Chapter 2

The Sugarcane: An Agriculture Aspect

2.1 Introduction

Sugarcane growing countries of the world are lying between the latitude $36.70^0$ north and $31.00^0$ south of the equator extending from tropical to subtropical zones. Sugarcane is renewable, natural agricultural resource because it provides sugar, besides bio-fuel, fibre, fertilizer and myriad of by-product with ecological sustainability [35].

Sugarcane juice is used for making white sugar, brown sugar and ethanol. The main by-products of sugar industry are bagass and molasses. Molasses, the chief by-product, is the main raw material for alcohol and for alcohol-based industries. Excess bagass is now being used as raw material in the paper industry. Besides, co-generation of power using bagass as fuel is considered feasible in most sugar-mills.

India is the world’s second largest producer of sugarcane and in a survey it is proved that sugarcane is the most remunerative crop and has a very high economic biomass to total biomass ratio in Indian economy.

2.2 Botany

Genetically, sugarcane originates from New Guinea. The sugarcane plant belongs to the grass family. Sugarcane is C4 plant with a high rate of photosynthesis (150-200% more compare to other plants). It is a perennial crop with high self tolerance. The plant tillers 4-12 stems, depending on the variety and site conditions, which can grow upto 3 to 5 meters. The sugar content in sugarcane plant fluctuates between 11 to
The main parts of the sugarcane plant are the Stalk, Leaf, and Root System as shown in Figure 2.1.

1. **The Stalk**: The sugarcane is propagated by stem cuttings, containing one or more buds. The sugarcane stalk consists of segments called joints, each joint is made up of a node and inter node. The node is the place where the leaf attaches to the stalk and where the bud and root primordia are present. Internodes of the sugarcane stalk are the sugar storage organs of the plant and vary in length and width widely with different varieties and growing conditions. The parts of sugarcane stalk are shown in Figure 2.2 and 2.3.

2. **The Leaf**: The leaves of the sugarcane are considered as the photosynthesis engine of the plant that generates the food for the growth by photosynthesis process in the form of glucose and sucrose. The leaf is divided into two parts as Sheath and Blade, separated by a blade joint. The leaves are usually attached
3. The Roots: Roots are the organs, responsible for taking up the water and nutrients from the soil, needed for plant growth. The roots of the plant provide structural support for the plant. Sett root and Shoot root are the main two types of the roots of the sugarcane. The sugarcane root system is special in the sense that the roots formed from the set dies off when the roots from the shoots start to develop. The root development is influenced by moisture, soil pores and nutrients [36].

2.3 Soil and Climatic Adaptation

2.3.1 Soil

Soil is a medium for supplying Air, Water, and Nutrient. Experimentally it is proved that high organic matter containing soil with; pH value of 7.5 to 8.5 is suitable for high yield and recovery of sugarcane. Sugarcane roots extend to 90 cm in depth and grow extremely well in medium to heavy soil to support the plant. Growth of the sugarcane will be poor in light sandy soils and water logged soils. To increase the yield
of sugarcane, in alkaline soil condition, researchers are recommending the dosages of Gypsum or Sulphur for soil reclamation.

### 2.3.2 Climatic Conditions

Sugarcane grows well in humid and hot weather. For more tillers it requires a temperature range of 30°C to 35°C and 70% of humidity for more vegetative growth. It needs a period of cool weather or a period of water stress for sucrose accumulation in the stems. Sugarcane in India is grown from 8° to 30° north latitude covering a wide varying range of climatic conditions and soils. The tropical region in the south of Vindhya, climatically best suited for sugarcane agriculture but subtropical region, north of the Vindhya is not suitable for the sugarcane agriculture due to higher temperature [37].

### 2.4 Sugarcane Varieties and Planting Season

#### 2.4.1 Sugarcane Varieties

Variety is the pivot around which the entire production revolves. Therefore, scientific sugarcane cultivation must start with choosing an appropriate variety after taking into consideration the agro climatic zone, the type of soil and the season concerned. For example, varieties of the sugarcane recommended after research and experiment in Maharashtra are Co-C671 and Co-86032, for high productivity and good sugar recovery.

#### 2.4.2 Planting Seasons

The duration of sugarcane crop in India ranges from 10-18 months, a 12 months crop is most common. Time of planting is governed by the weather conditions, Sugarcane requires about 25°C – 30°C temperature for good germinations. Spring and Autumn are two important planting seasons.

**Spring Planting**

In northern India spring planting is done in February-March, while in Peninsular India it is done in January-February. Spring planted crop is known as suru in Maharashtra and eksali in Gujarat and Andhra Pradesh.
Autumn Planting

This planting is very popular in northern India. It is done in September-October while in Bihar and Peninsular India in October-November. Autumn planting is also known as pre-seasonal planting in Maharashtra and Gujarat. The pre-seasonal crop matures in 13-15 months and supplies sugarcane in early crushing period.

Adsali Planting

In Maharashtra and Karnataka, adsali planting is done in July-August and the crop matures after 16-18 months. There is an increase in yield as well as sugar recovery because of extended growing season. The biggest advantage of adsali is that it passes through only one summer season. In the present scenario, the area under adsali planting is declining because of less availability of irrigation water.

Late Planting

Planting of sugarcane is delayed until harvesting of wheat in March-April, because wheat crop is cultivated on vast expanses in Rabi season in northern and central India. Research data has proved conclusively that delay in planting causes considerable reduction in the yield [38].

2.5 Seed Selection and Planting Methods

2.5.1 Seed Selection

Though the yield of the sugarcane depends upon the variety, quality of seed is equally an important criterion. Sugarcane is propagated by cuttings of section of the stalks called sets. The set should be fresh and juicy, age should be of 9 to 10 months, it should be free from pests and diseases, and eye buds should be fully developed. The distance at the sides of the node must be more than 2.5 inch in single node planting, so that the stalk will not evaporate, if water stress condition occurs [39].

2.5.2 Planting Methods

Following are the different planting methods of the sugarcane based on the type of soil and seed requirement.
Ridge and Furrows Method

Normally sugarcane is planted on ridge and furrows method by using three eyed (bunded) sets. Furrows are opened at every 75-90 cm according to the soil type. For this method 3.5 to 4 MT seed is required per hectare. For maintaining optimum plant population and easy management and for higher production, a row method of sugarcane planting is developed instead of conventional method of planting. Nowadays, planting is done by two eyed sets keeping 4-6 cm distance between two eyed sets. For this type of planting 2-2.5 MT seed is required per hectare.

STP (Spaced Transplanting) Method With Single Eye Set

Of late, in STP method single eyed sets are used for planting. Direct sets or seedlings grown in polythene bags in nurseries are transplanted into the field after 50-55 days. For this STP method 750 kg- 1MT seed per hectare is required, which saves seed cost by 60-70%. The distance between two sets kept at 30 cm during the plantation. This method is more economic and widely used.

Paired Row Method

In pair row method of planting cane sets are placed in subsequent two furrows and next furrow kept free of sets. In paired row method row to row distance varies from 2.5-3 feet depending upon soil type. In this method there is an advantage of saving in seed cost. Also growing intercrop in the space between the pairs is used to improve the sustainability of farming. Hence the crop management becomes easy. The crop gets sufficient sunlight and hence grows faster.

Wide Row Method

This is the new method of planting and is carried out in alternate furrows, leaving a row to row distance of about 150 cm results in efficient irrigation [40].

2.6 Sugarcane Management

The growth rate of sugarcane depends on the quality of seed selected, soil type and atmospheric conditions. Generally the growth stages and their duration are as below:

1. Germination - 15 to 30 days after planting
2. Till- ring - 31 to 120 days
3. Grand Growth Phase - 121 to 210 days
4 Maturity - 211 to 365 days

Each set of sugarcane contains one or more buds and circle of small dots above the node which are the root primordia. While germinating, the buds develop into primary shoot and the primordia develop into set of roots. The set root initiation and extension requires continuous presence of moisture in the top soil.

Till-ring is the major yield component affected by light, temperature, water and nutrients and density of planting. The number of stalk (stem) per unit area is the most important yield component hence till-ring is critical for high yields [41].

For high yield and good recovery, proper management of irrigation and fertilization rate is essential upto heavy soil stage. It is also important to identify, monitor and control the nutrient deficiencies, stress, diseases, and weed in the field.

2.7 Precision Farming Practices in Sugarcane

In India, 35 million farmers grow sugarcane and rely on sugarcane farming for their livelihoods. Another 50 million people depend on employment generated by the sugarcane farming. During the last 10 years, sugarcane production in India has fluctuated in between 233 to 355 million tons per year. It is also observed that the productivity at the farm level is as low as 40 tons per hectare. Unless sugarcane growing farmers are introduced to new methods for producing higher yield using Precision Farming it is difficult for them to meet with the production cost and profit ratio. To implement the modern technology for sugarcane agriculture a detailed study of sugarcane management is essential.

The growth stages of the sugarcane are germination, till-ring, grand growth phase and maturity. In germination stage, the buds develop into primary shoot and the primordia develop into set of roots, hence good quality seed is essential for the fast germination rate of bud. The set root initiation and extension requires continuous presence of moisture in the top soil.

Till-ring is the major yield component affected by light, temperature, water and nutrients and density of planting. The number of stalk (stem) per unit area is the most important yield component hence tillering is critical for high yields. For high yield and good recovery, proper management of irrigation and fertilization rate is essential upto heavy soil stage along with monitoring the growth of the sugarcane. It is also impor-
tant to identify nutrient deficiencies, monitor and control the stress, diseases, and weed in the field. Nutrient deficiency and stress can be identified by measuring chlorophyll content of leaves. Weeds in the field are controlled by mechanically or by applying weedcides in proper amount.

At the grand growth and maturity stage, sugarcane is less affected by diseases and deficiencies hence only water management is sufficient during this stage.

The various types of diseases that affect sugarcane determine the quality, quantity and stability of yield. The diseases in sugarcane not only reduce the yield but also affect the quality. Excessive use of pesticides for plant diseases treatment increases environmental degradation. Also pesticides are among the highest components in the production cost, so their use must be minimized. This can be achieved by measuring disease severity and target the diseases places, with an appropriate quantity and concentration of pesticides.

Thus advancement in sugarcane agriculture starts from the quality seed selection for proper planting methods and crop status management with efficient irrigation and fertilization, identification of stress and deficiencies, monitoring and controlling of weeds and diseases.

2.8 Concluding Remarks

In this chapter the physiology of sugarcane is discussed. Seed selection criteria, different planting seasons and methods are described. An overview of the Indian scenario of sugarcane cultivation is presented. Next chapter presents the basic concepts of the image processing system that is used in Precision Farming.