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Design and Fabrication of Low Cost Harvesting Machine Using 2 Stroke Scooter Engine

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Abstract: Agriculture & allied industries contribute 17.32% of India's GDP at present, but it was 54.3% in 1950's (after independence). According to the Ministry of agriculture and Farmer Welfare the average income of farmers in India is somewhere around 6000 .Rs (93.42$ @ 64.23.Rs per 1 USD) per month in which 47% comes from Cultivation and the rest from Non-agricultural activities. The statistics from the last 6 decade shows that agriculture sector is depleting due to lack of awareness about the technological revolutions in this field along with scarcity of basic needs. 60% of the people in India live in rural areas and most of them are upper lower class whose major source of income is agricultural. To address this issue we have decided to design and fabricate a low cost machine for harvesting to reduce the capital, labour and time for the financially weak farmers. We carried out this research in an area called Etukur (Guntur Dist, Andhra Pradesh) which falls under rural region of India. Here the debits of farmers are greater than their annual income, mostly their capital for cultivation goes to fertilizers, labour and land lords. The use of machineries to increase productivity and decrease the investment is not an option, since to an ordinary farmer it's not feasible. To validate our design whether it is profitable are not we carried out tests in terms of fuel consumption, work load, and time in comparison with existing machineries at different fields (i.e., Red Chile, Cotton, Vegetables fields which are prime crops in that region) of area 1 acre, 2 acre and 3 acres respectively. The model we choose to build is a compact one with 2 stroke Scooter Engine to power it. The results between existing (Tractors, Bullock Carts) and our design were compared in terms of above stated tests.

Keywords: Low cost agriculture harvest machine, 2 Stroke Petrol Scooter Engine, Design & fabrication, Fuel Consumption, Power to Weight Ratio, Time, Cost.

1. INTRODUCTION

A motor scooter is a motorcycle similar to a kick scooter with a seat, a floorboard, and small or low wheels. The United States Department of Transportation defines a scooter as a motorcycle that has a platform for the operator's feet or has integrated footrests, and has step-through architecture [1]. Scooters are popular for personal transport, partly due to being cheap to buy and operate and convenient to park and store. Licensing requirements for scooters are easier and cheaper than for cars in most parts of the world [2]. Generally, there is several type of scooter operation. The way how to produce power for this kind of transport is depend on its want to use. High power scooter usually use small engine with gasoline [3-5]. Another type is using electric motor operation whether dc or ac motor. This kind of bike usually use in small area and for recreation. There are multiple types of scooters available in the market. The scooter engine works on the principle of Internal Combustion Engine (IC) [6]. IC Engine converts heat energy into mechanical energy which is used to drive the components of a vehicle or a machine. Our harvesting machine is a mechanically driven one. Hence, it is evident through our literature survey that a scooter engine will be good choice because of its compactness and high weight to power ratio with low maintenance cost [7-8]. For this research we had taken a two stroke LML scooter engine with specifications as follows to convert heat energy to mechanical energy;

Table: 1 LML Engine Specifications

Engine Specifications	
Type	2 stroke
Cooling Type	Forced Air Cooled
Displacement	145.45 cc
Max Power	7.5 bhp (5.93 kW) @ 5500 rpm
Max Torque	10.8 Nm @ 3500 rpm
Ignition Type	CDI Electronic
Transmission Type	4-speed, Constant Mesh
Clutch Type	Wet Multidisc

To understand the reason for choosing this scooter engine as our power medium for the design, below comparison figures out;

Table: 2 Comparison of available harvesting models VS research model

Bullock Cart	Tractor	Scooter Engine
Rate of work is low	Rate of work is high	Rate of work is high
Can do one or two process	Can perform various process	Can perform multiple process
Not flexible and versatile	Flexible and versatile	More flexible than the tractor
Can't move easily in the	Can't move freely	Can move very easily in all types

fields		of fields
Weight is more	Heavy in weight	Less weight
	Power consumption is high	Power consumption is low
Maintenance cost is high	Maintenance cost is medium	Medium cost is minimal

In olden days we used bullock cart for transportation and harvesting after that we started using tractors instead of bullock cart because bullock cart will run with low speed and high maintenance cost and at present we are using tractors for harvesting. From the above Table 2 it is clear that to meet our low cost harvesting machine design we should use scooter engine for harvesting instead of tractor and bullock cart since the scooter will be having high cubic centimeter (CC), and weight to power ratio is more. Following is the methodology used to design and fabricate our harvesting machine.

- Conceptual design
- Sketching several type of design based on concept that being choose.
- Detailed Dimensions for workable drawings.
- Create a 3D model using SOLIDWORKS software.
- Computer Aided Engineering (CAE) analysis
- Analysis the design for strain stress structure by using ALGOR.
- Define critical point.
- Fabrication model refinement
- Modify the scooter engine according to the design.
- Refinement at several part of joining and sharp edge.
- Materials selection
- Selection of true material based on model design and criteria.
- Prototype Development
- Assemble all the part to the design.
- Testing
- Results

2. EXPERIMENTAL SETUP

CHASIS

Firstly, L-angular frame is cut into four pieces and welded together using arc welding machine. The dimensions are;

Length = 18 inches
Breath = 13 inches
Angular size = 2 inches

Fig 1: frame

Fig 2: Scooter engine is placed on frame

After making of frame the engine is mounted on it. Later Clutch wire and two brake wires are connected along with 1 accelerator wire and 1 choke wire. Instead of kick rod we mounted a (Bajaj ape 7 seated Autoriksha) drum which was used to crank the engine.

Engine Occupancy Dimensions
Length = 16 inches
Breath = 8 inches
Height = 15 inches

Wheels

For the existing motorcylcles wheel, the hub adds more wieght which is not suitable for our engine load capacity. To address this issue a new lite wieght wheel is made as shown in the Fig 3. The centre plate and outer wheel are connected with a 10 inche length plate. L –angular are provided on top of the wheels for traction on mud roads as shown in the Fig 3. The frame is attached to wheels with the help of two pillow bearings. To restrict the movement of bearings shaft collars were used as shown in Fig 5.

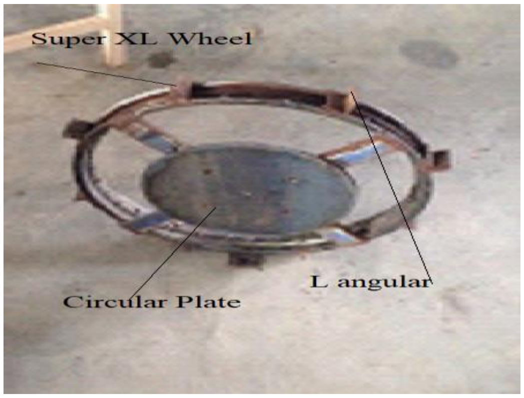


Fig 3: wheel, L-angular, circular plate

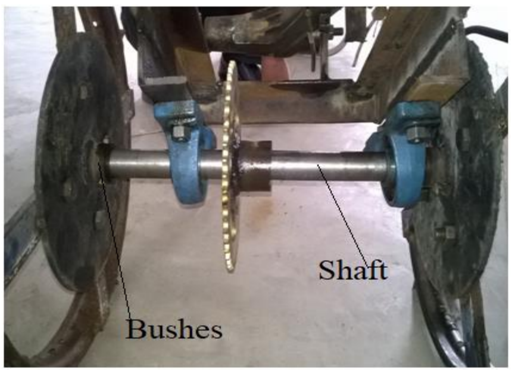


Fig 4: Shaft is connected between bushes

Shaft collar of diameter = 1.25cm
Pillow bearings of diameter = 1.25cm

Fig 5: pillow bearing and shaft collar

The gear wheel and a sprocket are placed at the centre of the shaft. Chain sprocket is connected to the cam shaft pulley of the engine by means of chain coupling. This sprocket is exactly in line with the cam shaft.

Fig 6: shaft with collar

Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear. The same working principle applies in this design as you can see from the Fig 8 power transmission happens with the help of a roller chain. Two bent rods are welded to the frame which supports drive system like acceleration, braking and steering of this machine.

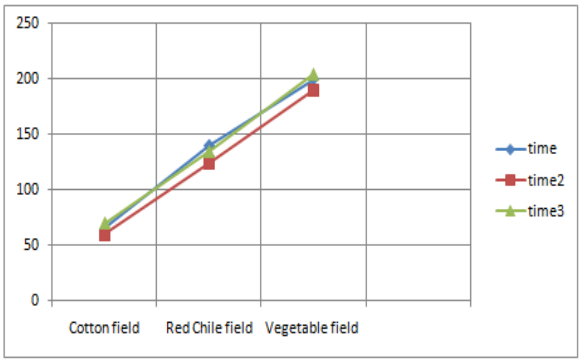
Fig 7: Handle through scooter engine

Fig 8: chain drive between cam shaft and sprocket

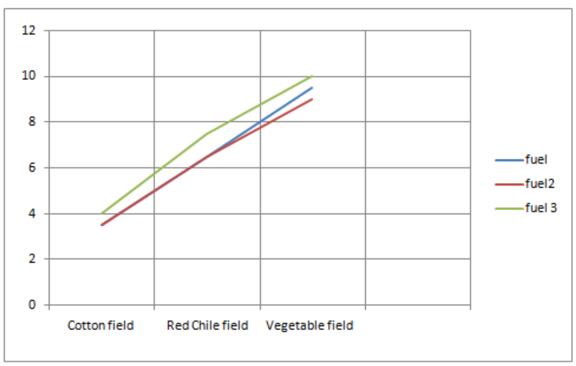
3. RESULTS AND DISCUSSION

For a period of more than a year we performed this research work across different crop fields in Etukur with existing models like Bullock Cart, Tractors along with our newly fabricated model for Harvesting. And calculated the fuel consumed, energy required, time consumed for the fields like Cotton field, Red Chile field and Vegetable field for variable areas like 1 acre, 2 acre and 3 acres of land.
The obtained results are,

Calculations using Tractor



Graph 1: between Different Fields vs Time



Graph 2: Between Fuel vs field

Cotton field

Table 3: cotton field

S.No	Acres	Time (In min)	Fuel (in lit)
01	1	65	3.5
02	2	140	6.5
03	3	200	9.5

Table 4: Red Chile field

S. No	Acres	Time (in min)	Fuel (in lit)
01	1	60	3.5
02	2	125	6.5
03	3	190	9.0

Table 5: Vegetable field

S.No	Acres	Time (in min)	Fuel (in lit)
01	1	70	4.0
02	2	135	7.5
03	3	205	10.0

Graphs between Time vs Fuel vs Field

Calculations using Bullock cart

Table 6: Cotton Field

S.No	Acres	Time (In min)	Fuel (in lit)
01	1	160	0
02	2	300	0
03	3	450	0

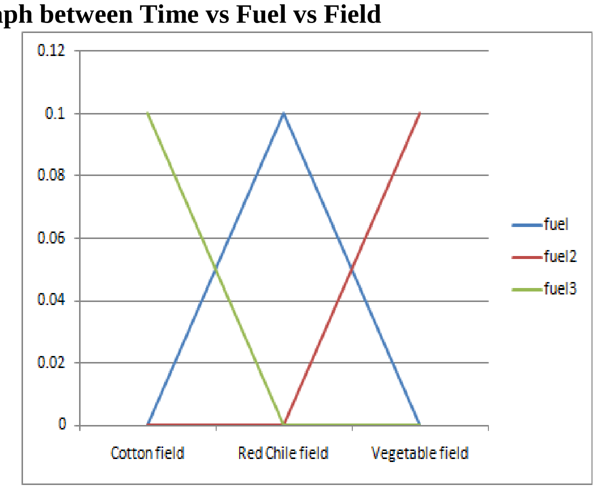
Table 7: Red Chile field

S.No	Acres	Time (In min)	Fuel (in lit)
01	1	150	0
02	2	310	0
03	3	450	0

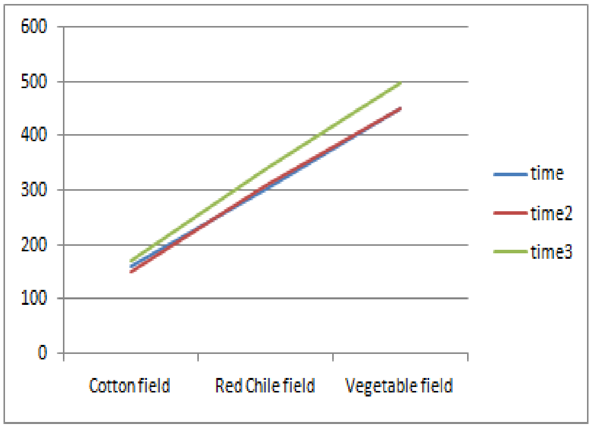
Table 8: Vegetable field

S.No	Acres	Time (min)	Fuel (lit)
01	1	170	0
02	2	340	0
03	3	500	0

Graph between Time vs Fuel vs Field



Graph 3: Between Time vs field



Graph 4: Between Fuel vs field

Note: In the above for bullock cart the fuel will not be consumed

Calculation for scooter engine

Conversions

1horse power = 0.745kw

1km/hr = 0.277m/sec

1acre = 4046.56 m^2

Formulas Used

Torque

TORQUE = FORCE x RADIUS.

If we divide both sides of that equation by RADIUS, we get:

(a)FORCE = TORQUE ÷ RADIUS

Now, if DISTANCE per revolution= RADIUSx2x π, then

(b)DISTANCE per minute = RADIUS x 2 x π x RPM

Power

POWER= (TORQUE ÷ RADIUS)x (RPM x RADIUS x 2 x π)

Fuel Consumption

Fuel consumption= mass * specific gravity/ time

Mass = 55kg

Specific gravity for petrol = 737.22 kg/m^3

Time = seconds

Cotton field

Table 9: Cotton Field (Gear 1)

Gear	1	1
Acre	1	2
Time (Min)	92	185
Distance (m^2)	4046.85	8093.7
Speed (m/sec)	2.21	2.21
Fuel Consumption (Litre/Acre)	0.95	1.85
Speed of the engine (RPM)	1650	1652
Power Consumption (w)	418.3	419.2
Torque (n-m)	3.25	3.28

Table 10: Cotton Fiel

d (Gear 2)

Gear	2	2
Acre	1	2
Time (Min)	82	164
Distance (m^2)	4046.85	8093.7
Speed (m/sec)	3.324	3.324
Fuel Consumption (Litre/Acre)	1.12	2.34
Speed of the engine (RPM)	1680	1685
Power Consumption (w)	534.7	419.2
Torque (n-m)	4.10	4.13

Table 11: Red Chile Field (Gear 1)

Gear	1	1
Acre	1	2
Time (Min)	90	182
Distance (m^2)	4046.85	8093.7
Speed (m/sec)	1.939	1.939
Fuel Consumption (Litre/Acre)	0.97	1.88
Speed of the engine (RPM)	1650	1652
Power Consumption (w)	414.6	417.2
Torque (n-m)	3.22	3.24

Table 12: Red Chile Field (Gear 2)

Gear	2	2
Acre	1	2
Time (Min)	80	160
Distance (m^2)	4046.85	8093.7
Speed (m/sec)	3.324	3.324
Fuel Consumption (Litre/Acre)	1.12	2.34
Speed of the engine (RPM)	1680	1685
Power Consumption (w)	538.8	542.8
Torque (n-m)	4.10	4.13

Table 13: Vegetable Field (Gear 1)

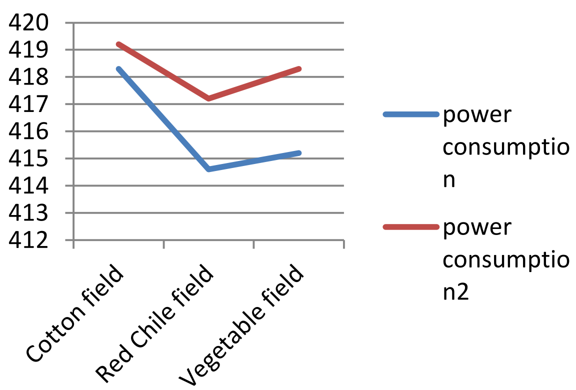
Gear	1	1
Acre	1	2
Time (Min)	88	167
Distance (m^2)	4046.85	8093.7
Speed (m/sec)	3.324	3.324
Fuel Consumption (Litre/Acre)	0.95	1.72

Speed of the engine (RPM)	1656	1662
Power Consumption (w)	414	418.3
Torque (n-m)	3.21	3.23

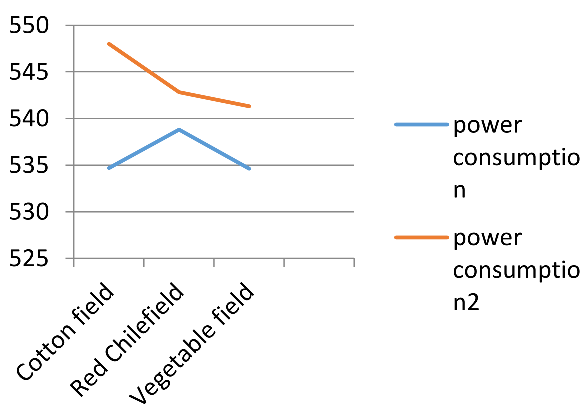
Table 14: Vegetable Field (Gear 2)

Gear	2	2
Acre	1	2
Time (Min)	80	160
Distance (m^2)	4046.85	8093.7
Speed (m/sec)	3.324	3.324
Fuel Consumption (Litre/Acre)	1.17	2.48
Speed of the engine (RPM)	1684	1689
Power Consumption (w)	534.6	541.3
Torque (n-m)	4.07	4.11

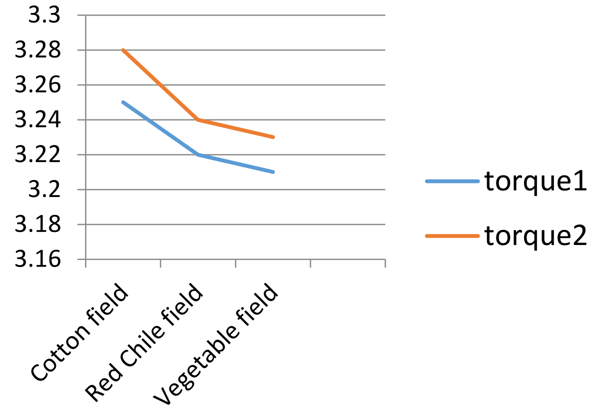
Power consumption
When the engine is in gear 1



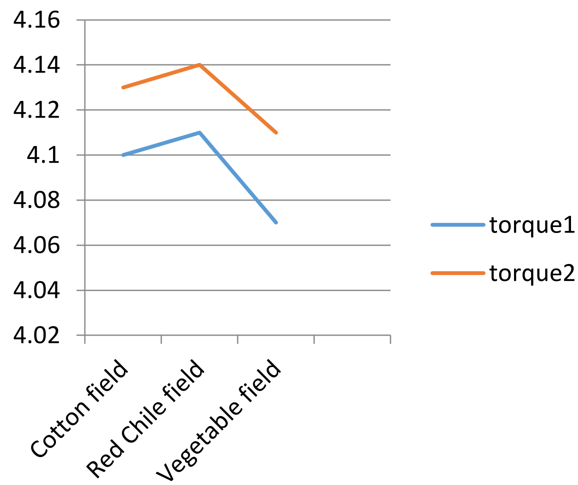
When the engine is in gear2



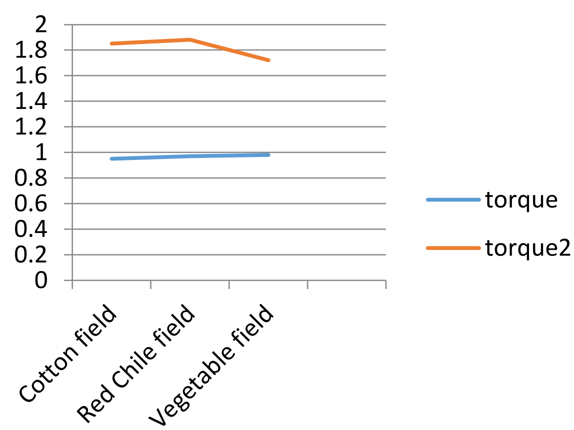
Torque
When the engine is gear 1



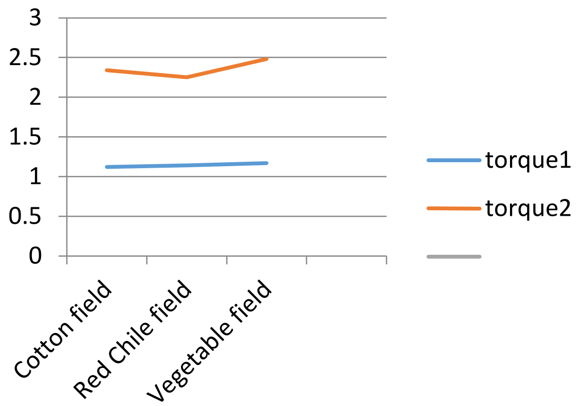
When the engine is gear 2



Fuel Consumption
When the engine is gear 1



When the engine is gear 2



4. CONCLUSION

The motive of this study is to design and fabricate a low cost agriculture harvesting machine which benefits the rural farmers of India. Using 2 Stroke Scooter Engine as a power source, we fabricated a harvesting machine which does the work as similar to a Tractor and Bullock cart. The results from experimental calculations are as follows,

- The average fuel consumption of Cotton field for Scooter Engine of 1, 2 acres was 1.035 & 2.095 liters respectively (Gear 1 & 2). Whereas the tractor consumed 3.5 & 6.5 liters for 1 & 2 acres.
- The average fuel consumption of Red Chile field for Scooter Engine of 1, 2 acres was 1.045 & 2.11 liters respectively (Gear 1 & 2). Whereas the tractor consumed 3.5 & 6.5 liters for 1 & 2 acres.
- The average fuel consumption of Vegetable field for Scooter Engine of 1, 2 acres was 1.06 & 2.1 liters respectively (Gear 1 & 2). Whereas the tractor consumed 4 & 7 liters for 1 & 2 acres.

It is evident that using Scooter instead of Tractor can be efficient in terms of fuel consumption for financial weak farmers. Here Bullock cart is not considered while comparing since it's the most costlier than the other two options. The total cost of this model was approximately 12000 .Rs (187.79 $ @ 63.91) which proves to be a cost effective one than the other available products in the market. The life of this model is still yet to be defined, since we fabricated this model in the year 2014 from then it is working without any issues till date. More than 5 working models are performing their operations in and around Etukur Village. The Major pro of this model is, it can be accessible to low workable space fields like Banana and other fields where the distance between the plants will be less.

In further the cons like time consumption to finish the job can be reduced with the help of high torque engines using cutting edge technology for cost reduction.

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