

SUGARCANE AND SUGAR-BEET SUGARCANE



Sugarcane and sugar-beet are two main crops that contribute approximately 56 and 44 per cent respectively of the total sugar production in the world. Sugarcane (*Saccharum officinarum* L.) is the main source of sugar cane in India and holds a prominent position as a cash crop. It occupies about 1.8 per cent of the total cropped area in the country. The area under sugarcane has been fluctuating from year to year. In the past decade, it has been swinging between 2 and 2.7 million hectares. The maximum crystal sugar produced so far is 4.26 million tonnes in any one year. Uttar Pradesh has the largest acreage under sugarcane, and it is about 57 per cent of the area under this crop in India and accounts for 47 per cent of the annual production in terms of raw sugar. But the production per hectare is highest in Karnataka (Mysore State), followed by Maharashtra and Andhra Pradesh.

SOIL. Sugarcane grows best on the medium heavy soils, but can also be raised on the lighter soils and heavy clay, provided there is adequate irrigation available in the former type of soils and drainage is good in the latter type of soils. In northern India, it is cultivated largely on the loams and clay loams of the gangetic and other alluviums, whereas in Peninsular India, it is grown on brown or reddish loams, laterites and black cotton soils. In many places, dark rich clay loams, 120 to 150 cm deep, and lying on a previous substratum of murum (disintegrated traprock) are used for this crop. The provision of proper drainage enables the resumption of cane cultivation on many heavy soils that may have become unfit for this crop owing to water-logging or alkalinity. In some areas in Peninsular India, where the soils are heavy, 70 to 100 cartloads of sand or red earth are added to the soil per hectare to improve its texture. Similarly, in sandy soils, tank silt is added to improve their water-holding capacity.

CLIMATE. Sugarcane is able to grow over a prolonged season. Under warm humid conditions, it can continue its growth, unless terminated by flowering. However, its height is strongly influenced by the age of the crop and seasons. Temperatures above 50° C arrest its growth; those below 20° C slow it down markedly and severe frost proves fatal. The crop does best in the tropical regions receiving a rainfall of 750 to 1,200 mm. It can also be grown in sub-tropical areas, but where the climate is subject to extremes, and dry season is long, the growth period of the crop is restricted to a bare four months in the year and yields, tend to be distinctly lower than those in the tropics. In tracts receiving a relatively high rainfall (1,200 to 1,500 mm), e.g. in parts of Uttar Pradesh, Bihar, Orissa, West Bengal and Assam, the crop is grown without irrigation and thrives on the moisture conserved in the soil. For ripening, it needs a cool, dry season; but where rainfall is too heavy and prolonged, the quality of the juice tends to be low, and where the weather remains comparatively warm and moist throughout the year, it does not ripen well. In years of drought, the crop becomes a little fibrous and in the dry areas generally, only the harder and more fibrous varieties can be grown. The climatic conditions of Maharashtra and parts of Karnataka, and the Telengana area of Andhra Pradesh are ideal for sugarcane; in some of these areas, its yield per hectare has shown a steady increase owing to improved culture. The acreage under sugarcane has also increased.

PREPARATORY TILLAGE. Sugarcane requires a very thorough and clean preparation of land. In Peninsular India, where sugarcane soils are mostly clays and clay loams, one or two deep ploughings and one cross-ploughing with a mould board plough are necessary. These operations should be followed by clod-crushing with a discharrow, or a junior cultivator or a beam clod-crusher or even with wooden mallets and stout sticks. In the alluvial loams of northern India, cultivators usually prepare their fields after winter rains, but when these rains fail, the fields are given a preparatory irrigation. After it, when the soil comes into vattar (right stage of moisture) it is cultivated quickly and thoroughly with a desi plough till it is reduced to a fine tilth. In Bihar, the fields meant for cane are left fallow during the preceding monsoon and are cultivated at intervals up to the time of planting cane. All this is done in order to conserve moisture and keep down weeds.

Cattle manure, compost and other slow-acting bulky organic materials are usually applied to the soil and incorporated into it well in advance of planting. This practice helps to decompose the manure and makes the nutrients available. Where cane is green-manured, the leguminous crop should be ploughed under about a month before planting the cane. In northern India, however, where a cold season intervenes, the green-manure crop is ploughed under in September and cane is planted several months later.

Sugarcane is planted either in furrows or trenches. Depending on the method of planting and the fertility of the soil, furrows or trenches are made half to one-and-a-half metres apart. Comparatively narrow spacings are adopted in northern India, where yields are usually low, whereas wider spacings are common in Peninsular

India where the aim is to obtain high yields. Furrows are made with a padded desi plough in northern India and with a heavy double mould-board ridger in Peninsular India. Furrows made with the desi plough are quite shallow, being about 10 cm deep, whereas those made with a ridger are about 20 cm deep. Where trench-planting is adopted, trenches are dug by hand-labour, using pick-axes and spades, and may be up to 25 cm deep. On large farms, all preparatory cultivation, including ploughing, clod-crushing, harrowing, and ridge-making are mechanized.

The adequacy of moisture is very necessary for the setts. In Peninsular India, arrangements for irrigation are made well before planting. In northern India and in Bihar, care is taken to conserve as much moisture in the soil as possible, so that the planted cane is able to germinate satisfactorily. All the same, as the planting is necessarily done during the comparatively dry season, considerable loss of moisture from the soil and sets takes place, and usually only 30 to 40 per cent of the buds germinate.

SEED. Healthy seed material, free from pests and diseases, and having high viability is essential for establishing the crop in the first instance. The top one-third to half portion of a cane, being comparatively immature, has buds of good viability and is best to be used as seed. The bottom portion is usually richer in sugar than the top portion, and it is best to utilize it for sugar or gur-making. In tropical India, setts for sowing are taken from well-manured, erect and healthy canes. In some places in Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu, crop nurseries are adequately fertilized, and well protected against pests and disease.

Before planting, the leaves of the cane stalks are stripped off by hand in order that buds on them may not be damaged. These stalks are then cut into 3-bud setts each usually 30 to 50 cm long. If seed is required at a distant place, whole canes should be transported without stripping off the leaves or cutting them into setts. If planting is for any reason to be delayed, but the seed canes have been harvested, they should be heaped in shade under a thick cover of straw or cane trash, and periodically sprinkled with water. Under the dry condition of northern India, the soaking of seed in water for four to six hours before sowing improves and hastens germination. Under irrigated conditions in Peninsular India, the planted setts are liable to rot, and in some areas they are attacked by the pineapple disease. To prevent rotting and infection with the disease, the dipping of the setts into a suitable fungicide, such as 0.5 per cent mercuric chloride or 0.25 per cent Aretan or Agallol solution or 1 kg of Perenox in 400 litres of water is recommended. Aretan, along with gamma BHC, is also recommended in northern India; the former improves the germination and keeps off fungal attack and the latter keeps off termites is serious, gamma BHC at 1 kg actual ingredient per hectare in emulsion form and diluted 300 times is sprinkled with a watering-can on the setts placed in the furrows.

Depending on the distance between the rows and the vigour and soundness of the buds, 25 to 35 thousand 3-bud setts are usually enough to plant a hectare. According as the cane is thick or thin, 1 1/2 to 3 tonnes of cane by weight is needed to provide about 10,000 3-bud setts. In the Punjab, Haryana and western Uttar Pradesh, 2-bud setts planted in rows, about 60 cm (about two feet) apart, have been found to give the best results. In the case of late planting, the seed-rate is often increased slightly, and the setts are planted a little closer in the row in order to guard against gappy germination.

IRRIGATION. In the case of sugarcane, the maintenance of optimum soil moisture during all stages of growth is one of the essential requisites for obtaining high yields. The crop should, therefore, be grown in areas of well-distributed rainfall or under an assured and adequate irrigation. In tropical India, depending on the type of the soil, the seasonal conditions, the variety grown, the method of planting and the rate of manuring, the total water requirement of the crop for optimum growth varies from 200 to 300 cm, inclusive of rainfall. The requirement of an adsali crop is proportionately higher. Where the soil is not retentive of moisture, and where there are no reserves of subsoil moisture, cane requires to be irrigated frequently.

In tropical India, usually one or two waterings are given at intervals of three or four days after planting to help the setts to germinate and the seedlings to establish themselves. Thereafter, in the absence of rains, cane is irrigated every 10 to 12 days during its growing period. In dry areas and in sandy-loams soils, irrigations may be needed at intervals as short as eight days. In deep clay loams, irrigation can be withheld for longer periods, say, up to two or three weeks. Frequent light irrigations, each 40 to 50 mm, adjusted to suit the growing period of the crop and the prevalent weather conditions, are very useful. Towards the time of harvesting, irrigation frequency is reduced, and just before harvest, irrigation is withheld for about a month.

In northern India the summer being drier and hotter the crop needs water more frequently than in southern India, but actually, adequate water for frequent irrigation is not available and irrigations are, therefore, usually given at comparatively long intervals. In canal irrigated areas, the frequency of irrigation depends entirely on the running of the canals. The severity of these conditions is slightly mitigated by the high water-holding capacity of the alluvial loam soil. In the Punjab State because of the lower rainfall, drier climate, and slightly coarser soils, the crop gets 8 to 10 irrigations during summer. In central and western Uttar Pradesh three to five irrigations are usually given, and they help the crop to tide over the summer. In the eastern Gangetic areas, cane subsists almost entirely on subsoil moisture and rainfall, and receives no irrigation at all. In the post-monsoon season the crop receives only one or two irrigations or none at all; however these post-monsoon irrigations only help to keep the crop in good condition, for cane does not make growth in winter. In areas where frost occurs, irrigations are applied to save the crop from them. Sugarcane responds to irrigation in northern India as it does in the south and it is profitable to apply frequent light irrigations to the crop during the hot weather. Where irrigation facilities are scarce in summer, trash-mulching in the interspaces of the cane rows is done for conserving the soil moisture.

INTERCULTURE AND AFTER-CARE. The first hoeing and weeding should be given to the crop three to four weeks after planting. But in northern India, usually the shoots take a long time to emerge and meanwhile the weeds, particularly the nutgrass come up rapidly in the planted field. This rapid infestation of the sown field calls for at least one blind hoeing which may have to be given within the first one or two weeks. After germination, depending on the field conditions and the frequency of irrigation, two or three more hoeings and weedings may be required during the first three months afterplanting with the coming up of the crop. Where cane is planted in furrows or trenches these are gradually filled up in the course of interculture. The use of bullock-drawn implements, like blade harrows for mulching, junior hoes for interculture and weeding and ridgers for earthing up and covering the fertilizer, lessen the costs of these operations. The final earthing-up should be completed before the monsoon rains, and should generally synchronize with the application of the final dose of fertilizer. Good care in weeding and interculture helps the clumps to tiller early and form canes. The crop should be so managed that it grows rapidly to form a canopy over the interspaces. This shading helps to keep down the weeds, the moisture loss from the soil surface.

Where the aim is to get crops of 75 tonnes and over per hectare, it is usual to earth up the standing crop in the rows. But whether the crop is earthed up or not it is very desirable to tie up the canes so that they may not sway during winds, and lodge. The best way to do the tying is to bring together the stalks from adjacent rows and tie them together with their own trash and old leaves. In many places in southern India, cane is tied at two or three levels with twist of cane trash, the twistline going from one end of the row to the other; sometimes the stalks are further propped up with bamboos. Many times they sow castor or arhar (tur) seeds around a planted field of cane. This acts as a wind-break.



SUGAR-BEET

Introduction. Sugar-beet (*Beta vulgaris* L), another important sugar-producing crop in which sugar is stored in roots, is purely a creation of plant-breeding. It accounts for nearly 44 per cent of the world's sugar production. Unlike sugarcane, which is a crop of the tropics, sugar-beet is essentially a crop of the temperate regions. Genetic and agro-technological improvements have now extended its frontiers to higher latitudes of subtropics as an irrigated winter crop. In countries, such as Syria, Iraq, Iran, Algeria and Israel, sugar-beet is fast assuming and of commercial importance. More recently, its cultivation has been extended to Pakistan. Sugar-beet is now in the experimental and semi commercial testing in subtropical India. In the Kashmir Valley sugar-beet holds out a promise as a rain-fed spring-sown crop.

Winter sugar-beet is a 6-7 month crop, sown in October and harvested in April and May. It is capable of yielding 35-45 tonnes of roots per hectare with a root-sugar content of 15 to 16 per cent. Sugar-beet thus opens up avenues for extending the working season of the sugar-mills of the Indian subtropical regions till the end of May and for generating beet-based sugar-processing capacities at high altitudes in the country.

A beginning has now been made to raise sugar-beet on a commercial scale in the Sriganagar area in Rajasthan and beet-sugar was made in the Ganganagar sugar-mills. In addition to sugar, the by-products from sugar-beet, viz. beet-pulp and molasses are highly valued as cattle feeds and for special fermentations and pharmaceuticals respectively.

Agro-climatic requirements. The northern and north-western region of subtropical India comprising Punjab, Haryana, Rajasthan and western Uttar Pradesh are potential areas for winter sugar-beet in the country. The Kashmir Valley has a good scope for the generation of a beet-based sugar industry.

Agronomy for sugar-beet cultivation

Soil. Sugar-beet grows best in loams and clayey loams with a near neutral reaction. It has a high tolerance to soil salinity and alkalinity but does poorly in acid soils. Poorly drained or water-logged soils are unsuitable for sugar-beet cultivation.

CROP ROTATION. Sugar-beet is susceptible to a number of soil-borne diseases. Their control through chemicals is difficult, costly and therefore, a long rotation to prevent the build up of diseases is of considerable importance as a prophylactic measure. A three to five year rotation would be the minimum (for fodder) sugar-beet, cotton-sugarcane (plant)-sugarcane (ratoon); guar-companion cropping of sugarcane and sugarbeet-Jowar for fodder-wheat-maize-sugar-beet.

SEEDBED. Sugarbeet is sown in lines, about 50 cm apart, either on flat beds or ridges. The crop is sown before the end of October. The crop has poor tolerance to delays in sowing and sowing beyond October are detrimental to yield and sugar-content.

VARIETIES. The diploid variety 'Ramonskaya O6' is presently recommended for commercial cultivation. In addition to satisfactory yield. The production of seed for use in this country is established in case of this variety. Seeds of these varieties are also multiplied in the country in Kashmir valley by obtaining foundation seeds from Denmark.

SEED RATE AND SEED TREATMENT. About 10 kg of un-processed seed is sufficient to sow one hectare. Seeds of the varieties currently recommended for cultivation are multigerm yielding 3 or 4 seedlings per (seed-ball). To facilitate germination, soaked in 0.25% solution of a mercurial Aretan or Agallol overnight. This is done required quantity of seed in a cloth bag into the solution until the seed soaks up and then hanging the bag in the open. The seed can be sown when it is dry.

SOWING. Sowing is done by dibbling manually or by drilling. The seeds are placed rather shallow, that is about 3 cm deep. Cotton-seed drills are found useful for sowing sugar-beet. A push-type drill for sowing sugar-beet has been designed and fabricated at the Indian Institute of Sugarcane Research Lucknow, to sow sugar-beet on ridges as well as on flat land. Dry sugar-beet seed may be sown with a seed-drill, if immediately followed by irrigation. If ridge-sowing is adopted, ridges are made 50 cm apart and 15 cm high with a country plough or a ridger or a double-mould board plough.

THINNING. The multigerm seeds of sugar-beet give rise to a cluster of seedlings and hence it is necessary to thin them to maintain a single robust plant per seed-pocket. A within-row spacing of 20 cm between things should be maintained. Gap-filling by transplanting is not recommended in the case of this crop, since transplanted seedlings give malformed or 'fangy' roots with poor weight. The dibbling of fresh seed to fill the gap may be done immediately as soon as they are visible.

INFRASTRUCTURE. Sugar-beet has very poor tolerance to weed competition and hence the crop should be kept weed-free at least for the first two months of its growth. Herbicides such as 'Betanol' and 'Runeat', have given good control of weeds in sugar-beet. The earthing-up of the crop should be completed by December after the last top-dressing of the fertilizer.

HARVESTING. At the time of harvesting, a country plough is run along the sugar-beet rows on both sides. This operation facilitates the lifting of the roots with a slight pull of the KUDALI. The plants after uprooting should be freed from the adhering soil, but the roots should not be washed in water for cleaning, as this practice induces rapid deterioration. The roots must be topped clean. Leaves or leaf bases allowed to remain on the roots seriously affect the recovery of sugar.

SEED PRODUCTION IN SUGAR-BEET. Indigenous seed production is established by the National Seeds Corporation of India and commercial seed is produced in the Kashmir and Kalpa Valleys.

Processing of sugar-beet for sugar manufactures Sugar-beet, unlike sugar-cane cannot be processed by gur or khandsari and can only be used for vacuum-pan-sugar-production. Sugar-beet roots, deteriorates fast after harvesting and have to be supplied to the sugar-mills within 48 hours of harvesting. Stock piling is not possible even for a few hours and hence well co-ordinated plan of harvesting and supplying roots is of almost importance.

Sugar from sugar-beetroot is extracted by adopting the diffusion process in special diffusers based on the counter current technique. It is not possible to extract juice from the sugar beet roots with roller mills. The adoption of carbonation process only for clarification and carbonation with disguisers and related accessories are essential to process sugar-beet in the traditional sugar-cane-based sugar-mills in this country. Unlike with sugar-cane extraneous fuel is also required as it does not provide bagasse for use as fuel. However, the beet-pulp and molasses produced as by-products obtained from the manufacturing of beet sugar have a good market and should be expected to more than offset the extra cost on fuel in beet-processing. The establishment of a profitable outlet for the by-products is, therefore, an economic necessity with this crop.

By-products-of sugar-beet and their utilization Beet-pulp, a residue obtained after the extraction of sugar, is a highly valuable cattle feed and can largely replace barley grain in feed concentrates. Beet-pulp can be fed to cattle as fresh or as dried pulp. The mixing of molasses with pulp improves its palatability.

The beet molasses is used as a raw material for several special fermentations and is also a rich source of lactic acid, vitamin B and other pharmaceutical preparations.

Farm Industrial by-products of sugar-beet Beet-tops are a highly nutritious cattle feed and are known to improve the milk yield of cows. They, however, contain oxalic acid and, hence the feeding of fresh tops to cattle is contra-indicated. Sun-dried tops with an addition of 60 g of finely ground lime per 100 kg of the tops is recommended for use as cattle feed