engineering properties of paddy seeds evaluated for the development of paddy seeder were size, shape, angle of repose and bulk density and the observations related to paddy seed varieties are presented as following.

4.1.1 Physical properties

4.1.1.1 Shape and size

The size and shape of selected paddy varieties were determined. The major (length), intermediate(width), minor(thickness) of theses varieties were measured. The dimensions of dry paddy seeds are given in Table 4.1. The mean linear dimensions of Jyothi variety which has higher geometric mean have a major axis (length) 9.41mm; intermediate axis(width) 2.91mm; minor axis (thickness) 2.2mm and geometric mean diameter 3.91mm. The mean linear dimensions of Supriya variety which has the least geometric mean have a major axis (length) 7.9mm; intermediate axis(width) 2.8 mm; minor axis (thickness) 2.01 mm and geometric mean diameter 3.53 mm.Similarly, Ponmani also has least value of geometric mean diameter of 3.53mm and have a major axis (length) 6.97mm; intermediate axis(width) 3.47mm; minor axis (thickness) 2.16mm.

Table 4.1 Physical dimensions of dry paddy seeds

Varieties	Length (mm)		Breadth (mm)		Thickness (mm)		Geometric mean(mm)
	Range	Mean	Range	Mean	Range	Mean	
Neeraja	9.04-9.34	9.244	2.41-2.7	2.552	1.8-1.98	1.89	3.540
Jaya	8.32-8.75	8.48	2.74-2.98	2.84	2.15-2.35	2.24	3.773
Ponmani	6.64-7.23	6.97	3.30-3.59	3.47	2.0-2.3	2.16	3.53
Athira	6.88-7.79	7.29	3-3.39	3.19	1.75-2.09	1.95	3.76
Mattatriveni	7.80-8.29	8.06	3.20-3.39	3.3	1.94-2	1.98	3.74
Makaram	8.15-8.34	8.24	3.1-3.52	3.3	2.2-2.65	1.68	3.56
Kanchana	7.52-9.20	8.51	2.15-2.79	2.51	2.12-2.42	2.27	3.57
Supriya	7.87-8.15	7.9	2.63-3.0	2.8	1.85-2.07	2.01	3.53
Swetha	7.8-8.2	7.96	2.87-3.2	2.99	1.8-2.1	1.94	3.58

Uma	7.2-8.1	7.58	3-3.4	3.1	1.9-2.15	2.03	3.62
Jyothi	9-9.9	9.41	2.6-3.2	2.91	2-2.4	2.2	3.91
Sreyas	7.7-8.1	7.94	2.7-3.2	2.96	2.1-2.35	2.22	3.73

Sphericity(φ) affects the uniform free flow of paddy seeds from the metering roller groove surface. The sphericity of selected predominant paddy variety was determined and presented in Table 4.2. Sphericity is highest for Ponmani variety which is about 0.536 and it is lowest for Neeraja variety which is about 0.383.

Table 4.2 Sphericity of paddy seeds

	Varieties	Sphericity
1.	Neeraja	0.383
2.	Jaya	0.445
3.	Ponmani	0.536
4.	Athira	0.489
5.	Mattatriveni	0.465
6.	Makaram	0.433
7.	Kanchana	0.428

8.	Supriya	0.448
9.	Swetha	0.450
10.	Uma	0.478
11.	Jyoti	0.416
12.	Sreyas	0.470

4.1.1.2 Thousand seed weight

The weight of 1000 paddy sample seeds were determined by using an electronic balance having an accuracy of 1 mg. Thousand seed weight of 12 samples were taken in grams and presented in thetable 4.3. Thousand seed weight is more for Jyoti which is about 27.8g and least for Athira variety which is about 21.6 g.

Table 4.3 Thousand seed weight of paddy seeds

	Varieties	Thousand seed weight (grams)
1.	Neeraja	23.3
2.	Jaya	25.8
3.	Ponmani	23.4
4.	Athira	21.6
5.	Mattatriveni	23.8

6.	Makaram	26.8
7.	Kanchana	27.4
8.	Supriya	25.2
9.	Swetha	20.8
10.	Uma	23.1
11.	Jyoti	27.8
12.	Sreyas	25.4

4.1.1.3 Bulk density

The bulk densitywas determined as the ratio of weight of the seeds and volume of beaker. The bulk density of 12 varieties of paddy seeds are presented in the table 4.4. The bulk density of Sreyas variety has the highest value of 0.578g/cm^3 and Neeraja variety has the lowest bulk density of value 0.512 g/cm^3.

Table 4.4 Bulk density of paddy seeds

	Varieties	Bulk density (g/cm^3)
1.	Neeraja	0.512
2.	Makaram	0.533

3.	Supriya	0.541
4.	Jaya	0.522
5.	Matathriveni	0.575
6.	Ponmani	0.576
7.	Swetha	0.542
8.	Athira	0.577
9.	Kanchana	0.575
10.	Sreyas	0.578
11.	Uma	0.571
12.	Jyothi	0.574

4.1.1.5. Moisture content

The moisture content of Mattatriveni and Neeraja varieties were found to be highest and lowest having value of 7.6% and 6.2% respectively.

Table 4.5 Moisture content of paddy seeds

	Varieties	Moisture content (%)
1.	Neeraja	6.28
2.	Makaram	6.8
3.	Supriya	7.23
4.	Jaya	7.10
5.	Matathriveni	7.6
6.	Ponmani	6.29
7.	Swetha	6.6
8.	Athira	7.14
9.	Kanchana	7.38
10.	Sreyas	7.00
11.	Uma	6.98
12.	Jyothi	7.52

4.1.2 Engineering properties

4.1.2.1 Angle of repose

From the available 12 predominant paddy varieties Sreyas was selected for the performance evaluation of the seeder. The angle of repose of Sreyas variety was found to be 40.3°.

Table 4.6 Angle of repose of Uma, Jyothi and Sreyas

	Varieties	**Angle of repose**
1	Uma	35.94°
2	Jyothi	35.2°
3	Sreyas	40.3°

4.2 **Developed model and its working**

The development and selection of the different components of the self-propelled paddy seeder were discussed above. The major components of the paddy seeder are illustrated in the Fig 4.1 and Fig 4.2. The prime mover of the machine gives drive to the paddle wheels through centrifugal clutch and reduction gear box. The two paddle wheels pull the machine and the two floats slides over the mud during operation. The speed of the machine is controlled by the throttle of the engine. The soaked seed are filled in the seed box before operation.

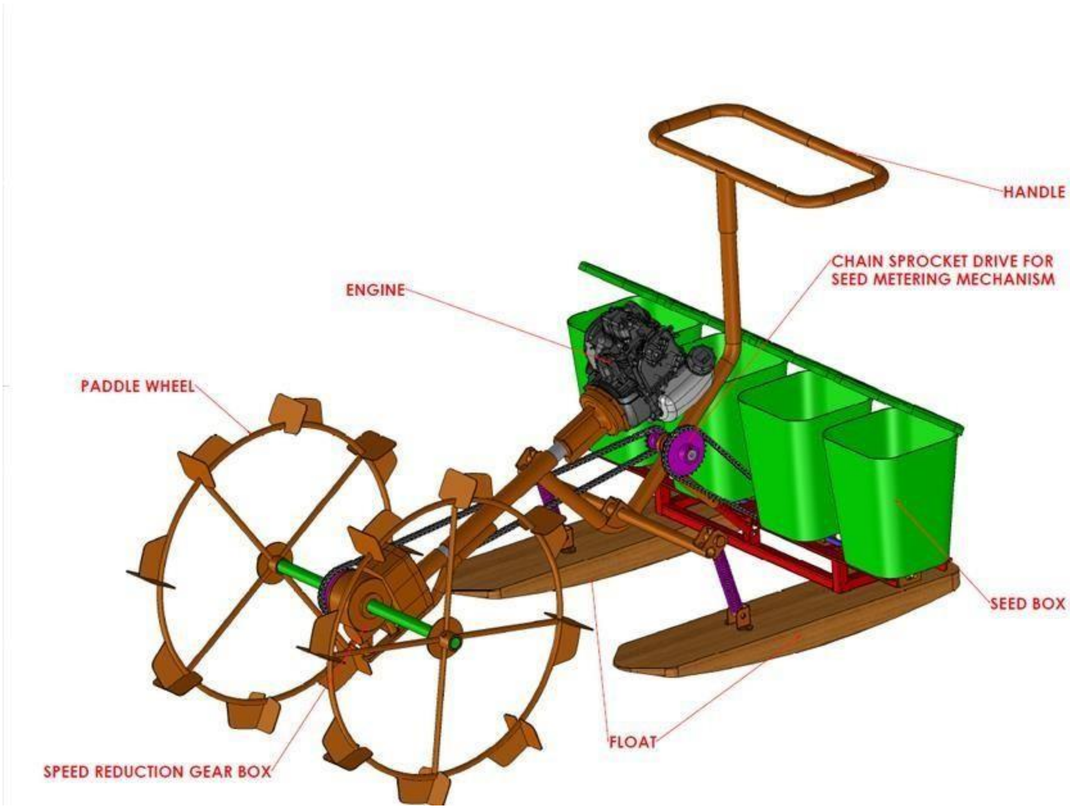


Fig 4.1 Self-propelled paddy seeder

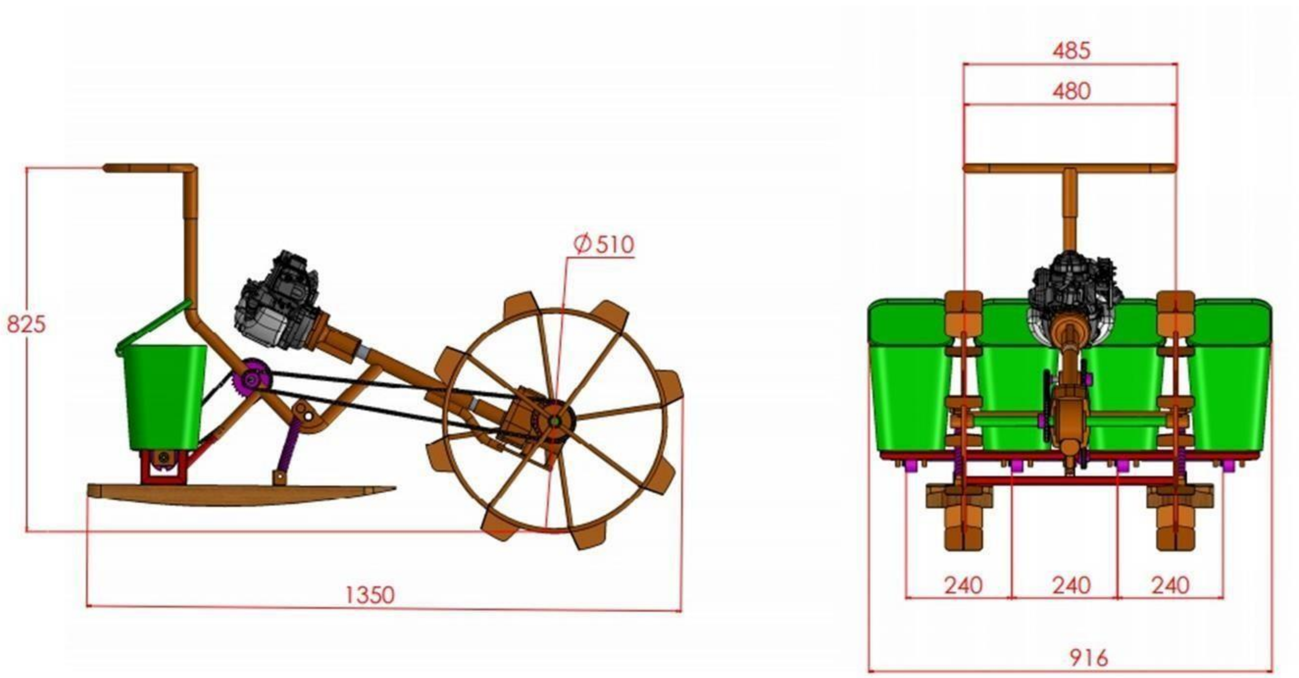


Fig 4.2-Dimensional drawing of self-propelled paddy seeder (all measurements are in mm)

Plate 4.1 Developed self-propelled paddy seeder

The paddle wheel drives the machine and the floats support the machine from the rear. The seeding cell unit delivers the pre-germinated paddy seeds precisely. The seed hopper is filled up to ½ to ¾ of its capacity. The gear box reduces the high speed to a minimum speed and transfer to the wheels. It results in the forward motion of seeder. Chain & sprocket takes the drive from wheel shaft to intermediate shaft and then to seed metering shaft. Nylon roller with grooves was mounted on the metering shaft and turns along with it . Seeds trapped in grooves falls by gravity.

4.3 TESTING AND PERFORMANCE EVALUATION

4.3.1 Result of calibration

The seed requirement per unit area was determined by calibrating the paddy seeder in the laboratory. Metering shaft was rotated for 10 revolutions and metered paddy seeds were collected from all the outlets and seed rate was calculated. Weight of seeds collected after 10 revolution is about 9.8g. The seed rate is obtained as 6.37kg/ha. The calculation is provided in the appendix V.

4.3.2 TEST PARAMETERS

4.3.2.1 Mean hill spacing

The hill to hill spacing of 10 observations are taken randomly and the mean hill spacing is obtained as 22 cm.

4.3.2.2 Missing index

The missing index was determined as 6.67%. Calculation of missing index is given in appendix VI.

4.3.2.3 Multiple index

The multiple indices were calculated as 4.44%. Calculation of multiple index is shown in the appendix VI

4.3.2.4 Quality of feed index

The quality of feed index was obtained as 88.89%. Calculations are provided in the appendix VI.

4.3.2.5 Number of seeds per hill

The number of seeds on each hill is observed as 3- 4.

4.3.2.6 Row to row spacing

The row to row spacing of 10 observations were taken randomly and mean row spacing is obtained as 23 cm.

Table 4.7 Row spacing, hill to hill spacing and seeds per hill

Sl. No.	Row Spacing (cm)	Hill to Hill spacing(cm)	Seeds per hill
1	23	25	2
2	25	24	2
3	25	22	3

4	24	26	4
5	22	20	3
6	23	19	2
7	25	23	3
8	23	21	3
9	24	22	2
10	25	20	4
Standard Deviation of hill to hill spacing = 2.29			
Coefficient Variation of hill to hill spacing = 10.35%			

4.3.2.7 Fuel consumption

The fuel consumption is obtained as 1.12 l/hr. Calculations are provided on appendix VII.

4.3.2.8 Theoretical field capacity

The estimated theoretical field capacity is 0.156 ha/hr. Calculations are provided in appendix VIII.

4.3.2.9 Effective field capacity

The effective field capacity is determined as 0.13 ha/hr. Calculations are provided in appendix VIII.

4.3.2.10 Field efficiency

Based on the calculations provided in appendix VIII, field efficiency is obtained as 81.25%.

4.3.2.11 Forward speed

The forward speed is obtained from the distance travelled and time taken to cover the distanceand the value is obtained as 1.69 km/hr.

4.3.2.12 Wheel slip

The wheel slip of 10.84 % is obtained during testing. Calculations are provided in appendix IX.

4.4 COST OF DEVELOPMENT

The cost for the development of self propelled paddy seeder is given in the table 4.8. The cost of the machine developed is about Rs 17980.

Table 4.8 Cost of development

1	Engine	5000
2	Gear box	3000
3	Frame and paddle wheel	2200
4	Seed boxes	380
5	Float	600
6	Fabrication cost	6000
7	Bearing	800
	Total	17980

APPENDICES

APPENDIX

Appendix-I- Calculation of perimeter and speed of the paddle wheel

Perimeter of the paddle wheel = $\pi \times D$

$= 3.14 \times 510$

$= 1601.4mm = 1.6014\ m$

Speed of paddle wheel, rpm $= \frac{\text{speed(km/hr)} \times 1000}{perimeter \times 60}$

$= \frac{(1.72(\frac{km}{h}) \times 1000)}{1.6014(m) \times 60}$

= 20rpm

Appendix-II Calculation of engine speed and torque at the paddle wheel

Speed of paddle wheel,rpm = 20

Speed of reduction = 236.4

Efficiency of clutch = 90%

Efficiency of transmission gear box = 94%

The required speed of engine , rpm = 20 x 236.4 x $\frac{100}{94} \times \frac{100}{90}$

= 5588

The maximum torque of the selected engine, Nm = 2.3

The maximum torque available at the paddle wheel , Nm = 236.4 x 2.3 = 543.7

Appendix-III Calculation of velocity ratio of speed reduction gear box

Velocity ratio of spur gear set $= \frac{Number\ of\ teeth\ on\ drive\ spur\ gear}{Number\ of\ teeth\ on\ driven\ spur\ gear} = \frac{41}{16} = 2.56$

Total speed reduction= velocity ratio of spur gear set× velocity ratio of spur gear set ×worm gear reduction

= 2.56×2.56×36 =236.4

Appendix-IV Drive for seed metering mechanism

Speed of paddle wheel, rpm = 20rpm

Number of teeth on driving sprocket on paddle wheel = 45

Number of teeth on driven sprocket on intermediate shaft =18

Number of teeth on driving sprocket on intermediate shaft=18

Number of teeth on driven sprocket on seed metering shaft=18

Step up Ratio = $\frac{45}{18} \times \frac{18}{18}$ = 2.5

Rpm of seed metering roller= 2.5×20 = 50 rpm

Appendix-V Calibration

Seeds collected after 10 revolution = 9.8g

Width of seed drill = 960mm = 96cm

Perimeter of wheel = 1601mm = 160.1cm

Distance travelled in 10 revolution =10 × 160.1 = 1601cm

Area covered for 10 revolution = 1601 × 96 = 15.37m^2

15.37 m^2 area needs 9.8g of seeds

Therefore, for 10000 m^2 = $\frac{9.8}{15.37}$ x $10000 = 6376g = 6.376kg/ha$

Appendix-VI Calculation of missing index, multiple index and quality of feed index

a) Calculation of missing index (%)

- No. of spaces taken(N) =45
- No. of missed hills(n_1) = 3
- Missing index $= \frac{n_1}{N} \times 100 = \frac{3}{45} \times 100 = 6.67$

b) Calculation of multiple index (%)

- No. of spaces taken (N) = 45
- No. multiple hills(n_2) = 2
- Multiple index $= \frac{n_2}{N} \times 100 = \frac{2}{45} \times 100 = 4.44$

c) Quality of feed index (%)

- Quality of feed index = 100− (miss index + multiple index)

  = 100−(6.67+4.44) = 88.89%

Appendix-VII Calculation of fuel consumption

Fuel consumption for test field, ml = 140 ml

Time taken to cover up the area, s = 448 s

Fuel consumption $= \frac{fuel\ consumed\ in\ litre}{hours\ of\ operation} = \frac{140}{1000} \times \frac{3600}{448}$

= 1.12 l/h

Appendix- VIII Calculation of forward speed, theoretical field capacity, effective field capacity and field efficiency

a) Forward speed, kmph

Avg. Distance travelled, m = 16

Time taken, s = 34

Forward speed, kmph$= \frac{Avg\ distance\ travelled}{time\ taken}$=1.69

b) Theoretical Field Capacity, ha/h

Theoretical width (W)= 0.96 m

Theoretical Field Capacity, ha/h= $\frac{WS}{10}$ = 0.156

c) Effective field capacity

Tested plot area =160m^2

Time taken to cover the above area=448s

Effective field capacity = $\frac{160\times3600}{10000\times448}$ = 0.13

d) Field efficiency

Field efficiency= $\frac{effective\ field\ capacity}{theoretical\ field\ capacity} \times 100 = 81.25\%$

Appendix- IX Calculation of wheel slip

Wheel revolutions, rev = 11

Eff. wheel diameter, m = 0.5m

Perimeter, m = 1.51m

Theoretical distance covered = $No.\ of\ revolution\ covered \times perimeter\ of\ wheel$

$= 11\times 1.51$ = 17.27m

Actual distance covered = 15.40m

Wheel slip = $\frac{\textbf{theoretical distance covered} - \textbf{actual distance covered}}{\textbf{theoretical distance covered}}$x100

= $\frac{17.27-15.40}{17.27}\times 100$ = 10.4%

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

Agriculture plays a vital role in sustaining human life by providing food, raw materials, and livelihoods for a significant portion of the global population. It has a prominent role in the Indian economy. Rice, one of the most important crops of India, occupies 24 per cent of gross cropped area of the country, i.e., 45 million ha under rice, in the world. Manual transplanting, broadcasting, mechanical transplanting and drum seeders are the various methods adopted in seeding of paddy. These methods pose various disadvantages like labour intensive, wastage of seed, high seed rate, competition among seedlings, low yield, difficulty in intercultural operations and high cost Thus, direct seeding offers great advantage in the management of seed material, labour, cost and inputs management on the way to establish the rice crop without much differential difference in yield reduction compared to other rice establishing methods. The direct seeding of rice technique offers viable option to reduce the limitations of transplanted paddy.

The development of the self-propelled paddy seeder has proved to be a significant advancement in the field of agricultural technology. This project aimed to address the challenges faced by farmers during the paddy seeding process and provide them with an efficient and effective solution. Through research, and development, we have successfully created a self-propelled paddy seeder that offers numerous benefits to farmers. The key features of this innovative machine include its autonomous operation, precision seed placement, and compatibility with various paddy field conditions.

The main frame was developed as per the requirement. Two paddle wheels of diameter 510 mm and perimeter 1601mm is provided for the forward motion of the seeder. The power to the paddle wheel is transmitted from the engine through centrifugal clutch and gear box. A two – stroke petrol engine of 'MARUYAMA 420' brush cutter which has a power of 1.51KW/7000rpm is used. The machine consists of four seed hoppers mounted on a supporting frame which is attached to the main frame. The seeds from the hoppers are delivered by cell feed seed metering mechanism. The drive to the seed metering mechanism is transmitted from the wheel by chain and sprocket mechanism which consists of two pairs of sprockets having teeth of 45,18,18 and 18. Two floats are provided for easy sliding of the machine in the puddled field.

The calibration tests were conducted under the laboratory conditions. For 10 revolutions of the paddle wheel 9.8g of seeds were obtained, from which the seed rate was determined as 6.37kg/ha. The field test was successfully conducted in a plot of 16 m x 10m. The paddy variety used was Sreyas. The number seeds per hill was found to be 2-3. The theoretical field capacity, actual field capacity and field efficiency of the machine was 0.156ha/hr , 0.13ha/hr and 81.25% respectively. The wheel slip obtained was 10.4%. The machine has a row and hill spacing of 24 cm. The seeding cell unit delivers the pre-germinated paddy seeds precisely. So, it is concluded that the paddy seeder unit could be useful in eliminating drudgery in transplanting and possibly reducethe seeding rate variation by maintaining a desirable drum fill condition.

By automating the seeding process, our self-propelled paddy seeder eliminates the need for manual labour, reducing the physical strain on farmers and improving overall efficiency. The precision seed placement ensures optimal seed spacing, leading to better crop yield and uniform growth. During field trials, our self-propelled paddy seeder demonstrated excellent performance and reliability. Furthermore, this technology contributes to sustainable agriculture practices by reducing seed wastage, optimizing resource utilization, and minimizing environmental impact.

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DEVELOPMENT AND PERFORMANCE EVALUATION OF SELF-PROPELLED PADDY SEEDER

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ABSTRACT

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ABSTRACT

A self-propelled paddy seeder with cell feed seed metering system is developed. The machine is equipped with prime mover of 1.51 kW two stroke petrol engine to drive two paddle wheels and the seed metering mechanism. In the working process the drive from the engine is transferred to the gear box through centrifugal clutch. The gear box with a reduction ratio 236:1 reduces the speed to desirable level where the human can walk in clayey soil. The drive for the seed metering mechanism is derived from the paddle wheel shaft and the speed is stepped up to rotate the seeding cell unit. The row spacing and hill spacing of the machine is 24 cm respectively. The two floats provided at the rear to slide the machine over the mud in the paddy fields while in seeding operation. The machine can reduce the labour and cost of operation by precisely placing he optimum no. of seeds. The seed placement in rows enable the inter row weeding in such seeding system.

Testing and performance evaluation was done in a field of 16 m×10 m by using Sreyas seeds. Various test parameters such as miss index, multiple index, row spacing, hill spacing, field efficiency, fuel consumption and wheel slip were determined as 6.67%, 4.44%, 23cm, 22cm, 81.25%, 1.12l/h and 10.4% respectively.

The developed self-propelled paddy seeder eliminates the need for manual labor, reducing the physical strain on farmers and improving overall efficiency while ensuring precise seed placement, optimal seed spacing, and better crop yield with uniform growth. This technology contributes to sustainable agriculture practices by minimizing seed wastage, optimizing resource utilization, and reducing environmental impact, thereby promoting more efficient and environmentally friendly farming methods.