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Design & Development of Rice Planter Machine

Dhanesh D Patil [1], Dr. Mangesh R Phate [2]

Student, Department of Mechanical Engineering, Sinhgad Institute of Technology & Science, Nahre, Pune, India[1]

Associate Professor, Department of Mechanical Engineering, Sinhgad Institute of Technology & Science, Nahre, Pune, India[2]

Abstract: Need of rice trans-planter machine is growing nowadays because it unique features seeding in well sequence and in well manner. Seeding by rice trans-planter saves too much efforts of human being. Class of people who uses this kind of machines is farmers and they are having poor economic background. This paper provides guidelines for developments in rice Trans-planters used in India. Rice planting is very old method from many years ago & having long history since many years & their methods of rice planting are changed in this decade. Use of rice Trans planter machines is new trend but current machines having high cost of purchase. So the main focus of this project is to minimise the cost of that machine.

Keywords: Rice planter; Cost minimization; Design & development

I. Introduction

India is a country of villages, having large population around two third of its population are dependent on agriculture. The sole culprit for slogging in pace of accretion in agro industry is dependency on traditional approaches and equipment. For enhancing the per capita agricultural production, various innovative efforts are made at national level under the name Agricultural Revolution. Revolution is confined to economic growth which may result from various economic factor but technological progress have been and will continue to be the primary source of development. Technology refers to the application of scientific approach for practical purpose as well as industrial purpose for enacting and enriching goods and services. For the production of rice and onion, which is gradually a major production crop in kokan the rice should be dropped at a regular interval. But the existing equipment does not fulfill these criteria in India. In existing system, plant are dropped manually at the cross point of longitudinal and lateral cultivation which increase the cultivation time as well as labor cost. But by this device both the operation i.e. cultivation and rice planting can be done simultaneously. In this system there is no need to drops the rice plant more than one times and no wastage of costly rice plant s. And we save the production cost as well as cultivation time and labor cost. And, get more yields. In existing system there was a possibility to germination of more than one plant at a single position, and transplantation of that extra plant was necessary. But in this system of drilling, this type of problem considered as negligible. In future, this device will help the rice planter farmers of kokan to change his life style. The rice trans-planter consists of prime mover, transmission mechanism, lugged wheels, rice ling tray, rice ling tray shifter, pickup fork and pickup fork cleaner. It is a walk behind type rice transplanted using mat type nursery and it transplants the rice ling uniformly without damaging them. The planting depth and start to end spacing can be adjusted. Automatic depth control helps in maintaining uniform planting depth.

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II. RESEARCH METHODOLOGY

Selection of Area of research

Farmers are not aware of the advantages associated with transplanting of paddy over the broadcasting. But they are unable to practice it for high scarcity of labor. Still the transplanting machines available for the country are imported. Engine driven transplanters are high in cost and the inter-raw, intra-raw spacing are fixed which are not suitable for the Sri Lankan condition. Existing manually operated transplanters are inefficient. The main reason for the poor acceptance was the law capacity of the machine. A simple engine operated transplanter or manually operated transplanter having an average capacity of one hectare per day would be a better solution.

Method of establishments

Here are two methods practices in establishment of paddy in India. Those are direct sowing/seeding and Transplanting. 1 Direct sowing / seeding there are two types- Wet seeding & dry seeding. Wet seeding Pre germinated seeds are used to broad-casted into puddled as well as leveled fields which are free from standing water. At same time of puddling basal fertilizer must be added in it. Spraying should be done when seedlings will come up to 10 inches long. The stand establishment by this method varies with the quality of land preparation, weed competition, water management & rain water during the first period after sowing. Dry seeding unterminated dry seeds are sown into dry mud in orientation as per requirement. Rate of seed varies with the conditions & the type of physical damages & impurities of the seeds. Rate of seed varies from 145Kg/ha to 290Kg/ha depending on the level of weed infestation in dry seeded rice. Well development of plant, No transplanting shock to the plant, Suitable method for short duration varieties.

III. LITRATURE SURVEY

Baldev Raj, Kamboj Dharam [1] studied production of rice and onion, which is gradually a major production crop in kokan the rice should be dropped at a regular interval. But the existing equipment does not fulfill these criteria in India. In existing system, plant are dropped manually at the cross point of longitudinal and lateral cultivation which increase the cultivation time as well as labor cost. But by this device both the operation i.e. cultivation and rice planting can be done simultaneously. In this system there is no need to drops the rice plant more than one times and no wastage of costly rice plant s. And we save the production cost as well as cultivation time and labor cost. And, get more yields. In existing system there was a possibility to germination of more than one plant at a single position, and transplantation of that extra plant was necessary. But in this system of drilling, this type of problem considered as negligible. In future, this device will help the rice planter farmers of kokan to change his life style. The rice transplanted consists of prime mover, transmission, engine, float, lugged wheels, rice ling tray, rice ling tray shifter, pickup fork and pickup fork cleaner. It is a walk behind type rice transplanted using mat type nursery and it transplants the rice ling uniformly without damaging them. The plant depth & start to end spacing can be adjusted. Automatic depth control maintains uniform planting depth. The machine clutch mechanism for safety, which prevents break down of planting device from the impact against stones in the field. For operation, the machine is transported to the field and mat type nursery is loaded in the tray of the transplanted. The machine is put in running mode and operated in the puddle field. The performance of the transplanted is checked within 2.2-3.2 m of travel for transplanted rice lings for hill distance, depth of plant and number of rice seeds per hill. If the transplanting is in order the machine is operated in regular planting conditions. The common practice of establishing rice in the rice-wheat system in India is manual transplanting of seedlings in the puddled soil. Besides being costly, cumbersome, and time consuming, puddling results in degradation of soil and the formation of a hard pan, which impedes root growth of subsequent upland crops.

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Bir Yadav [2] studied that northwestern region of India has played a leading role in the agricultural transformation of the country. Food security of India is highly dependent on this region as evident from the contribution of this region to the national buffer stock of food grains. Therefore, sustainable production of rice in this region is crucial for the food security of India. In most of the north-west India, the common practice of establishing rice in the rice-wheat systems is manual transplanting of seedlings in puddled soils. Puddling is achieved by repeated intensive tillage under ponded-water conditions, which helps in reducing water losses through percolation and controlling weeds by water stagnation in rice fields. Puddling is a rather extreme form of tillage because it results in aggregate breakdown and destruction of macropores. Besides being costly, cumbersome, and time consuming, puddling results in degradation of soil and other natural resources and subsequently poses difficulties in seedbed preparation for succeeding no rice crops in rotation. The use of continuous puddling results in the formation of a hardpan with a consequent increase in bulk density and lowering of hydraulic conductivity below the plow layer. The hard pan impedes root growth of subsequent upland crops, including wheat and maize. Decreased availability and increasing cost of labor have increased the cost of rice cultivation through conventional methods Implementation of the government's policies has been creating a labor scarcity in northwest India as rice transplanting in this region is de-pendent on migrant laborers from the eastern states of India. In addition, the plant population of rice remains quite low in manual transplanting compared to the recommended plant density.

Mahesh Kumar [3] had done total CAD design with overall dimensions. A rice transplanter is a specialized machine used to transplant rice seedlings in the field. A common rice transplanter comprises: seedling tray like a shed roof on which mat type rice nursery is set, seedling tray shifter that shifts the seedling tray like the carriage of typewriters, Plural pickup forks that pick seedlings up from mat type nursery on the seedling tray and put the seedlings into the earth, as if the seedling were taken between human fingers. 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 three groups as follows: By band manual, manually operated machines i.e. work by man power and third is mechanically operated machines work by engine power. Transplanting by hand - This method is good for small fields and to fill patches.

Ministry of agriculture of India [4] have statistics of farming parameters in India. It includes area under farming of rice, gain in rice sector etc. The major sector in India is Agriculture sector. Paddy is the main crop in Agriculture sector. The net extent harvested in 2010 Yala season was 376,024 hectares and the total production was 1,671,054 MT and the net extent harvested in 2010/2011 Maha season was 525,017 hectares and the total production was 1,993,014 MT. The agriculture contribution to the national GDP was 11.9 in 2010. About 1.8 million farm families are engaged in paddy Cultivation Island wide. The per capita consumption of rice fluctuate around 100 kg per year. Rice demand will increase at 1.1% per year and to meet that requirement rice production must grow at the rate of 2.9% per year According to the Department of Agriculture, Government of India 2010 the distribution of the methods of establishment of rice in 2000 Yala season had been Broadcasting 85.5% Row seeding 0.1%, Transplanting in rows 1.4%, and Random Transplanting 12.6%. The method of establishment of rice depends on Age of the variety, Availability of moisture, Climatic conditions, Availability of inputs and labor, Among these reasons, availability of inputs and labor play a huge role on deciding the method of establishment of rice. The performance of the rice planting machine was investigated field conditions to optimize the design and operating parameters for rice planting. The effect of operational speed of the disc, and shape of the entry of plant spacing (coefficient of variation) then crank mechanism put the plant and pushing downward direction. Optimization of the regression equations incorporating speed of the disc and operating vacuum pressure through iteration further revealed that a disc, operating at speeds from 0.34 to 0.44 m/s, yielded similar performance.

Robert fisher [5] placed article in Wikipedia. He told about 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.

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Although rice is grown in areas other than Asia, rice transplanters are used mainly in East, Southeast, and South Asia. This is because rice can be grown without transplanting, by simply sowing seeds on field, and farmers outside Asia prefer this fuss-free way at the expense of reduced yield.

IV. PROPOSED SYSTEM

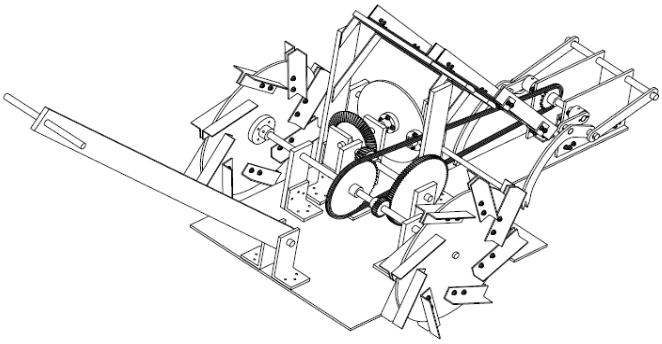

Figure 1: Market Available Planter Machine [2].

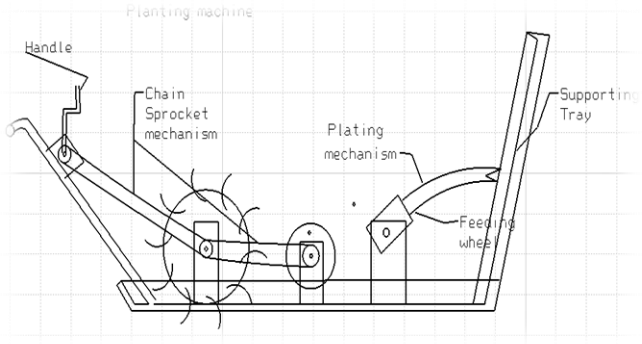

Figure 2: Proposed system for Planter Machine.

Rice planter are available in wide range and verity of several things in the agriculture market. But all this planter machines having complex mechanism and large number of parts which leads to increase in cost. New system is designed on basis of cost and simple mechanism so system having simple arm mechanism, simple four bar mechanism.

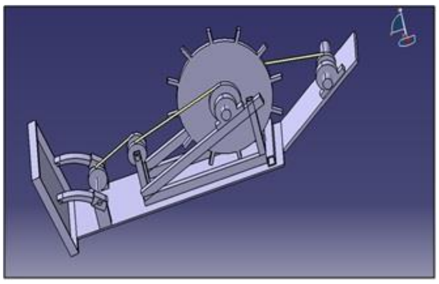

Figure 3: CATIA Model of Rice Trans-planter.

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Also this system having less number of parts than market available. Additional parameters also provided which regular planter machines don't have in certain range of cost. This parameters contains height adjuster of main wheel, depth adjuster of picking arm, additional power source to drive the wheel etc.

V. DESIGN OF SYSTEM

For frame design as shown in the figure 6, let us assume that Mass of rice plants is 5kg & Mass of frame and accessories is 20kg.

Total Mass (M) = 25kg (Assuming)
Total Force (F) = M× g ----- (1A)
Where (g) is acceleration due to gravity
F = 25×9.81 N
F = 981 N

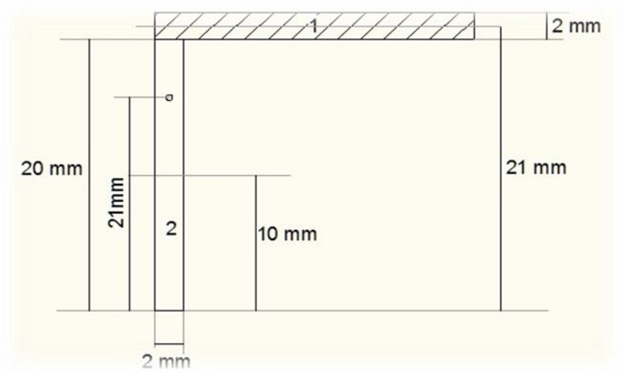

Figure 4: Layout view of frame.

There are four key points where total weight acts on links, so considering load is distributed equally at each point i.e. each link.
Force acting on each link is given by
$F_1 = F/4$ ------(2A)
$F_1 = 981/4 = 245.2$ N
Length of link 1 is 910mm so bending moment (M) for link 1 is given by
$M = F_1 \times L_1$ ------- (3A)
M = 245.25 × (910/1000)
M = 223.17 N-m
We are using MS angle over MS flat because MS angle has comparatively high strength in twisting & bending than MS flat. So selecting MS angle of (22 × 22 × 2) mm dimensions.
Calculating Moment of Inertia for MS angle (I_g)
$I_g = (b \times d^3 / 12)$ ----------(4A)
Here,

σ permissible = S_{ut} / N_f

σ permissible = 650/2 = 325 N/mm^2

$I_{G1} = (22 \text{ x } 2^3)/12 = 14.666\text{mm}^4$
$I_{G2} = (20^3 \text{ x } 2)/12 = 1333.33\text{mm}^4$

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y = C.G. of the system= $(A_1y_1+ A_2y_2)/(A_1+ A_2)$ --- (5A)

y = [{(22 x 2) x 2} + {(20 x 2) x 10}] / {(20 x 2) + (22 x 2)}
y = 15.76 mm
Now, I_P = Moment of Inertia about parallel axis.
$Ip = (I_G+Ah^2)$ --- (6A)
So, $I_{P1} = (I_{G1}+A_1 h_1^2)$
I_{P1} = 14.666 + {44 x $(21-15.76)^2$}
$I_{P2 =}$ 1222.80 mm^4
$I_{P2} = (I_{G2}+A_2 h_2^2)$
I_{P2} = 1333.33 + {40 x $(15.76 - 10)^2$}
I_{P2} = 2660.434 mm^4
So, Moment of inertia
$I = I_{P1} + I_{P2}$
I = 1222.80 + 2660.434
I = 3883.234 mm^4
We know that,
(M/I) = (σ/y) --- (7A)
σ_{actual} = (M x y)/ I
σ_{actual} = (223.17 x 10^3 x 15.76) / 3883.234
σ_{actual} = 90.572 N/mm^2
As, $\sigma_{actual} < \sigma_{permissible}$
So, Design is safe.

Design of main shaft

Total Force acting on frame = 981 N
As, power is transmitted to rear axle only the force acting on frame is equally distributed into rear wheel.
So, $R_A= R_B$ =981/2 = 490.5 N
Now, considering F.B.D. of wheel shown in figure 6,
Where, μ = Frictional Coefficient = 0.33 & R_N = Normal Reaction.
$F_1 = \mu \times R_N$ ---- (8A)
F_1 = 0.33 x 490.5
F_1 = 161.865 N
For 2 rear wheels Resultant force,
$F_R = 2 \times F_1$
F_R = 2 x 161.865
F_R = 323.73 N
Torque transmitted (T),
$T = F_R \times r$ --- (9A)
T = 323 x (300/2000)
T = 48.45 N-m
Maximum Torsional shear stress (τ_{max}):
For shaft we are selecting C45 material.

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So, for C45
S_{yt}=Yield strength of shaft material= 330 N/mm^2,
S_{ut}=Tensile strength of shaft material= 60 N/mm^2,
According to A.S.M.E. code,
$\tau_{max} = 0.18\ S_{ut} = 0.18 \times 600 = 108$ N/mm^2
OR
$\tau_{max} = 0.3\ S_{yt} = 0.3 \times 330 = 99$ N/mm^2
$\tau_{max} = 99$ N/mm^2 (Selecting minimum value),
so,
$\tau_{max} = 99 \times 0.75$
$\tau_{max} = 74.25$ N/mm^2
Now,$(\tau_{max} / R) = (T / J)$ --- (10A)
Where, τ_{max} = maximum torsional shear stress, N/mm^2
R= Radius of shaft, mm
T =Torque transmitted, N/mm^2
J = Polar moment of Inertia, mm^4
So, substituting values we get,
$(74.25 / [d/2])= ([48.45 \times 10^3] / [\pi d^4/32])$
d^3=3330.1430
d = 14.933 mm
So, for safety we are selecting the shaft diameter d = 20 mm.
As, Intermediate shaft also had to transmit same torque & also its length is smaller than that of rear shaft. We are selecting same material & same diameter of shaft 20 mm.

Selection of Bearing for main shaft

As load acting on bearing consist of two components Radial & Thrust. So we have used single row deep groove bearing. This bearing has high load carrying capacity & suitable for high running speed.

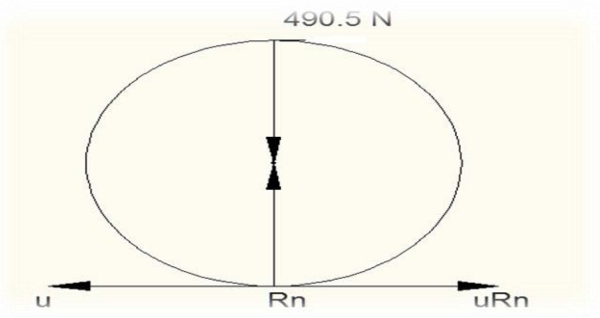

Figure 5: Main shaft from wheel.

Where d = Inner diameter of bearing in mm
D = Outer diameter of bearing in mm
B = Axial width of bearing in mm
C = Dynamic load capacity in N

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C_o = Static load capacity in N
Now, $P_0 = X_0 F_{or} + Y_0 F_{oa}$ ----- (11A)
Where,
d = Inner diameter of bearing in mm
D = Outer diameter of bearing in mm
B = Axial width of bearing in mm

Principle Dimension mm			Basic load rating in N		Designation
d	D	B	C	C_o	
20	47	14	1000	655	6204

Table 1: Selection of Bearing.

C = Dynamic load capacity in N
C_o = Static load capacity in N
As per equation 11A
OR
$P_0 = F_{or}$
Where, P_0 = equivalent static load, N
F_{or} = Static radial load, N
F_{oa} = Static thrust load, N
For Single row deep groove ball bearing,
X_0 =Static radial factor = 0.6 & Y_0 = Static thrust factor = 0.5
Substituting the values we get,
P_0 = 245.25N
As, $C_0 > P_0$
Design is safe.

VI. EXPERIMENTATION

There are several parameters that acts as input and output parameters. It quantified as a number of seeds planted per hour. Another pair of input and output parameters is size of tray and number of seeds per tray, it describes capacity of machine. Next important pair of input and output parameter is number of rotation of wheel and number of seeds planted. It is quantified as numbers of seeds planted per unit rotation of wheel. Same as this another pair is distance traveled by machine and number of seeds planted. It is quantified as number of seed planted per unit length of travel. The experimentation of this rice trans-planter machine is carried out farm with mud where the seed of rice can easily planted.
Input Parameters-
A - Level of Mud 1: Soft Mud 2: Medium Mud 3: Hard Mud
B- Time Span (1:3M 2: 5M 3:10 M) M- Minutes
C- Age Group (1: below 25 yr., 2: 25-30, 3: Above 30yr)

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Output Parameters-
OP1- Distance travelled in meters (m)
OP2- Number of seeds planted (n)
OP3- Depth planting (cm)
PD – Pulse Difference

Exp. No	A	B	C	OP 1 (m)	OP 2 (n)	OP 3 (cm)	PD
1	1	1	1	20	18	4.2	5
2	1	2	1	48	40	4.2	5
3	1	1	2	20	18	4.2	9
4	1	2	3	48	40	4.2	12
5	1	3	2	98	90	4.2	12
6	1	3	3	98	90	4.2	14
7	1	1	3	20	18	4.2	8
8	2	1	1	20	18	4.1	5
9	2	2	1	48	40	4.1	9
10	2	1	2	20	18	4.1	5
11	2	2	3	48	40	4.1	9
12	2	3	2	98	90	4.1	14
13	2	3	3	98	90	4.1	14
14	2	1	3	20	18	4.1	6
15	3	1	1	18	16	4	6
16	3	2	1	36	38	4	10
17	3	1	2	18	16	4	6
18	3	2	3	36	38	4	10
19	3	3	2	94	92	4	15
20	3	3	3	94	92	4	15
21	3	1	3	18	16	4	6

Table 2: Observation Table.

VII. CONCLUSION

Newly developed system is also effective as compared systems available in the market. New trans-planter having simple construction and less number of parts which minimizes the cost of development for it. Two bar mechanism is used to carry out the motion of the arms. Total cost required to develop the system is also less. New rice trans-planter machine is more flexible than machines available in the market at starting cost.

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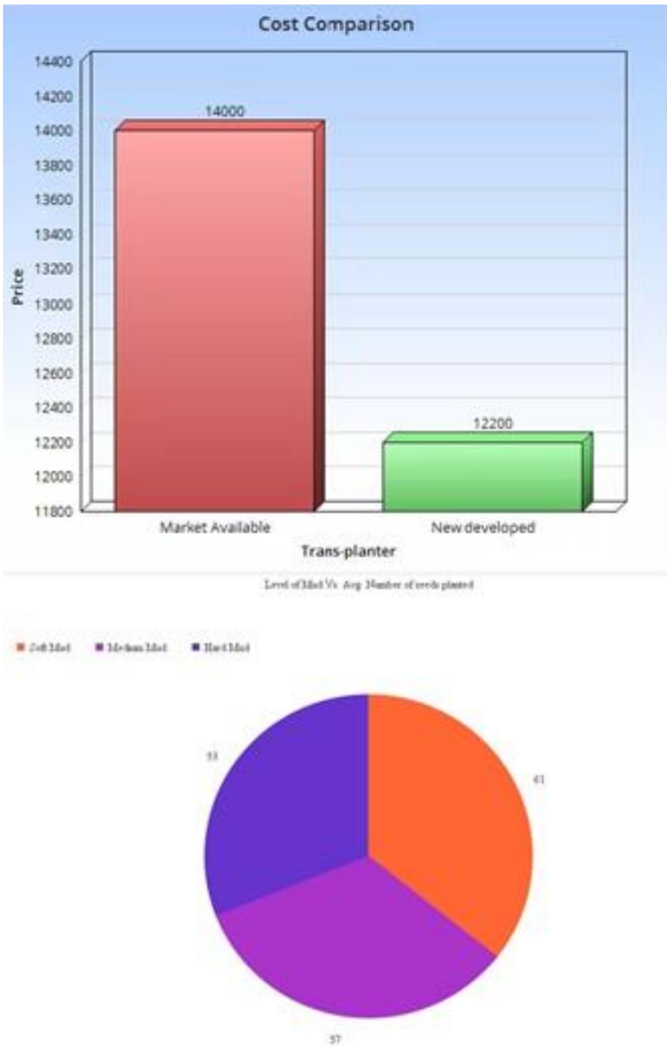

Figure 6: Cost Comparison & Number of seeds planted.

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