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INARI-Automated Rice Plantation Machine

Rahil Pednekar[1], Gulvir Parihar[2], Prof. Rupesh Deshbhratar[3]
[1, 2]Student, [3]Assistant Professor (Guide), Mechanical Engineering Department, Thakur College of Engineering and Technology, Mumbai

Abstract: ***The most important sector for Indian Economy is agriculture sector. Majority of the employment in India is in the agriculture sector.***
Labour intensive and drudgery are the orthodox way of rice plantation. Mechanized rice plantation machine is cost-effective & operation friendly. In spite of having an edge over the orthodox machine, adoption rate of mechanized plantation machines are quite low because of high investment at early stage & also due lack of knowledge to the farmers. For mechanical machine, well puddled and levelled field is required with no standing water on the surface because it creates more floating hills. Fields should be accessible for a smooth entry, exit, and tour of machines. Plantation machines and its maintenance are expensive, so poor farmers cannot afford them. Need of training on machine operations makes it time consuming and expensive.
Considering the growing population, it is a huge challenge to suffice the entire population. Mechanization in paddy sector will have higher yield and it will release most of the work force to other sectors. The aim of this project is to design a mechanized rice plantation machine to plant rice saplings by farmers in the country. The basic requirements for small scale cropping machines are, they should be suitable for small farms, simple in design and technology and versatile for use in different farm operations.
In this system there is no need to drop rice plant not more than once. Use of high intensive cropping, proper time of operations is one of the major parameters to achieve using this machine. Using two row paddy plantation machine yield of crops can be increased considerably. The farmers can produce much more quantity and better quality.
The two row paddy rice plantation machine is quick way of sowing the sapling, proper spacing between successive saplings. Labour required for operating machine is reduced, due to which labour cost is reduced. This project helps the farmers in lots of department of rice plantation.

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I. INTRODUCTION

Considering the world population, almost 50-60% have rice in their everyday meal. Rice is mainly produced and consumed in the Asian region. India has the largest area under paddy in the world and ranks first in the production of rice. Average rice production per hectare in India is 2.2 tonnes. Climatic condition such as temperature and humidity plays a vital role in rice production.
(i) Pre-Planting (ii) Post-production (iii) Growth these are the steps used in the production of rice.
North Eastern part of India is considered to be the prime region for rice production. The seven sister region of India covers 7-8% of the total region of rice cultured in India and in terms of rice produced, accounts to only 5-6% of the total national rice production. However, this region is delayed in terms of rice produced cause of lack of work force. (i) age of the variety (ii) availability of moisture (iii) climatic conditions (iv) Availability of inputs and labour are the factors responsible for cultivation. Considering from the above, availability of inputs and labour is an important criteria. Several attempts has been made to mechanize transplanting operation by bringing in various machines and research is under progress to reduce the production cost with less working load there by reducing stress. Transplanting needs chronic bending down and straighten up for transplanting process on the other hand mechanical machine requires energy to tug the machine in field. Because of costlier automated machine, it is unfeasible for a farmer to buy a non-subsidized automated paddy plantation machine. Venture has been made to engineer a manual operated paddy plantation machine.

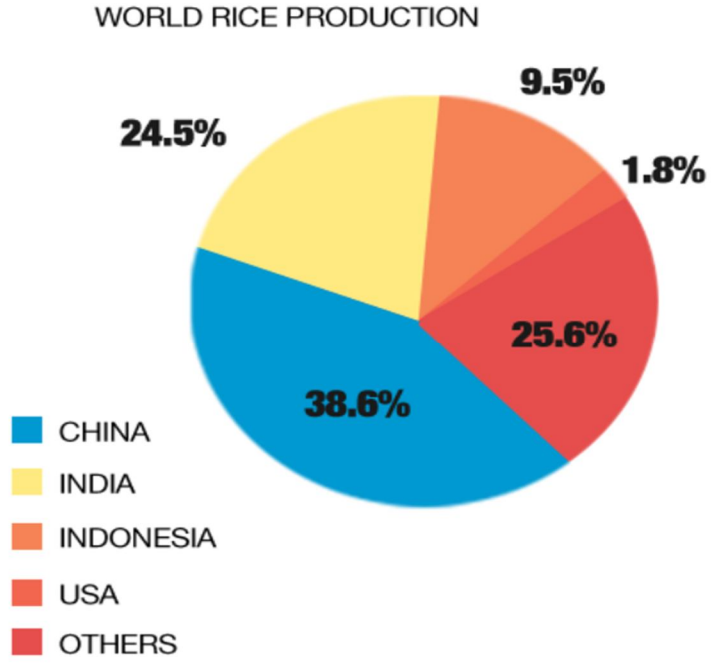

Fig 1.1.1 World rice production.

A. Background

Based on archeological survey, rice was first domesticated in the part of the Yangtze River valley. Archaeological site clearly shows the transformation from the cultivation of wild rice to domesticated rice. There was a speedy evolution of rice cultivation into mainland of Southeast Asia.
At present, the larger part of all rice produced comes from China, India, Indonesia and other Asian countries.

B. Importance of the Project

Use of rice plantation machines is the new trend but current machines having high cost of purchase. So the main focus of this project is to minimize the cost of that machine.

C. Perspective of Customers

The customers, looking at the benefits that would be offered by this automated rice plantation machine, would be surely willing to get this machine for enabling better yield, high productivity and less labour cost.

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D. Objectives

1) Perfect vertical positioning of saplings when placed inside the soil.
2) As it is manually operated machine, experienced workers are not required.
3) Planting saplings evenly without damaging them.
4) Easily transportable and cost effective.
5) Reduce labour charges and the man power requirement.
6) Prevents backache problem of farmers.
7) Satisfactory working of machine on different soil conditions.

E. Summary

In India, paddy cultivation is mostly done by transplanting method. It has been observed that transplanting is labour consuming operation, puddling and transplanting shares 50 percent of total production cost. Manual plantation machine is very common used in most of the rice growing countries. Transplanting of rice seedlings manually in puddled soil is a very tedious and labour intensive activity in Indian agriculture. Mechanization in agriculture has released lots of agricultural workers in the industrial sectors, which reduces level of manpower and increase the burdens on the worker. All current methods of producing rice depend largely on availability of manual labour. In traditional methods 250-300 man hours are required per hectare for rice production. Many operations in agriculture need to be performed by machines. This will reduce the labour requirement which is the principal motivating force in mechanization.

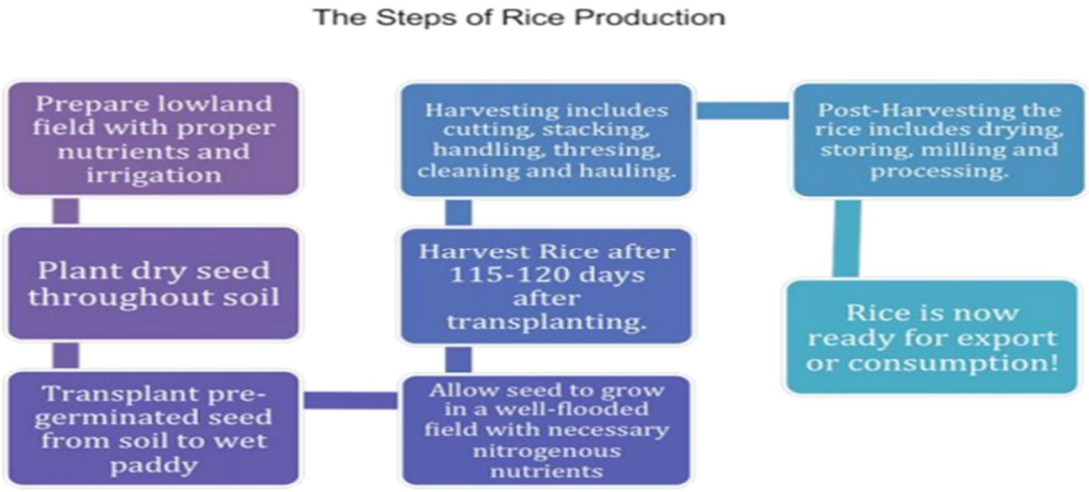

Fig. 1.6.1 Steps of rice production.

II. LITERATURE SURVEY & PROPOSED WORK

A. Literature Review

Murumkar R.P, Muthamilselvan M,Rajib Bhowmik[1], in their paper stated that Rice being the important crop cover about one fourth of the total cropped area and cater food to half of the Indian population. In this paper they carried an experiment on performance testing of four row self-propelled paddy tansplanter and it was seen that the machine per hectare saved 30 days of labor. They also tried to develop 6-row and 8-row paddy transplanter machine with 25 Hp tractor and observed that transplanting quality is not up to the mark due to depression caused by wheels. Hence they decided to develop two row machine for small farmers and found that time saved was 91% compared to hand transplanting.

Aswinietal Garget[2], studied that what is the age of seedlings and its effect planted by the rice planter. Observations on speed of operation, depth of placement of seedlings, number of seedlings per hill, time taken for turning ,total area covered and many other factors were recorded. This paper also discussed about study conducted for six-row transplanter and its disadvantages. This paper also stated the influence of selected seedling its parameters and checking the performance of the speed of planting by rice transplanter. Lastly they have given number of results in form of graphs between various parameters like cost, production ,problems, solutions etc .

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Dixit, R Khurana, JaskarnSingh[3], this paper discussed about characteristics of mat type methods of raising paddy seedlings, Economics of raising mat type seedlings by different methods with the help of table as well as methods of preparation of seedling mats. They also stated advantages and disadvantages of Manual Transplanting of Paddy followed by the discussion of development of paddy trans-planter. Moving further they gave the classification of paddy transplanter based on power source based on the development i.e. Manually operated ,Self-propelled walk behind type ,Self-propelled riding type, Tractor operated Manually operated, Self-propelled walk behind type, Self-propelled riding type, Tractor operated. They discussed about parameter affecting the performance of paddy trans-planter as well as machine parameters. Lastly they gave list of results in table form followed by conclusions.

Mahesh Kumar [4], had done total CAD design with overall dimensions. A rice transplanter is a specialized machine used to transplant rice seedlings in the field. Machine transplanting using rice transplanters requires considerably less time and labor than manual transplanting. It increases the approximate area that a person can plant from 700 to 10,000 m 2 /day. Transplanting of paddy seedlings can be categorized into threegroups as follows: By band manual, manually operated machines i.e. work by man power and third is mechanically operated machines work by engine power.

Robert fisher [5], in his paper gave basic types of rice planter machine and history of origin.A rice transplanter is a specialized transplanter fitted to transplant rice seedlings onto paddy field. Mainly two types of rice transplanter i.e., riding type and walking type. Riding type is power driven and can usually transplant six lines in one pass. On the other hand, walking type is manually driven and can usually transplant four lines in one pass.

Rajvir Yadav [6], (2007) carried an experiment using six row manual transplanter. Under their study the field capacity of traditional method was less compared to that of this transplanter and average force male used to push the transplanter was 139.32 N and female used nearly 145.12 N to pull the transplanter

S.K. Mohanty [7], (2014) performed an experiment using female workers on 3-row 4-row and 5-row transplanter for a particular area of land calculating its performance. He came to a conclusion that the 3-row transplanter was best among other transplanters used in the experiment

B. Terminologies Used

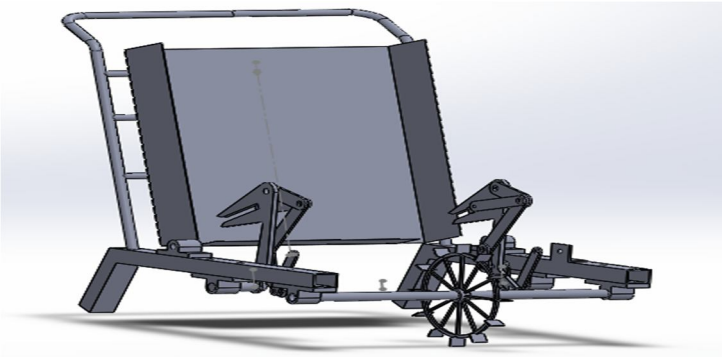

Fig. 2.2.1 CAD Model of two row rice plantation machine.

1) *Chain-Sprocket:* chain is used for emanation of mechanical power from driving to driven components. chain is driven by sprocket, which is also called toothed wheel. In this machine we will use chain to transmit power from one shaft to another and to transmit power to picker arm shaft, gear mechanism is used to maintain the 1:6 reduction ratio.

Fig.2.2.2 Chain-sprocket.

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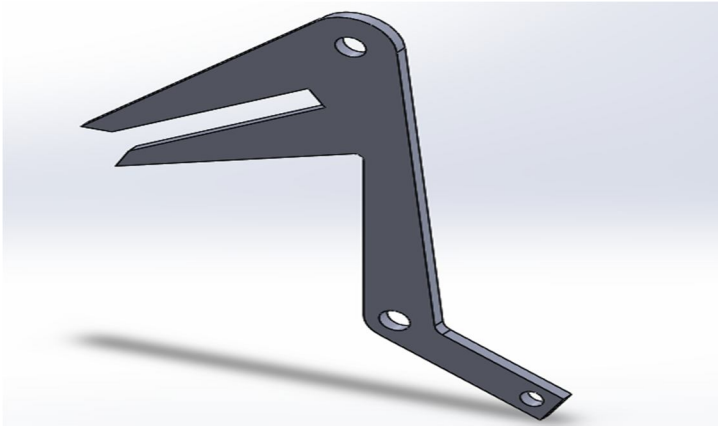
2) *Picker-arm Mechanism:* Picker arm assembly (8 links) is fixed on the shaft with gears. The saplings are arranged on supporting plate and the picker arm picks up the sapling one by one and once the sapling is taken, the sapling above the lower sapling takes place of previous one. And the process continues until the shaft rotates.



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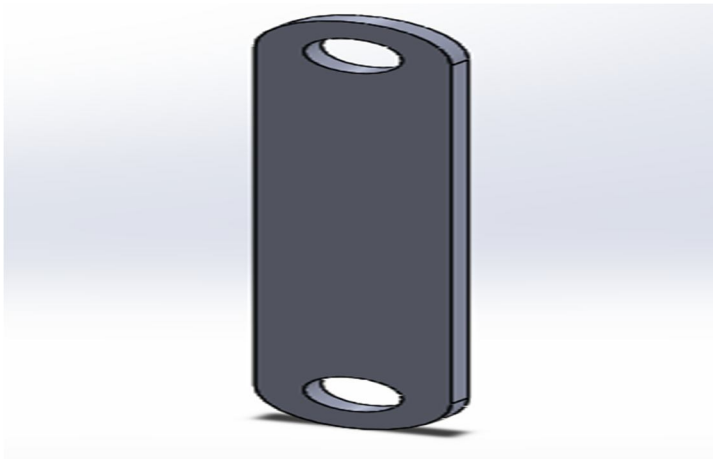
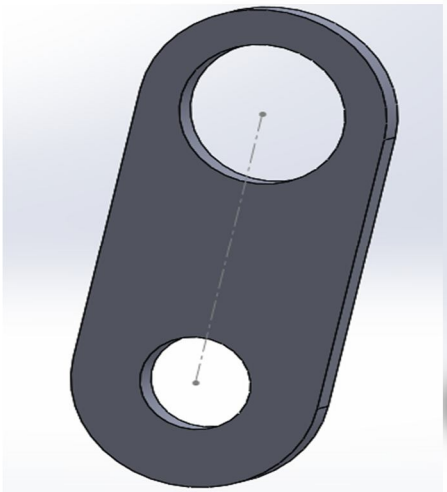


Fig.2.2.4 link 2.



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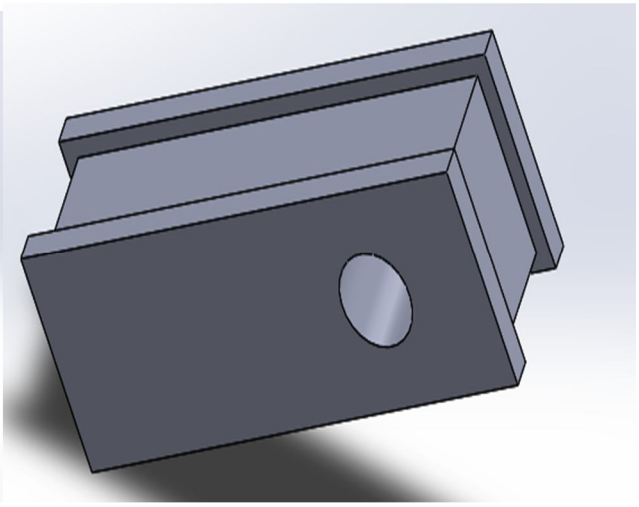

Fig.2.2.6 Link 4.

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Fig.2.2.7 Link 5.

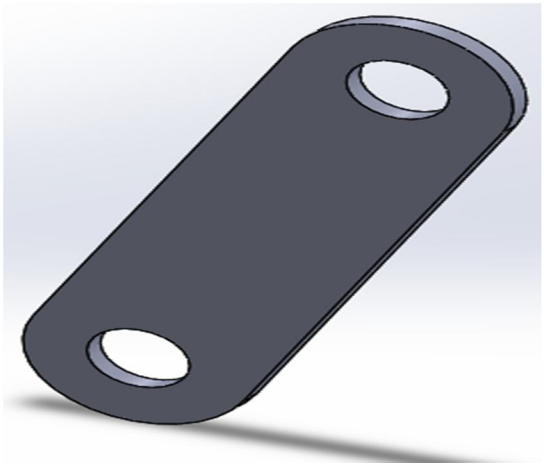

Fig.2.2.8 Link 6.

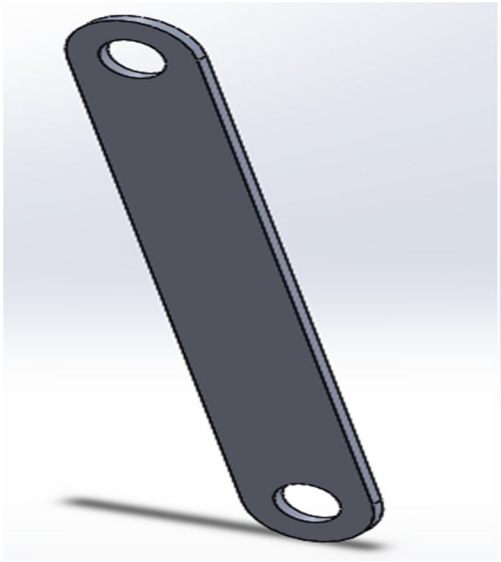

Fig.2.2.9 Link 7.

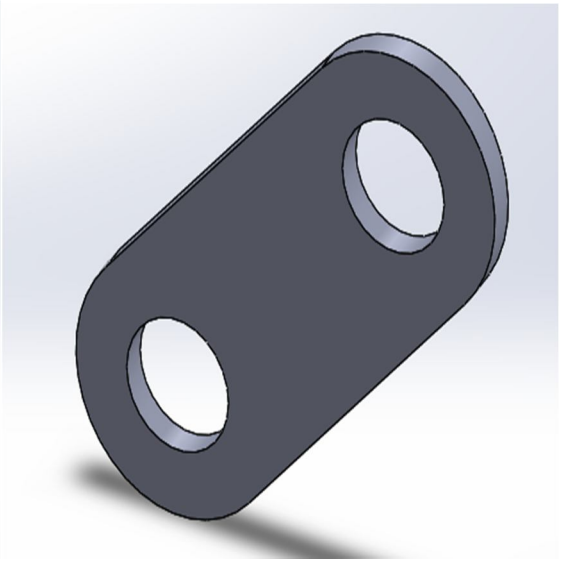

Fig.2.2.10 Link 8.

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3) *Bearing:* A bearing is used to reduce friction between moving parts. A bearing is used to constrain relative motion to desired motion only. It provides free rotation movement around fixed axis. Mainly bearings are used to reduce the friction. Bearings transfer axial and radial loads from source to structure supporting it.

Fig.2.2.11 Pillow Block Bearing.

Fig.2.2.12 Ball Bearing.

4) *Seedling Supporting Plate:* A thin plate is used to keep the saplings in proper manner. This plate is mounted with the support on horizontal rectangular bar in inclined position.

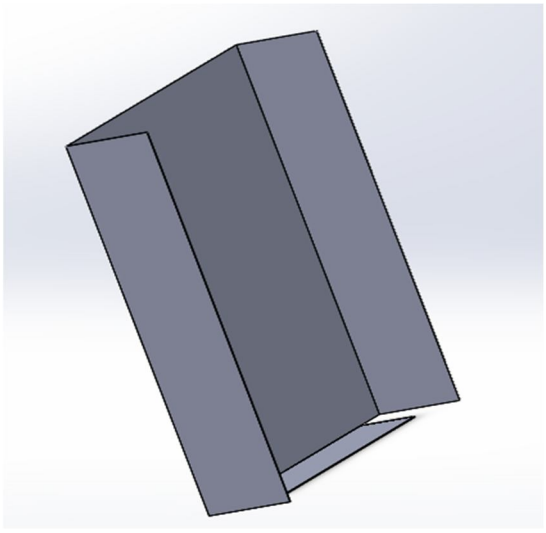

Fig.2.2.13 Supporting Plate.

5) *Pedal/ Wheel :* Wheel is used to give better stability to the machine. Also, wheel helps in smooth motion of the machine in paddy field, reducing the force required to push the machine.

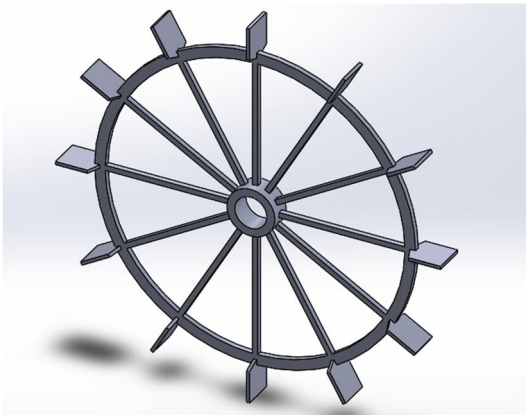

Fig.2.2.14 pedal/wheel.

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6) *Spur Gears:* A gear wheel with teeth projecting parallel to wheel's axis. Spur gear are used to achieve the required gear reduction ratio of 1:6 The chain and sprocket system only gives 1:4 reduction ratio, hence two spur gears of 30&45 teeth are used to get 1.5 reduction.

Hence when the complete mechanism is clubbed, gears will gives 1:6 reduction ratio.

Fig.2.2.15 spur Gears (meshed)

C. Materials Used

1) *Aluminum:* Since it is light weight and has good corrosion resistance, also being ductile, can be used to make the frame structure.

Fig.2.3.1 Aluminium Material.

2) *Mild Steel :* For the main mechanism mild steel is a preferred as it has high resistance to breakage, quite malleable even when cold, also it can be welded to itself or other materials as well.

Fig.2.3.2 Mild Steel Material.

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III. ANALYSIS AND PLANNING

A. Planning

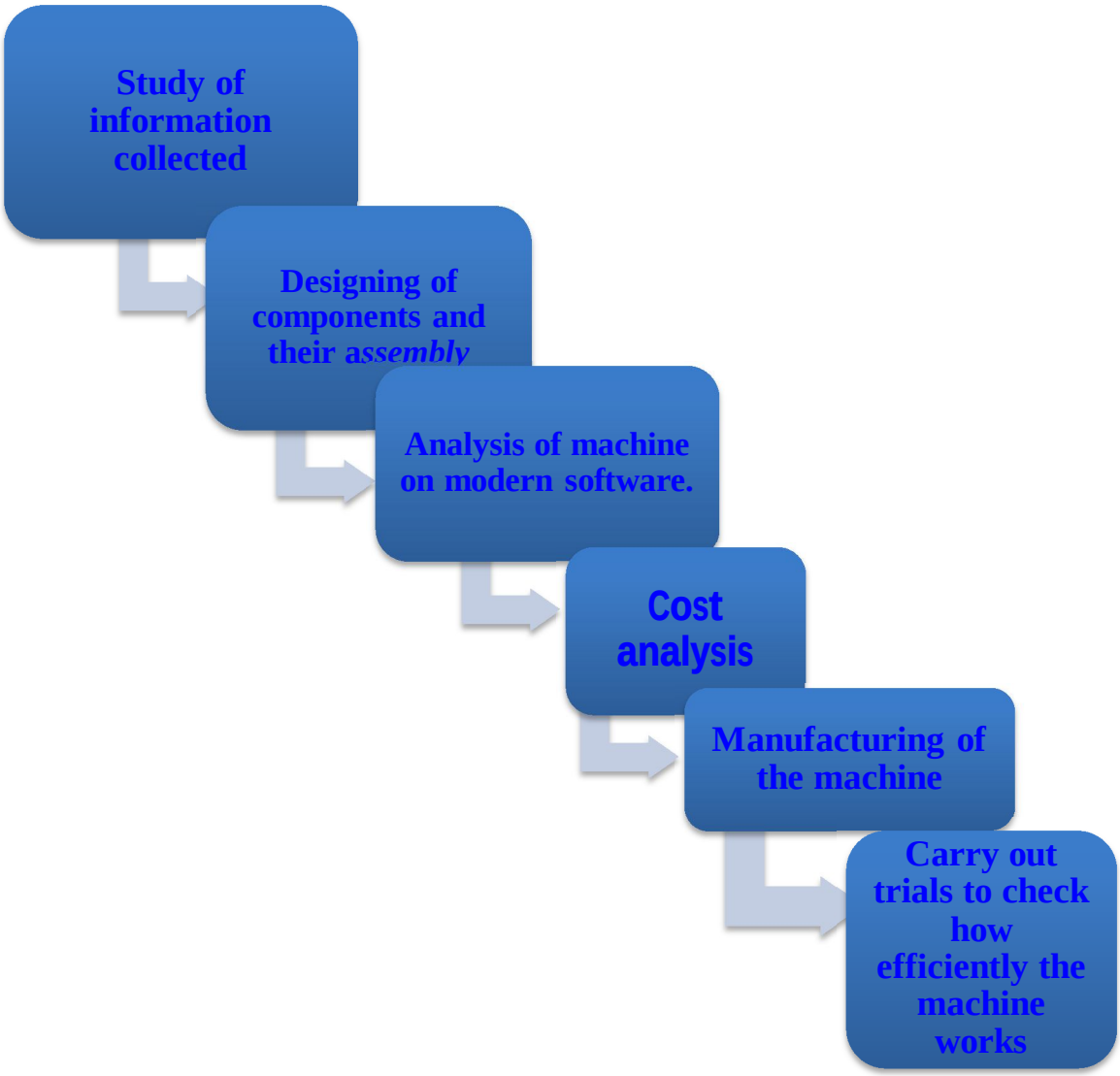

Fig. 3.1.1 Flowchart of planning

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B. Analysis

Table 3.2.1 comparison of manual transplanting and mechanized planting

Parameters	Manual transplanting	Mechanized Machine
1) The hrs required to cover 1 ha	Up to 30 person-days per ha (approximately)	Up to 2-3 person-days per ha (approximately)
2) Manpower required	To cover 1 ha the number of labourers required is approximately 12-14.	To cover 1 ha only 2-3 labourers required.
3) Spacing between successive sampling	As the saplings are sowed by hand the spacing is not uniform as well as plant density.	Considering two row paddy plantation machine, uniform spacing and plant density can be achieved.
4) Labour Availability	During peak periods where labour requirement is more, it is difficult to get labour on time.	As it requires 2-3 labourers, Its the effective option during peak periods.
5) Yield of crops	The seedlings are sowed by hand, therefore recovery is slow and mature non uniformly.(Estimated upto 4 to 6 tonnes/ha)	Seedlings recover fast, tiller vigorously, and mature uniformly. (Estimated upto 10 to 12 tonne/ha)
6) Labour cost	As the no. of labourers are more, cost is more. (Approximately 11000-12000 Rs. per ha)	Comparatively less cost. (considering 150-200 Rs. per hour).
7) Limitations	Time consumed is more, health issues of labourers, good crop yield is less, transplanting is tideous, etc.	Less time required, due to use of machine farmers don't face much health isssues, due to proper plantaion yield of crop is great,

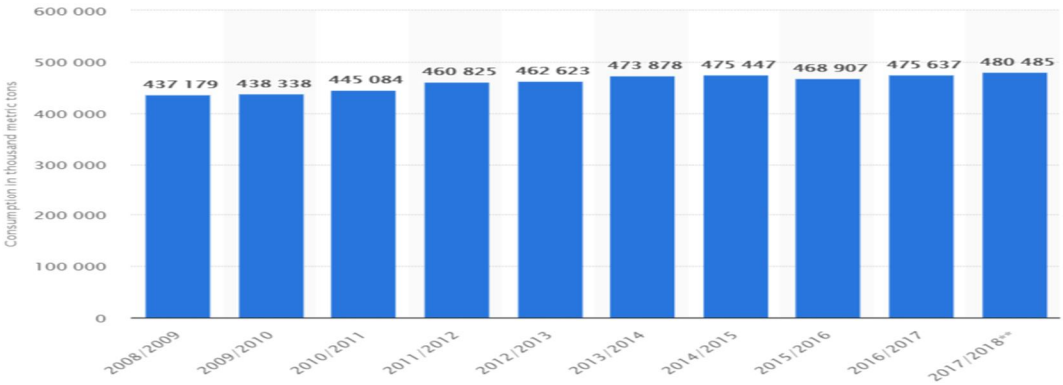

Fig. 3.2.1 Rice consumption graph

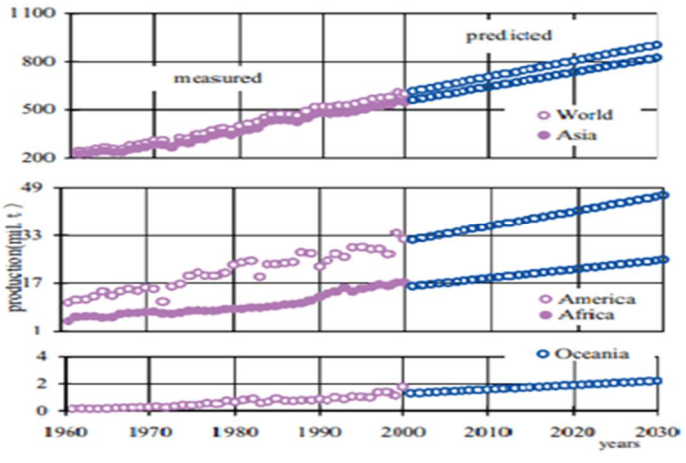

Fig. 3.2.2 changes of measured and predicted rice production

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IV. DESIGN AND IMPLEMENTATION

A. *Design Considerations*

1) *Size of Farm:* Because of hilly terrain area there is problem of transportation of a commercially available self propelled eight row rice plantation machine, from one plot to another and restricting its use on large scale.
2) *Undulating Terrain:* Rice plots in Konkan are available on terraces resulting into difficulties in transportation of machine into fields. The machinery developed for this region must be light in weight which could be transported by two to three persons from one field to another.
3) *Good Operating Conditions:* In order to obtain satisfactory operation, good quality work and efficiency of the developed machine besides ensuring good technical condition and correct operation of the machine, suitable soil conditions in the field

B. *Mechanism Used*

The picker arm mechanism consists of 4- bar mechanism and slider crank mechanism. Slider crank mechanism is connected to 4-bar mechanism so that the picker arm can have a 360 degree rotation, which will lead to picking up of sapling one at a time and planting the sapling inside the soil and so on.

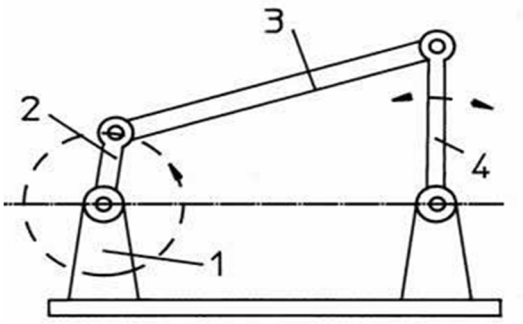

Fig.4.2.1 Four-bar Mechanism -1 fixed block (housing), 2 crank, 3 coupler (connecting rod), 4 rocker.

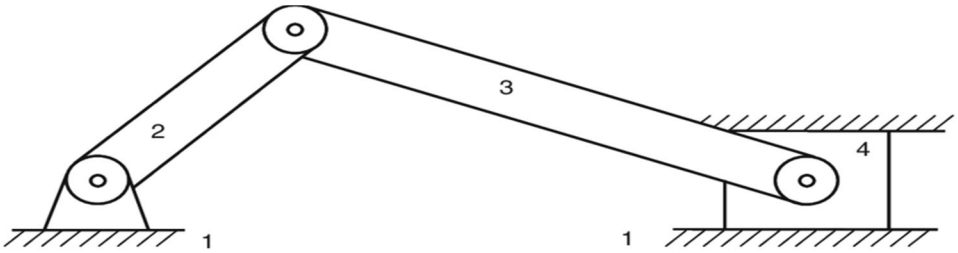

Fig.4.2.2 Slider Crank Mechansim.

1) *Design of Gear & bearing*
a) *Spur Gear Design*

i) Number of teeths

Z_1=30 teeth ----------pinion
Z_2=45 teeth ----------gear
I= (Z_2/Z_1) =1.5 -------- reduction ratio

ii) Material : Mild Steel

HBN=126; ultimate tensile strength (σ_{ut}) =440 N/m ^{2}
σb = 440/ FOS =440/4 =110 N/m ^{2}
since materials used are same pinion is weaker element

iii) Module Determination:

module =2mm
ψ = b/m =10
b=20 mm

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b) Static Strength Of Gear Tooth

$F_s = m*b* \sigma b \ *Y_1$

$= 2*20*110*0.3882$

$= 1708.08$ N

i) Dynamic Load Acting On Gear Tooth

$V_m = (\pi *D_m *N)/60$ …… $V_m = (\pi *m*Z1 *N)/60$ ……..$V_m = (\pi *0.002 *30 *80)/60 = 0.2513$ m/s

$C_v = (5.5 + Vm^{0.5})/5.5$ …….. $C_v = (5.5 + 0.2513^{0.5})/5.5 = 1.0911$

$F_t = 200$N… (value taken from papers)

$F_d = F_t * C_v = 200 * 1.0911 = 218.22$N

$F_d < F_s$; Design is Safe.

ii) Wear Strength Of Gear Tooth

$Q = 2i/(i+1) = (2*1.5)/(1.5+1) = 1.2$

$K = (\sigma_c^2 * \sin\alpha * (1/E_1 + 1/E_2))/1.4 = 1.9062$

$\sigma_c = (2.8 *126) - 70 = 282.8$ N/mm^2

$E_1 = E_2 = 2.05*10^6$ kgf/cm^2

$F_w = d_1 *Q*k*b$

$= 0.2*30*1.2*1.9062*2 = 27.4493$ kgf $= 274.493$ N

$F_d < F_w$; Design is safe for pitting wear

2) Bearing Design

Radial Load $F_r = 80$N

N=80rpm

Expected life $L_h = 10000$ hrs (Assume)

a) Equivalent Load acting

$P_e = X*V*F_r*S*K_t*K_r$

$= 1*1*80*1.2*1*1.2 = 115.2$ N

b) Life in million revolutions

$(L_h *N* 60)/10^6 = 48$ mr

i.e. $L_{mr} = 48$ mr

c) Calculation of Dynamic Capacity of Bearing

$L_{mr} = (C/P_e)^k$

$48 = (C/0.1152)^3$

Therefore, C = 0.4187 KN = 41.87 kgf

D = 20 mm

SERIES	D (mm)	C_0 (kgf)	C (kgf)
6004	20	450	735
6204	20	655	1000
6304	20	765	1250
6404	20	1660	2400

All series can be used ,

Considering cost and its usage, 6004 series can be used.

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C. Making of Machine

Fig.4.3.1 pedals/wheels.

Fig.4.3.2 Links Assembly.

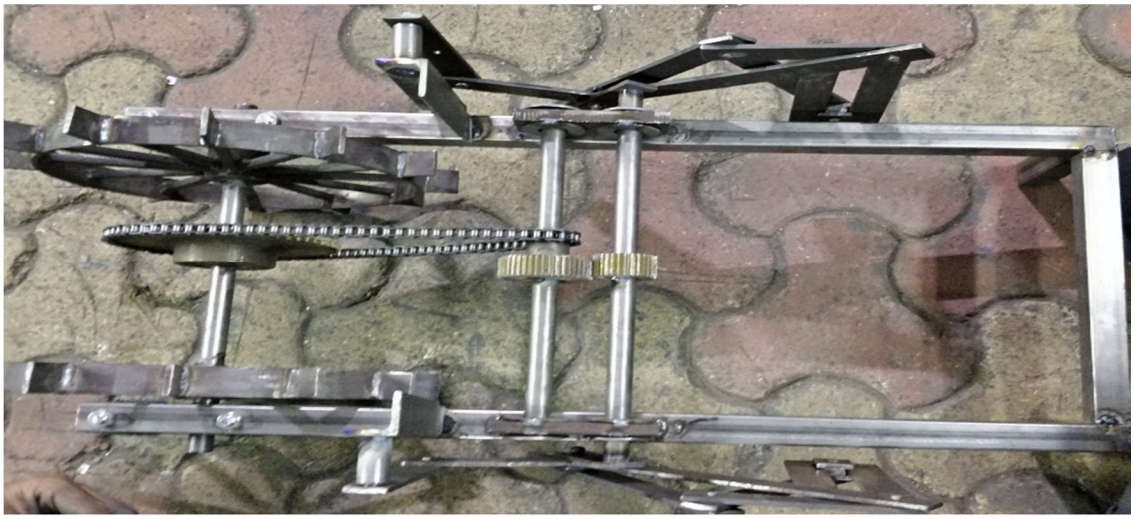

Fig. 4.3.3 Assembly.

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V. RESULT AND DISCUSSION

A. *Comparison*

1) Automated rice planting machines are available in the market, but they are huge i.e. they are 6-8 row planters.
2) It requires tractor or probably engine to run them, which inculcates to use of fuel which leads to increase in cost.
3) There is one more kind of two row paddy plantation machine in Japan, which cost around 25-30K.
4) The machine they have created is complex and has number of small linkages and mechanisms which increases the maintenance cost or if any issue in the links, spare parts availability might become an issue.
5) Hence, what we have thought is of making a two row paddy plantation machine, but quite simpler one.
6) Our machine has only three mechanisms and 8 links which can be easily available if any issue in the mechanism.
7) We have created this design by ourselves and it's not a copy of any other machine.
8) Our machine is available at lesser rate, which will help the farmers in both financial as well as planting.

Fig.5.1.1 existing machines.

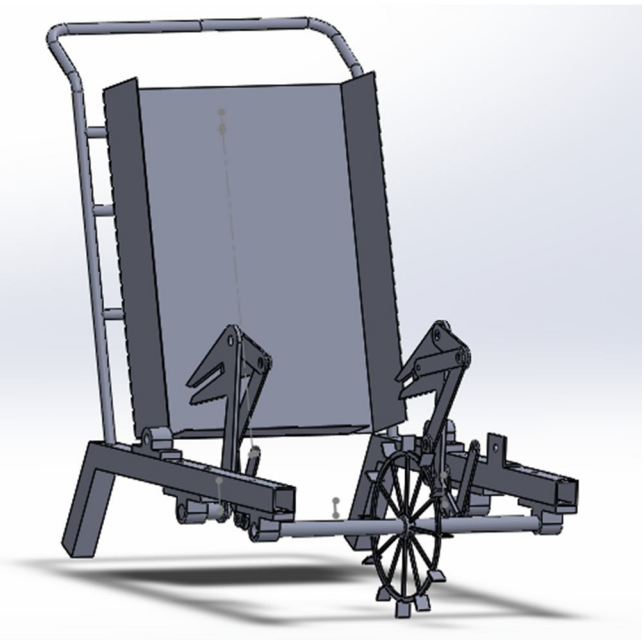

fig.5.1.2 newly designed model.

B. *Cost Analysis*

Sr No.	DESCRIPTION	QTY	RATE	AMOUNT
1	MS square pipe 30 x 30	1 No	1000/-	1000.00
2	MS flat 30 x 5 mm & square rod	1 No	1500/-	1500.00
3	MS sheet 1 mm	1 No	1000/-	1000.00
4	Shafts	5 Nos	750/-	3750.00
5	3/8 sprocket 60 teeth/ 15 teeth	2 Nos	450/-	900.00
6	Gear module 2 45 teeth/ 30 teeth	2 Nos	425/-	850.00
7	Chain 1.2 meter	1 No	800/-	800.00
8	Pillow block bearing UCP 204	2 Nos	600/-	1200.00
9	6004-2Z/C3 SKF ball bearing	4 Nos	1000/-	4000.00
10	hardware nut/ bolts rivets		500/-	500.00
11	Labour			6687.00
TOTAL	TOTAL			22187.00

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C. Expected Outcomes

1) Farmers can plant the rice saplings in very less time using this machine compared to the manual transplanting process.
2) It will reduce the requirement of the labour.
3) This machine will reduce the back ache problem for farmers.
4) The saplings can be planted evenly without damaging them.
5) Sapling plantation will be executed in a specific manner.

Fig 5.3.1 SWOT analysis

D. Future Scope

If successfully implemented, system can be developed further to:

1) This machine can be fully automated using engine which can again reduce the efforts for transplantation.
2) The number of rows of plantation at a time can be increased with the increase in number of picker arm assembly.
3) Machine could be advanced to plant several rows concurrently.

VI. CONCLUSION

A. Conclusion

1) This machine will help in increasing Productivity of the rice.
2) The rice plantation machine will work satisfactorily to solve various problems of farmers.
3) Based on the current progress, it can be assured that the project will be completed as per the given timeline.

Hence, INARI Automated rice plantation machine, the device is independent of tractor so it is suitable for poor farmer. It saves the time as well as labor cost.

Fig. 6.1.1 Rice yield.

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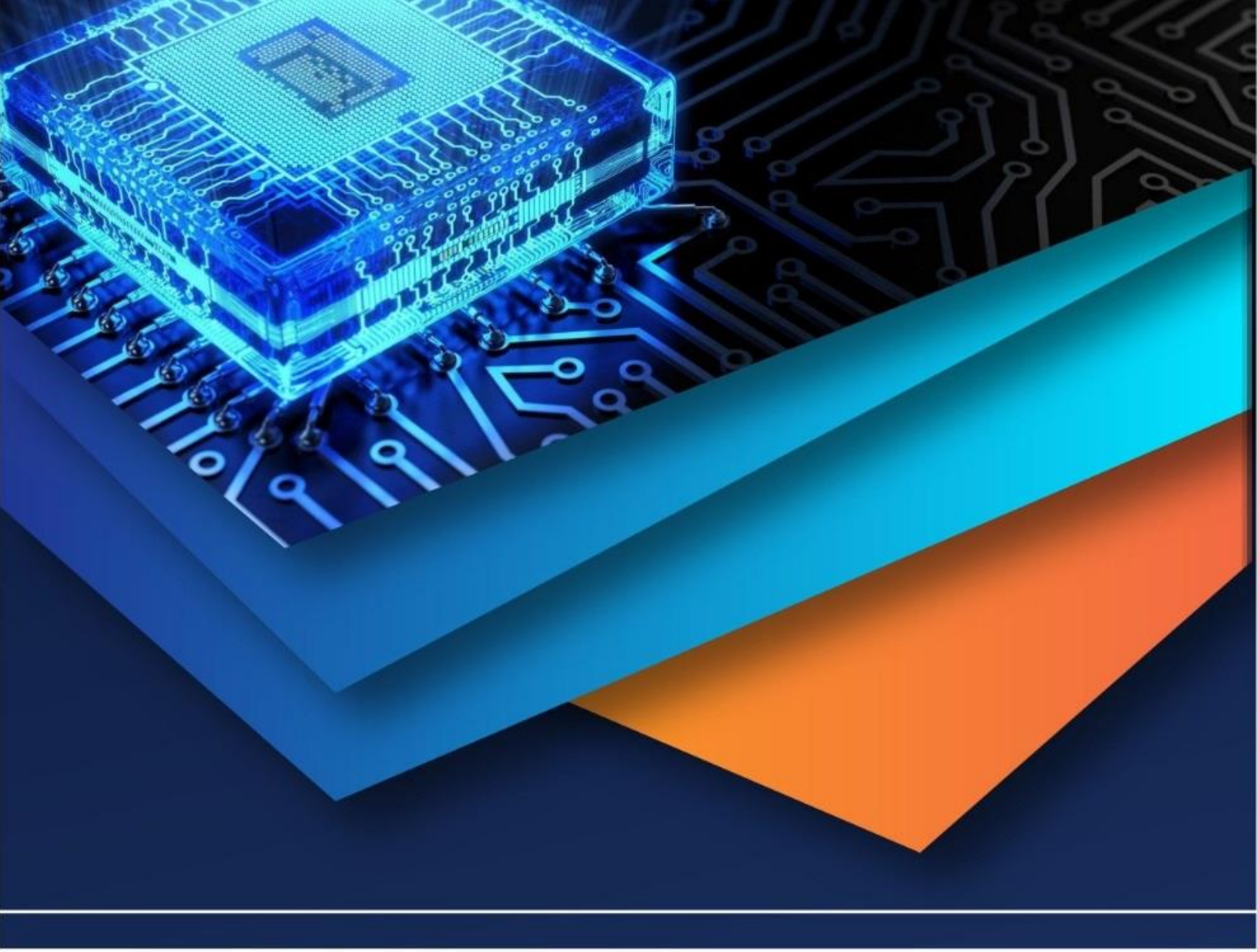

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