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Participant Handbook

Sector
Agriculture and Allied

Sub-Sector
Agriculture Crop Production

Occupation
Field Crops Cultivation (Cash Crop)

Reference ID: **AGR/Q0203, Version 1.0**
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Sugarcane Cultivator

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> Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission.

Shri Narendra Modi
Prime Minister of India

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AGRICULTURE SKILL COUNCIL OF INDIA

for

SKILLING CONTENT: PARTICIPANT HANDBOOK

Complying to National Occupational Standards of
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S.S. Ang

Authorised Signatory
(Agriculture Skill Council of India)

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It is expected that this publication would meet the complete requirements of QP/NOS based training delivery, we welcome the suggestions from users, Industry experts and other stakeholders for any improvement in future.

About this book

Sugarcane Cultivator is responsible for the cultivation and harvesting of sugarcane crop in a given piece of land. The sugarcane cultivator is also responsible for the selling of the harvested sugarcane. The Sugarcane Cultivator needs to adapt follow recommended practices for a particular agro climatic zone, type of soil, rainfall pattern and climatic conditions to achieve the best possible yield. This Participant Handbook is intended to enable the participant to prepare himself/herself for working as sugar cane grower both at small scale and for commercial purpose as per the Qualification Pack (QP). This book has emerged keeping in view the problems of producing a quality sugar cane being faced by the producer. Despite availability of extensive literature, the farmer faces the dilemma of when and how to use the information. Keeping in view the literacy level of the farmer, efforts have been made to represent the information through appropriate images and use of simple language. This would help in bringing more clarity of the functions and processes to be followed while cultivating the crop. This book should be used under the facilitation of trainer or facilitator to earn knowledge and skill in the sugarcane cultivation.

This handbook would enable the participant to implement the learnings by improving himself/herself in following critical pillars of success:

- **Knowledge and Understanding**: Adequate operational knowledge and understanding to perform the required task
- **Performance Criteria**: Gain the required skills through hands on training and perform the required operations within the specified standards
- **Professional Skills**: Ability to make operational decisions pertaining to the area of work.

The job requires the individual to have ability to work in the fields and have decision-making capability related to sugarcane cultivation. This handbook incorporates all the necessary information related to sugarcane cultivation. Besides the cultivation practices, this handbook is also an endeavor to develop communication and decision making skills to interface with various stakeholders in the production and supply chain system.

Symbols Used


Key Learning Outcomes


Steps


Time


Tips


Notes


Unit Objectives


Exercise

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1. Introduction

Unit 1.1 - Importance of sugarcane

Unit 1.2 - Morphology and growth phases of sugarcane plant

Key Learning Outcomes

At the end of this module, you will be able to:

- Understand and study the scope and opportunities of sugarcane crop cultivation
- Understand the role of sugarcane cultivator
- Classify agro-climatic conditions required for sugarcane cultivation
- Understand morphology of the sugarcane plant

UNIT 1.1: Importance of Sugarcane

Unit Objectives

At the end of this unit, you will be able to:

- Describe the economic importance of sugarcane
- Identify different species of sugarcane and understand breeding history
- Explain the different utilities of sugarcane

1.1.1 Importance of Sugarcane

Sugarcane (*Saccharum* spp.) is a tall perennial tropical grass. It belongs to the grass family Gramineae and genus *Saccharum* L. It is grown between 35°N and 35°S latitude from sea level to 1600 m above sea level. It is cultivated on a variety of soils around the world from loamy sand to clay. It requires a temperature of 24°C to 30°C and an evenly distributed rainfall/irrigation of 2000 mm for optimum growth. Thus, tropical climate is the most suitable for sugarcane cultivation. However, the sugarcane crop is also being successfully grown in subtropical areas. Sugarcane plant produces shoots (tillers) at the base, which ripen into un-branched stems, commonly known as cane stalks or canes, which are reservoirs of sugar accumulation in them. Nearly 60 per cent of the world sugar comes from sugarcane.

Sugarcane is mainly an industrial crop as the cane is supplied to sugar industries, where various products, from its juice are prepared by using a series of industry. The by-products from sugarcane further require some form of industry. Only a fraction of its production is used in small scale industry for making local Khandsari' and 'gur'. Sugarcane's products like sugar and fermented products are very important in making and preserving various kind of medicines like syrups, liquids; capsules etc. Sugarcane provides a juice, which is used for making white sugar, and jaggery (gur) and many by-products 1ike bagasse and molasses. Bagasse is used as a fuel, for production of fiber board, papers, plastics and furfural. Molasses is used in distilleries for the manufacture of ethyl alcohol, butyl alcohol, citric acid etc. Rum is the best potable spirit made from molasses. Molasses, also, is used as an additive to feeds for livestock. Green tops of cane are a good source of fodder for cattle. Its remains are good manure in alkaline and saline soils. Press mud (filter cake), obtained during sugar manufacture, is used as fertilizer while bagasse is used as fuel in the sugar industry as well as for papermaking.

It is also used for chewing and extraction of juice for beverage purpose. The sugarcane cultivation and sugar industry in India plays a vital role towards socio-economic development in the rural areas by mobilizing rural resources and generating higher income and employment opportunities. About 7.5 percent of the rural population, covering about 45 million sugarcane farmers, their dependents and a large number of agricultural labours are involved in sugarcane cultivation, harvesting and ancillary activities

1.1.2 Different Species of Sugarcane

Sugarcane, *Saccharum* spp, is a strongly growing grass with a C4 carbon cycle photosynthetic pathway and a high chromosome number. It is indigenous to tropical South and Southeast Asia. Different species likely originated in different locations, with *Saccharum barberi* originating in India and *S. edule* and *S. officinarum* in New Guinea. The earliest known production of crystalline sugar began in northern India. The *Saccharum* genus was believed to consist of six major species, including two wild species *S. spontaneum and S. robustum* and four cultivated species, *S. officinarum*, *S. barberi*, *S. sinense* and *S. edule* (D'Hont et al., 1998; Irvine, 1999). However, there were controversial reports by Irvine 1999 mentioning the existence of only two *Saccharum* species: viz. *S. officinarum* and *S. Spontaneum*. The *Saccharum* genus together with related genera, such as Erianthus, Miscanthus, *Narenga*, and *Sclerostachya* were referred to as the ''*Saccharum* Complex'' (Mukherjee, 1999). Sugarcane [*Saccharum* spp.] is a perennial grass, belonging to the Poaceae family and Andropogoneae tribe, which is grown widely in tropical and subtropical regions. It is the highest yielding crop worldwide (Henry et al., 2010) and accounts for approximately 75% of the world sugar production (Bull et al., 1963; Dillon et al., 2007). The origin of modern sugarcane cultivars is from inter-specific hybridizations of domesticated species *S. officinarum* [$2n = 80$, $x = 10$], which is characterized by high sugar and low fiber content (Daniels et al., 1987) and the wild species *S. spontaneum* [$2n = 40–128$, $x = 8$], which is resistant to biotic and abiotic stresses (Panje et al., 1960; Silva et al., 1993). Modern sugarcane genotypes are highly polyploid and aneuploid with multiple alleles at each locus. The genome composition of sugarcane cultivars has been estimated as 85% from *S. officinarum* and 15% from *S. spontaneum* (D'hont et al., 1995). The genome complexity in *Saccahrum* spp. has made sugarcane and energy cane breeding cumbersome. The genotypes utilized over decades in earlier breeding programs are a limited number of *S. spontaneum* and *S. officinarum* clones, which has resulted in a narrow genetic base of sugarcane cultivars (Lima et al., 2002).

1.1.3 Brief History of Sugarcane Breeding in India

In British India, sugarcane was grown over a large area where soil and climatic conditions were not favourable for varieties of *S. officinarum*. The hardy indigenous varieties were adapted to these conditions, but their yield of sugar was very low. The problem of the breeders at Coimbatore, India, was to produce high-yielding varieties adapted to these conditions. During the first few years of breeding at Coimbatore a Javanese variety, POJ 213, was largely used as a female parent. It had to be given up, however, because of the susceptibility of its seedlings to mosaic, red rot, and smut. In recent years most of the parents employed are of Coimbatore origin. Coimbatore was the first station to deliberately use *S. spontaneum* (India) in crosses with *S. officinarum* (1912). It is remarkable that a commercial seedling, Co 205, was obtained from the first generation Co 205 has a fair sugar yield and is susceptible to mosaic. Its behaviour is in marked contrast to the behaviour of the F_1 seedlings of *S. officinarum* x *S. spontaneum* (Java), which have low sugar content and are immune to mosaic.

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All sugar cane species interbreed, and the major commercial cultivars are complex hybrids. In recent past a good number of improved sugarcane varieties have been developed through targeted approaches having desirable features like cane yield, quality and resistance to pests and diseases.

1.1.4 Nobilization of Cane: A Historical Land Mark

It was a gradual development, dependent upon a number of complementary discoveries and participated in by various investigators through a period of several decades. Calamities that threaten the very existence of the industry seem several times to have provided the stimulus for progress in the understanding of fundamental biological principles, and the Sereh epidemic is a noteworthy example. At the time of the outbreak, the leading variety in Java was the Zwart Cheribon (Louisiana Purple), which had little natural resistance and was the principal sufferer. The disease was especially refractory in yielding to study, and even today the etiology is obscure. It was discovered, however, that certain varieties, notably Chunnee brought from British India, were resistant. With this fact and the discovery - or more properly the presenting of convincing evidence-that certain varieties of sugarcane develop viable seeds, the means for solution of the *Sereh* problem suggested themselves. Chunnee is a very thin cane somewhat resembling the wild *S. spontaneum*. The planters of Java, accustomed to the large-barrelled, heavy-yielding tropical varieties, were prejudiced against it. As it was totally unacceptable as a substitute for the Cheribon and Preangce, crosses were attempted between these and the Chunnee. Some of the resulting hybrids were more to the liking of planters in habit and conformation, but still somewhat disappointing. Meantime, the industry was maintained because it was found that susceptible varieties grown in the mountains did not suffer from Sereh, and seed cane from this source planted in the valleys and on the coastal plain gave rise to plants acceptable to the mills as plant cane or first-year crops. However, the ratoons arising from the stubble of these plant canes suffered severely from Sereh. An expensive readjustment in methods of culture, involving transportation each year of cuttings or bibit from the higher elevations to the lowlands, was necessary. This enabled the industry to survive, but naturally it was distasteful to those engaged in commercial cane husbandry. A wild-growing or semiwild plant unaffected by Sereh was found on the lower slopes of Tjercmai, an extinct volcano. It was presumed' that this interesting plant, called Kassoer, resulted from natural crossing of Zwart Cheribon and Glagah, a form of *S. spontaneum*. The possibility that it was a disease-resistant cross provided a clue for the utilization of *Glagah* as well as *Kassoer* itself in crosses-a process later to become known as Nobilization of the more primitive, hardy, and disease-resistant forms of sugarcane. Following this, hundreds of thousands of seedlings have been produced and carefully tested by crossings and repeated back-crossings with numerous superior but susceptible noble varieties, and the system or method of breeding has resulted in varieties not only equal but infinitely superior to the *Zwart Cheribon* in the days before the *Sereh* epidemic. The impetus given to improvement of the cane because of these disease epidemics has continued to the present day but it cannot be claimed that they are solely responsible for such efforts in modern times. Other factors have played roles of almost equal importance.

Notes

UNIT 1.2: Morphology of Sugarcane Plant

Unit Objectives

At the end of this unit, you will be able to:

- Understand the morphology and growth phases of sugarcane plant
- Describe the structure of roots, stem, leaves, seeds and inflorescence

1.2.1 Morphology of Sugarcane Plant

Stem

The stem varies upto four meters in length and about five-cm in diameter. Its colour varies from green to yellowish-green, greenish-yellow or purple depending upon the variety but the colour usually turns purple if it remains exposed to sunlight. The stem may be stripped in some varieties. It is differentiated into 15- 20 joints, each comprising of a node and an internode. The node consists of a lateral bud (eye) lodged in the leaf axis. The root band consists of 2-3 regular to irregular rows of root primordia and a growth ring (meristematic zone). Generally, the nodes are spaced 15-25 cm apart but are much closer at the upper portion of the stem. The buds are arranged in two rows, occurring alternately on opposite sides of the stalk. Each bud consists of scales and meristematic tissue. The size, shape and position of the buds may vary with regard to nodes, which serve as varietal characters. The upper portion of the internode just below the node has a waxy band. In some varieties, the internode may also have ivory markings in the form of hair-like violet to purple lines running longitudinally on its surface or deep growth cracks (splits) or a bud groove.

For commercial production, the stem cuttings (setts or seed-pieces) with viable buds are planted to propagate the sugarcane plant. Primary shoots develop from the buds on the underground seed cuttings, which in turn give rise to secondary and tertiary shoots. These shoots (tillers) mature into cane stalks and constitute a clump or a stool (Fig 1.1.1). The underground portion of the stool (stubble) is composed of many short joints, each with an internode and a node. Every node has a bud, which facilitates propagation.

Leaf

Leaves are attached to the stem at the base of the nodes alternately, in two rows on opposite sides. Each leaf consists of two parts, a sheath and a blade. The sheath is tubular in shape but broader at the base. At first, it adheres closely to the stem but may loosen later on. The sheath is separated from the blade by the dewlap (collar or transverse mark). On the inner side of the transverse mark is present a membranous appendage called 'ligule' while the auricles or ligular processes occurs at either end of the ligule on the upper part of the sheath margin. These descriptors of plants are very useful in varietal classification and identification. Length and width of the leaf blade vary considerably in different varieties. Generally, leaf blade is often about a metre in length and 5 cm in width in many varieties. The leaf blade has a prominent mid-rib and spines on the margin of the blade. The leaf sheath may also have hair like bristles/ spines on its surface.

Roots

Two types of roots develop shortly after the sett is planted. The roots coming out of the root primordia (sett roots) are thin and branched. The germinating shoot initially depends upon these for its water and nutrient requirements. Later, this function is taken up by the roots formed by the tillers (shoot roots) while the sett roots die (Fig 1.2.1). Each shoot produces its own root system. The buttress roots developed from the bases/nodes of the young shoots are quite succulent and serve the function of anchorage for the plant.

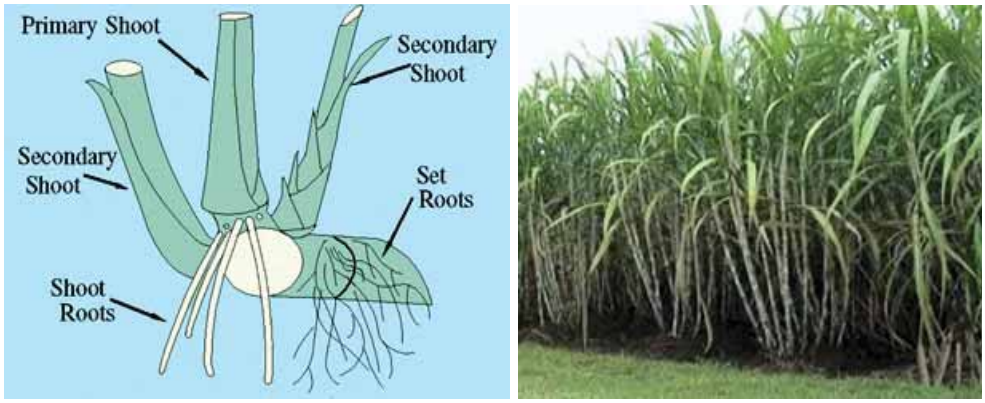

Fig 1.2.1 Root and shoot (clump) system in sugarcane plant

Inflorescence

When the cane reaches maturity, it changes from vegetative to reproductive phase. The terminal meristem ceases to produce leaves and is transformed into an inflorescence, which is a compound panicle called a 'tassel' or an 'arrow' (Fig 1.2.2). The sugarcane plant generally requires twelve and half-hours day length and 20°C-25°C night temperature for floral induction. It flowers profusely in south India, but only rarely under north Indian conditions. Flowering lowers juice quality.

Seed

The seed is monocotyledonous called caryopsis. It is very small in size (1 mm long) and yellowish brown in colour with a tuft of basal silky hairs for wind dispersal. The seeds, collectively known as 'fluff' or 'fuzz' (Fig 1.2.2), soon loose viability but if freeze dried, these retain viability for quite a long period. The seeds are sown in small nursery beds to produce seedlings, which after transplanting are evaluated at different stages.

Fig 1.2.2 Sugarcane inflorescence (Arrow) and true seed (fuzz of fluff)

Exercise

1. Name cultivated and wild species of sugarcane.
Ans:_____

2. Sugarcane is an important industrial crop; comment.
Ans:_____

3. Why we grow sugarcane?
Ans:_____

4. Enlist different major sugarcane growing states of sugarcane.
Ans:_____

Notes