CHAPTER - I
INTRODUCTION

1.1 General

Agriculture in simple words, may be defined as a large-scale process of cultivating land or raising stock for producing food, feed, fibre and other desired products. Agriculture has remained traditionally the most important economic activity in our country, that a majority of the rural households are directly or indirectly dependent on agriculture is an established fact. After independence, agricultural production has been brought up by bringing additional area under cultivation, extension of irrigation facilities, use of better seeds and modern seed placement techniques, water management and plant protection. Agriculture has made rapid strides since independence i.e. From food shortages and import to self-sufficiency and exports, from subsistence farming to intensive and technology lead cultivation.

Agricultural mechanization has contributed in savings in seed, fertilizer, time and labour requirement and has lead to increase in cropping intensity and higher productivity. Also, it has reduced drudgery of farm workers, especially that of women is substantial (Pandey, 2008).

The average farm size in India is small (1.16 ha) while small and marginal land holdings (less than 2.0 ha) account for 85 % of land holdings. The combine share of agricultural workers and draught animals in total farm power availability in India reduced from 60.8 % in 1971-72 to 10.1 % in 2012-13. The average farm power availability needs to be increased from 1.84 to 2.5 kW/ha by 2025 to assure timeliness and quality in field operations. The available farm power and productivity in India are expected to reach 2.2 kW/ha and 2.3 t/ha, respectively by the year 2020. Therefore, India adopts a policy of selective mechanization under diverse conditions, which makes the agricultural mechanization a challenging task (Mehta and Chandel, 2016).

1.2 Sugarcane

Sugarcane (Saccharum officinarum) is an important cash crop mostly grown in tropical and subtropical countries of the world. Sugarcane is cultivated between 32° N
to 32° S latitude covering more than 90 countries of the world. In India, sugarcane is grown between 70° N to 32° S latitude covering large variation in climate, soil crop spread and productivity (Kumar and Tripathi, 2015). In India, Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu and Gujarat are the main sugarcane producing state. Sugarcane crop is pride of Gujarat state and plays a vital role in agricultural economy of the state.

Sugarcane is a perennial grass that forms lateral shoots at the base to produce multiple stems, typically 3 to 4 m (10 to 13 ft) high and about 5 cm in diameter the stems grow into cane stalk, which when mature constitutes around 75 % of the entire plant. A mature stalk is typically composed of 11-16 % fiber, 12-16 % soluble sugars, 2-3 % non-sugars, and 63-73 % water. A sugarcane crop is sensitive to the climate, soil type, irrigation, fertilizers, insects, disease control, varieties and the harvest period. The average yield of cane stalk is 60-70 tonnes per ha per year. However, this figure can vary between 30 and 180 tonnes per hectare depending on knowledge and crop management approach used in sugarcane cultivation. Sugarcane is a cash crop but it is also used as livestock fodder (Perez, 1997).

### Table 1.1: State wise Area, Production and Yield of Sugarcane (FAO, 2016)

<table>
<thead>
<tr>
<th>State</th>
<th>Area (Million ha)</th>
<th>Production (Million tonne)</th>
<th>Yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uttar Pradesh</td>
<td>2.23</td>
<td>135.16</td>
<td>60665</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>0.94</td>
<td>76.55</td>
<td>81702</td>
</tr>
<tr>
<td>Karnataka</td>
<td>0.42</td>
<td>35.91</td>
<td>85500</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>0.33</td>
<td>31.76</td>
<td>97007</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>0.19</td>
<td>15.36</td>
<td>80000</td>
</tr>
<tr>
<td>Bihar</td>
<td>0.27</td>
<td>13.48</td>
<td>50740</td>
</tr>
<tr>
<td>Gujarat</td>
<td>0.17</td>
<td>12.55</td>
<td>72126</td>
</tr>
<tr>
<td>Haryana</td>
<td>0.10</td>
<td>7.45</td>
<td>73000</td>
</tr>
<tr>
<td>Uttarakhand</td>
<td>0.10</td>
<td>6.43</td>
<td>61846</td>
</tr>
<tr>
<td>Punjab</td>
<td>0.09</td>
<td>6.31</td>
<td>70918</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>0.07</td>
<td>3.31</td>
<td>46621</td>
</tr>
<tr>
<td>West Bengal</td>
<td>0.02</td>
<td>1.71</td>
<td>100294</td>
</tr>
<tr>
<td>Assam</td>
<td>0.03</td>
<td>0.97</td>
<td>33414</td>
</tr>
<tr>
<td>Odisha</td>
<td>0.01</td>
<td>0.94</td>
<td>65951</td>
</tr>
<tr>
<td>Others</td>
<td>0.04</td>
<td>2.14</td>
<td>53500</td>
</tr>
<tr>
<td>All India</td>
<td>5.01</td>
<td>350.02</td>
<td>69838</td>
</tr>
</tbody>
</table>
Gujarat is the seventh largest sugarcane producing state in India and account for about 3% of total sugarcane production in the country (Anon., 2017a). Sugarcane is grown in a large area in Gujarat, which is more than 0.17 million ha of land. Surat, Navsari, Bharuch, Valsad, Junagadh and Bhavnagar are some of the major sugarcane producing districts in Gujarat. The Sugarcane production in Gujarat is about 12.55 million tons (FAO 2016).

1.3 Package of Practices for Sugarcane Crop

1.3.1 Types of soil and soil requirements

Soil is a medium for plant growth. It provides nutrients, water and anchorage to the growing plants. Maintenance of proper physical, chemical and biological conditions of the soil is necessary for realizing higher growth, yield and quality of sugarcane. A well-drained, deep, loamy soil with a bulk density of 1.1 to 1.2 g/cm$^3$ (1.3-1.4 g/cm$^3$ in sandy soils). The optimum soil pH is about 6.5 but sugarcane can tolerate considerable degree of soil acidity and alkalinity (Anon., 2013).

1.3.2 Climate

Sugarcane grows well in climate with extremes of high or low temperatures. Growth is closely related to temperature. Optimum temperature for sprouting (germination) of stem cuttings is 32° to 38°. Ripening, however, relatively low temperatures in the range of 12° to 14° are desirable, since this has a noticeable influence on the reduction of vegetative growth rate and enrichment of sucrose in the cane (Anon., 2012).

1.3.3 Varieties

Different varieties like Co 775, Co 975, Co 671, Co 8338, Co 7527, Co 6304, Co 8021, Co 62175, Co 8011, Co 740, Co-85004 and CoC-86008 etc (Anon., 2017b). are cultivated as a kharif Sugarcane varieties and Co-86032, Co-8021, CoLK8001 etc. are cultivated as summer sugarcane varieties. Surat as a region of state is a major producer of sugarcane crop.

1.3.4 Season

In India, sugarcane is planted thrice a year in October (autumn), February-March (spring) and July (adsali). Spring cane is planted in February-March in Uttar Pradesh and January February in Gujrat and also in Bihar (Anon., 2009).
1.3.5 Planting and ratooning

The popular planting method in the Gujarat State is ridge and furrow. In this system of planting a single, two and three eye buds are used with 120 cm distance between furrows in heavy soil and 105 cm distance in light to medium soil. Planting is done by placing sets in the furrows. It is helpful in aeration, sunlight, and field operations (Anon., 2017c). Moreover, it is popular amongst the farmers for ease in management. Sugarcane as perennial crop requires more than a year in field. It is important to prepare land by deep ploughing for planting crop. In such case ratoon sugarcane production is comparatively less. Therefore, to obtain satisfactory yield from ratoon sugarcane proper ratoon management is necessary. Ratoon management consists of stubble shaving, off-barring, fertilizer application, and inter culturing operation. Ratooning is a method of harvesting a crop which leaves the roots and the lower parts of the plant uncut to give the ratoon or the stubble crop. The main benefit of ratooning is that the crop matures earlier in the season. Ratooning can also decrease the cost of preparing the field and planting. This method cannot be used endlessly as the yield of the ratoon crop decreases after each cycle. The successive rations are thinner and have lesser sucrose content. Ratooning is most often used with crops which are known to give a steady yield for three years under most conditions (Anon., 2017d).

Advantages of ratoon crop

1. No preparatory cultivation is required.

2. Saving in the cost of seed material.

3. Saving of labour since many operations such as collection of seed cane, cutting of the setts and planting are not undertaken in rations.

4. The leftover in the field especially in the form of fallen leaves, trash, etc., in due course of time gets converted in to organic matter.

5. Ratoon crops generally come to maturity at least one month early.

6. The expenditure involved in growing ratoon crops is less as compared to plant crop.
1.3.6 Irrigation

The amount of water required in each irrigation depends on soil type and temperatures during the growing season, besides methods of application. Irrigation is given at 8-14 days interval depending on types of soil and season.

1.3.7 Fertilizer requirement

The maximum rate of nutrient uptake (kg/ha/day) worked by Malavolta (1994) in sugarcane maiden crop versus ratoon crop has precisely established that the later requires higher nutrients. Evidently, the myth prevailing amongst the growers is that higher nutrients are required for the ratoon crop. The efficient nutrient amount needs to be added. So, more application of fertilizers to meet the requirements of all the essential nutrients will not achieve the vital objectives of plant nutrition. Also, fertilizer must be drilled and placed near root zone of the crop at proper depth and distance, concurrent with optimum nutrient ratios to achieve higher production. In addition, the conventional method for application of fertilizer by broadcast method in sugarcane crop as well as ratoon crop followed by the farmers expose the fertilizer to sunlight. The fertilizer application must be scheduled in order to meet the enhanced demand by the succeeding ratoon crop and reducing the production cost as shown in Table (1.2).

**Table 1.2: Maximum rate of nutrient uptake (kg/ha/day) (Malavolta,1994)**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Element</th>
<th>Plant cane 8-14 month (180 days) Kg/ha/day</th>
<th>First ratoon 4-8 months (120 days) Kg/ha/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>N</td>
<td>0.59</td>
<td>0.73</td>
</tr>
<tr>
<td>2.</td>
<td>P</td>
<td>0.08</td>
<td>0.11</td>
</tr>
<tr>
<td>3.</td>
<td>K</td>
<td>0.71</td>
<td>0.95</td>
</tr>
<tr>
<td>4.</td>
<td>Ca</td>
<td>0.45</td>
<td>0.33</td>
</tr>
<tr>
<td>5.</td>
<td>Mg</td>
<td>0.24</td>
<td>0.26</td>
</tr>
<tr>
<td>6.</td>
<td>S</td>
<td>0.16</td>
<td>0.31</td>
</tr>
</tbody>
</table>

1.3.8 Yield

The average yield varies between 60-70 tons/ha, depending on whether it is an irrigated crop or not (Perez, 1997). Once the cane has been treated, the yield in sugarcane be as much as 6-8 tons/ha for rain crops and 8-11 tons/ha in irrigated cultivation (Anon., 2017e).
1.3.9 Comparison between develop device and conventional method

In sugarcane cultivation, Indian farmers with large land holding capacity are using sugarcane harvester. Such practices become costly because of use of expensive machinery and also one of the major drawbacks of sugarcane harvester is the crop has to be planted newly after each harvest. In case of marginal and small-scale farmers, they harvest sugarcane manually. If it is a ratoon crop, the sugarcane cultivation can be economically affordable because almost 10–20 t/ha trash is remained in the field after sugarcane harvest which is usually removed or burnt for performing inter culturing and fertiliser application. Trash burning resulted in loss of organic carbon, plant nutrients such as N and S (Hemwong et al. 2009). and then application of fertilizer and secondary tillage operation are carried out separately by labour which results in wasting of time, money and requires increased man power.

So, there is a tremendous need of such stubble shaver cum fertilizer applicator. The machine will be operated in the field after about 5-8 days from the day of sugarcane harvesting. This machine will shave stubble of harvested sugarcane in uniform pattern and apply fertilizer. During operation, rotating action of cutting blade will trim non-uniform height of stubble into a uniform height, simultaneously fertilizer is also being applied by means of ground wheel- rotor assembly. Ground wheel rotor assembly consists of a ground wheel, two shafts and a rotor mechanism by which fertilizer is applied. The shaft of metering mechanism gets drive from ground wheel with help of chain and sprocket. The rotor cups are exposed to the fertilizer which takes fertilizer from the auxiliary box and delivers to the opening of fertilizer tube. Further it is delivered to the fertilizer tubes which are attached to the boot at rear side of the tynes. This machine also pulverizes soil by means of the cultivator tynes included in off barring system. The cultivator tynes of off barring system are used because it penetrates into the soil so fertilizer is applied at uniform depth. As mentioned above stubble shaver cum fertilizer applicator will perform three operations of stubble shaving, fertilizer application and secondary tillage (cultivation) at same time.

By using these equipment, the following benefits can be avail.

- Better crop management
- Better germination
- Labour saving
- Timely operation
• Save time
• Reduce cost
• Three operations at same time
• Increased production and improved economic condition of the farmer
• Water saving

1.4 Justification

Looking to the present situation of the sugarcane cultivation in India, especially in case those sprout; While harvesting manually, an uneven height of stubble remains after harvest because approach angle of harvesting knife varies vigorously while cutting. In order to overcome this problem of uneven height of stubble, it has to be shaved manually again.

Traditionally stubble shaving is performed manually and it had problems related to uniform height of stubble, had to perform three separate operations for stubble shaving, fertilizer application and off barring.

Plate 1.1: (a) Sugarcane harvesting done by manually and (b) after harvesting uneven height of stubble remain in the field

From discussion with farmers it was found that on an average 10 cm to 25 cm height of stubble remains in the field. This difference in stubble height leads to the development of tillers at different height, in turn, it yields the crops at widely varying heights while harvesting.

From reviewed research work it could be said that very limited work is carried out on the uniform stubble shaving of sugarcane. Stubble shaving and drilling of fertilizer are recommended within a week of harvest of sugarcane. But manual operation delays the whole cultivation process and it requires more labours.
To address all the above issues, a new prototype of tractor operated sugarcane stubble shaver was designed to perform multiple operations such as stubble shaving, off barring and placement of basal dose of fertilisers all to gather, while retaining the trash at the soil surface. Stubble shaver shaves the stubbles while off baring unit trims the root zone along the side wise of stubble and it forms a trench to place the fertilizer at uniform depth. The performance of the developed machine was evaluated.

The evaluation was conducted by comparing the conventionally existing manual method and newly developed mechanical method in terms of uniformity of operation, time and economic aspects.

Considering the aspects mentioned above, a study has been undertaken with the following objectives.

1.5 Objectives

1. To develop a tractor operated stubble shaver cum fertilizer applicator for sugarcane crop.

2. To evaluate the performance of the developed machine.

3. To work out cost economics of the developed machine.