DESIGN AND FABRICATE CEREAL CROPS CUTTING EQUIPMENT

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1 INTRODUCTION

AGRICULTURE IN INDIA

The history of agriculture in India dates back to the Rigveda, written about 1100 BC. Today India ranks second worldwide in farm output. Agriculture and allied structures like forestry and fisheries accounted for 13.7% of the GDP (Gross Domestic Product) in 2013, about 50% of the total workforce. The economic contribution of agriculture to India’s GDP is steadily declining with the country’s broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in overall socio-economic fabric of India.

As Per the 2010 FAO world agriculture statistics, India is the world's largest producer of many fresh fruits and vegetables, milk, major spices, select fresh meats, select fibrous crops such as jute, several staples such as millets and castor oil seed. India is the second largest producer of wheat and rice, the world's major food staples. India ranked within the world's five largest producers of over 80% of agricultural produce items, including many cash crops such as coffee and cotton, in 2010. India is also one of the world's five largest producers of livestock and poultry meat, with one of the fastest growth rates, as of 2011.

“Slow agricultural growth is a concern for policymakers as some two thirds of India’s people depend on rural employment for a living. Current agricultural practices are neither economically nor environmentally sustainable and India’s yields for many agricultural commodities are low. Poorly maintained irrigation systems and almost universal lack of good extension services are
among the factors responsible. Farmers access to markets is hampered by poor roads, rudimentary market infrastructure, and excessive regulation.”

“With a population of just over 1.2 billion, India is the world’s largest democracy. In the past decade, the country has witnessed accelerated economic growth, emerged as a global player with the world’s fourth largest economy in purchasing power parity terms, and made progress towards achieving most of the millennium development goals. India’s integration into the global economy has been accompanied by impressive economic growth that has brought significant economic and social benefits to the country. Nevertheless, disparities in income and human development are on the rise. Preliminary estimates suggest that in 2009-10 the combined all India poverty rate was 32% compared to 37% in 2004-05. Going forward, it will be essential for India to build a productive, competitive and diversified agricultural sector and facilitate rural, non-farm entrepreneurship and employment. Encouraging policies that promote competition in agricultural marketing will ensure that farmers receive better prices.”

**Chick Pea Cultivation**

Chickpea is grown in tropical, sub-tropical and temperate regions. Kabuli type is grown in temperate regions while the desi type chickpea is grown in the semi-arid tropics (Muehlbauer and Singh, 1987; Malhotra et al., 1987). Chickpea is valued for its nutritive seeds with high protein content, 25.3-28.9 %, after de husking (Hulse, 1991). Chickpea seeds are eaten fresh as green vegetables, parched, fried, roasted, and boiled; as snack food, sweet and condiments; seeds are ground and the flour can be used as soup, dhal, and to make bread; prepared with pepper, salt and lemon it is served as a side dish (Saxena, 1990). Dhal is the split chickpea without its seedcoat, dried and cooked into a thick soup or ground into flour for snacks and sweetmeats (Saxena, 1990; Hulse, 1991). "Sprouted seeds are eaten as a vegetable or added to salads. Young plants and green pods are eaten like spinach. A small proportion of canned chickpea is also used in Turkey and Latin America, and to produce fermented food. Animal feed is another use of chickpea in many developing countries. An adhesive may also be prepared; although not water-resistant, it is suitable for plywood. Gram husks, and green or dried stems and leaves are used for stock feed; whole seeds may be milled directly for feed. Leaves are said to yield an indigo like dye. Acid exudates from the leaves can be applied medicinally or used as vinegar. In Chile, a cooked chickpea-milk (4:1) mixture was good for feeding infants, effectively controlling diarrhea. Chickpeas yield 21% starch suitable for textile sizing, giving a light finish to silk, wool, and cotton cloth.

Chickpeas mature in 3-7 months and the leaves turn brown/yellow during maturity. For dry seeds, the plants are harvested at maturity or slightly earlier by cutting them close to the ground or
uprooting. The plants are stacked in the field for a few days to dry and later the crop is threshed by trampling or beating with wooden flails. The chaff is separated from the grain by winnowing. Tall cultivars are suitable for mechanized harvesting in which case combines can be used. Chickpeas are usually stored in bags, but are more subject to insect damage than when stored in bulk. Proper cleaning, drying, and aeration are necessary to control seed beetles.

FIELD SURVEY

Present Methods of Cultivation

- Manual methods of cultivation
- Manual cutting and Threshing machine for seed separation

In this method the crops are removed as mentioned in the traditional method and then crops are tied together to form a bundle. These bundles are garnered and taken to threshing machine. The threshing machine separates the seeds from the crops. These machines are available in most of the villages. The cost of such machine is estimated around 1.5-2Lakh rupees after subsidy.

- Combine Harvester

The combine harvester is a machine that harvests grain crops. The name derives from its combining three separate operations comprising harvesting—reaping, threshing, and winnowing—into a single process. The waste straw left behind on the field is the remaining dried stems and leaves of the crop with limited nutrients which is either chopped and spread on the field or baled for feed and bedding for livestock. Combine harvesters are
one of the most economically important labor saving inventions, enabling a small fraction of the population to be engaged in agriculture.

**PRESENT DESIGN**

The picture of the present design of cutting equipment is shown in fig 1.3. Since it has some drawbacks it needs improvement. This time the same problem is taken as project topic. It is the second phase of chick pea harvester and the drawbacks which are associated with the present design are given below.

**Drawbacks of the Present Design:**

1. The speed of the blade used for cutting is more and thus resulting into unwanted vibration in the machine.

   **Solutions:**
   
   - Find the shear force to cut the stem of chickpea.
   - Keeping the force in mind calculate the stroke length of blade and calculate its reciprocating speed.
Then do the calculations for the dimensions of crank rpm and connecting rod length.

2. The motion of reel is derived from front wheel; this is restricting the turning of the wheel.

   **Solutions:**
   - We need to find a different source for rotating the reel.
   - To turn the front wheel turning mechanism should be included in the machine to enable easy rotation of the front wheel.
   - The axles have to be installed to the wheels using standard automobile design which enables smooth forward movement.
   - The wheels used are not suitable for the field/farm hence good quality wheels are to be attached.

3. The present design of the machine is specifically designed for AC motor. The speed and forces required to drive the machine are estimated as per ac motor.

   **Solution:**
   - We intend to use an engine as a prime mover hence the speeds and forces are to be calculated for a machine using an engine. The vibrations will be more hence the weight of machine has to be increased.

4. The present design can cut the crops and can store it but there is no mechanism to separate the seeds from the plant.

   **Solution:**
   - We decided to make use of a threshing unit which can separate the seeds from the plant and it is attached just before the storage.

**PROBLEM STATEMENT**

To design and fabricate cereal crops cutting equipment.
2. OBJECTIVES

- Design should be ‘Simple’ to operate and ‘Safe’.
- It should have ‘Low Cost of Maintenance’.
- It should require Less Man Power.
- The design should be Robust and Reliable
- The design should consist of a threshing unit.

3 METHODOLOGY

Methodology is the Systematic, Theoretical analysis of the methods applied to a field of study or the theoretical analysis of the body of methods and principles associated with a branch of study.

1. Studying the present design
2. Identifying the potential problems
3. Field survey
4. Problem definition
5. Literature review
6. Methodology
7. Establishing functions
8. Generate multiple solutions
9. Selecting best solution
10. Analysis and fabrication
11. Testing
12. Documentation
3.1 Studying the present design

The project started by studying the present design. The problems pertaining to present design are listed. Out of all the problems few important problems are identified and considered for further development.

Identifying the potential problems

After studying the present machine we identified some of the problems and out of them some important problems are considered for further improvement. Few important problems are it doesn’t have prime mover, it doesn’t have turning mechanism, it doesn’t have thresher unit, it doesn’t have proper crop cutting mechanism.

Field survey

After identifying the problems in the present machine field survey was conducted. Field survey is conducted in five places namely Chincholi (Gulbarga District), Byahatti, Kundagol, Sutagatti, Dharwad (agricultural university). From field survey we identified some of the elements which must be present in new machines. They are threshing unit, the movement of the wheels are to be derived from prime mover, the motions for other components are to be derived from diesel engine.
**Problem definition**

From studying the present machine its limitations and by field survey inputs we framed our problem definition as “To design and fabricate cereal crops cutting equipment”.

**Literature review**

Literature review is done to solve the problems which are identified in studying the present machine and to fulfill the input taken by field survey. For that we referred some papers namely “Conceptual design of a chickpea harvesting header”, “Fundamental Limits in Combine Harvester Header Height Control”, “Integrated Robust Optimal Design (IROD) of Header Height Control System for Combine Harvester”, “Nonlinear System Identification on a Combine Harvester”. We also referred some literatures on diesel engine and some literatures regarding how actually harvesting of chickpea done.

**Methodology**

Methodology followed

- Studying the present design
- Identifying the potential problems
- Field survey
- Problem definition
- Literature survey
- Methodology
- Establishing functions
- Generating multiple solutions
- Selecting best solution
- Analysis and fabrication
- Testing
- Documentation.

**Establishing functions**

- Cutting the crops
- Transferring the crops
- Separating the seeds and the crops
- Collecting the seeds

**Generate multiple solutions**

Multiple solutions are generated to overcome problems which are identified by studying the present design and field survey. We generated four alternatives with the help of morphological chart. We generated alternatives for different cutting mechanisms and with the petrol engine and diesel engine as prime mover.

**Selecting best solution**

With the help of evaluation matrix chart scoring and problems identified when studying the present design and field survey keeping this in we identified the best solution which solves the problems.
Analysis and fabrication

Analysis of the chassis of the model is analyzed using an analysis software Ansys. The total force acting on the chassis is considered and analyzed. The fabrication of the model is done in local industry i.e Dani industries.

Testing

The model developed, will be tested using the concepts of design of experiments. Each sub model will be individually checked on different factors and the desired responses are measured. Then the models overall working is tested in the field.

Documentation

DESIGN ALTERNATIVES

Alternative 1

Alternative 2

Cutter mechanism
Alternative 2

Cutter mechanism

Alternative 3

BEST SELECTED DESIGN- ALTERNATIVE 3
FABRICATION

The fabrication of chick pea harvester is carried out in different steps of completing each part and main parts of harvester are as follows.

1. Frame

2. Primary thresher.


4. Sieve plate (vibrator).

5. Blade holder.

6. Blade (cutter)

7. Conveyor.

Finished model of cereal crops cutting equipment
5. Conclusion

The harvester developed is just proof of concept. This has to still undergo a detailed analysis of components used. The new design of the cutter bar is to be tested and changed as per the requirements. The innovative three stage threshing mechanism will result in a yielding good quality seeds. As the machine is designed to run on diesel engine it does not require an external agent to drive it (power tiller or tractor). The machine can be operated by single labor. The machine will eliminate the labor problem and struggles of labor in cutting the crop. This machine will serve a great deal for small scale chickpea cultivators.

6. Future Scope

Though the machine has some innovative concepts, there is still a lot if scope for development like

- The machine has to be provided with gear box for different speed ad torque generation.
- The machine can be made lighter by doing detailed analysis of the design and removing excess material wherever it is not necessary.
- There is lot of space wastage in the threshing unit, the design of the components should be meticulously refined.
- With minimal modifications this machine can be used for harvesting of different crops.
- Additionally provision can be provided of connecting to a tiller or tractor instead of the diesel. (for the farmers who already own a tiller or tractor)
- A better and large storage unit has to be provided to collect the seeds.
- The flow of the unwanted crop waste is to be made more efficient.