1. Introduction

Sugarcane is a most important cash crop of India. It involves less risk and farmers are assured up to some extent about return even in adverse condition. Sugarcane provides raw material for the second largest agro-based industry after textile. The sugar industry is an instrumental in generating the sizable employment in the rural sector directly and through its ancillary units. It is estimated that about 50 million farmers and their dependents are engaged in the cultivation of sugarcane and about 0.5 million skilled and unskilled workers are engaged in sugar factories and its allied industries. The sugar industry in India has been a focal point for socio-economic development in the rural areas by mobilizing rural resources, generating employment and enhancing farm income.

There are 716 installed sugar factories (Co-operative-326, Private-347 & Public-43) in the country as on 31.01.2016, with sufficient crushing capacity to produce around 330 lakh MT of sugar.

2. Major Sugarcane Growing States

Sugarcane is grown in various states in subtropical and tropical regions of the country. Main sugarcane growing States are:

a) **Sub Tropical**: Uttar Pradesh, Uttarakhand, Haryana, Punjab, Bihar with an annual rainfall of 180 to 2000 mm. The climate ranges from humid, moist sub-humid and dry sub-humid to cold arid, semiarid and arid.

b) **Tropical region**: Karnataka, Tamil Nadu, Maharashtra, Andhra Pradesh, Gujarat, Madhya Pradesh with an annual rainfall of 602 to 3640 mm having moist to dry sub-humid and semi-arid to dry semi-arid climates.

3. Important regions/ zones for sugarcane cultivation in India:

Broadly there are two distinct agro-climatic regions of sugarcane cultivation in India, viz., tropical and subtropical. Tropical region shared about 45% and 55% of the total sugarcane area and production in the country, respectively. Sub-tropical region accounted for about 55% and 45% of total area and production of sugarcane, respectively.

3.1 Tropical Sugarcane region

The tropical sugarcane region includes the states of Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat, Madhya Pradesh, Goa, Pondicherry and Kerala. The coastal areas of A.P. and Tamil Nadu have high sugarcane productivity. Floods, water logging and diseases such as red rot are the main problems. In the tropical region climatic conditions are more favourable for its growth. It is cultivated with better package of practices and higher irrigation levels. The growing season is long with more equitable and favourable conditions without serious weather extremes. Being a tropical country, the agro-climatic conditions of tropical India favour higher sugarcane and sugar yields. The tropical region contributes about 55 per cent to the total cane production in the country. The average cane yields of the major states of the region including Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh and Gujarat is around 80 tonnes per hectare. Maharashtra and the adjoining area of Karnataka, Gujarat and A.P. record higher sugar recovery. Long hours of sunshine, cool nights with clear skies and the latitudinal position of this area are highly favourable for sugar accumulation. Moisture stress during the early part of the cane growths mostly during March to June is a major constraint in the state of Maharashtra & other part of region lacking perennial source of irrigation.

3.2 Sub-tropical sugarcane region

Around 55 per cent of total cane area in the country is in the sub-tropics. U.P, Bihar, Haryana and Punjab comes under this region. Extremes of climate is the characteristic feature of this region. During April to June, the weather is very hot and dry. July to October is rainy season accounting for most of the rainfall from South-West monsoon rains. December and January are the very cold months temperature touching sub-zero levels in many places. November to March are cool months with clear sky. The cane yield is lower in the subtropics due to various reasons viz., short growing season, high temperature disparity besides other factors like moisture stress, pest and disease problem, floods and water logging and very poor ratoons. The average yield of the four major states (U.P, Bihar, Punjab and Haryana) is around 60 tonnes per hectare. However, there is considerable potential to be exploited.

4. Area, Production & Yield of Sugarcane

Area, production & yield of sugarcane in major States during last 6 years & current year is at **Annexure I.** State wise normal area, production & yield of sugarcane is at **Annexure II.** Area, production & yield of major sugarcane countries during 2010 to 2014 is at **Annexure III.**

5. Varieties:- The ruling varieties of sugarcane in different States are given as under:

Andhra Pradesh:

Early varieties: Co.6907, 84A125, 81A99, 83A30, 85A261, 87A298, Co.8014, 86V96, 91V83.

Mid-late Varieties: COA7607, CO8021, COT.8201, Co7805, COV92102 (83V15), 83V288.

Late varieties: Co.7219, CoR8001, 87A380, Co7706

Bihar: Bo 99, CoP 9301, CoSe 98231, CoS 8436, Cos 95255, Bo 102, Bo 91, Bo 110, CoP 9206, CoSe 95422, CoSe 92423, UP 9530.

Gujarat: Co 86002, Co 86032, CoSi 95071, Co 86249, CoN 05072.

Haryana: CoJ 64, CoS 8436, CoS 88230, CoS 767.

Karnataka: Co 94012, CoC 671, Co 92020, Co 8014, Co 86032, Co 62175, Co 8371, Co 740, Co 8011.

Maharashtra: CoC 671, Co 86032, Co 8011, Co 94012, CoM 265, Co 92005.

Odisha: Co 62175, CoA 89085, Co 87A298, Co86V96

Punjab: CoJ 85, CoJ 88, CoS8436, CoH 119, Co89003.

Tamil Nadu: Co 94012, Co 94010, CoC 24.

Uttar Pradesh: CoS 8436, Coj 64, CoS88230, CoS 98231, CoS 767, CoS 8432, CoPt 90223, CoS 92423, CoS97264, CoLk 8102.

Uttrakhand: CoS 8436, CoS 88230, Cos 767, CoS 97264, CoSe 92423

6. Temperature requirement for different growth stages of sugarcane

S.No	Critical Stages of sugarcane	Max. Temp. (^{o}C)	Min. Temp. (^{o}C)	Relative Humidity (%)
1	Germination	32.0	20.0	-
2	Tillering	35.0	18.0	-
3	Grand growth	30.0	14.0	80.85
4	Ripening	30.0	20.0	50-55

7. Soil: Heavy soils with good drainage are preferred for sugarcane cultivation, though it grows well on medium & light-textured soils also with assured irrigation. Soils with 0.5-0.6 % carbon content & pH 6.5 to 7.5 are most suitable for sugarcane growth. In northern India, it is cultivated largely on the loams & clay loams of Gangetic & other alluviums, and in peninsular India, it is grown on brown or reddish loams, laterites and black cotton soils.

8. State and season wise time of sowing and harvesting

Sugarcane take generally one year to mature in sub tropical states (U.P., Punjab, Haryana, Bihar etc.) called "Eksali" however in some tropical states it matures in 18 months (Andhra Pradesh, Karnataka, Maharashtra etc.) called "Adsali". In India, the planting seasons of sugarcane in different States is given at **Annexure-IV.**

9. Method of planting: Sugarcane can be planted as per the recommendation for the region i.e. Autumn Planting (15 Sept. to Oct.) and Spring Planting (Feb. to March). Improved method of planting should be adopted like, deep furrow, trench methods, ring pit method and paired row method instead of furrow system.

10. Seeding technologies

Seed rate: Seed rate in sugarcane varies from region to region. Generally higher seed rate are used in north western India (Punjab, Haryana and Rajasthan) because of the lower germination percent and also adverse climatic condition (very hot weather with desiccating winds) during tillering phase. A northern region seed rate generally varies from 40,000 to 60,000 three budded setts per hectares while in southern region it range between 25,000 to 40,000 three budded setts.

Row spacing: Effect of row spacing from 45 to 120 cm has been tried on growth, yield and quality of sugarcane. Optimum inter rows spacing range between 60-100 cm under different situation and location.

Depth: About 80% of the sugarcane roots go up to a depth 60 cm. Hence deep ploughing of sugarcane fields is necessary. Initially one or two deep ploughings with tractor drawn disc plough or mould board plough or animal drawn mould board plough have to be done at least to a depth of 30 cm. This has to be followed by ploughing with other light tillage implements.

11. Water management

In sugarcane, maintenance of optimum soil moisture during all stages of crop growth is one of the essential requisites for obtaining high yield. The crop should, therefore, be grown in areas of well-distributed rainfall or under assured and adequate irrigation. In tropical India, total water requirement of the crop for optimum growth varies from 2000 to 3000 mm inclusive of rainfall. The requirement of an adsali crop is proportionately higher (3200 to 3500 mm). In sub-tropical India, the water requirement is 1400-1800 mm.

In tropical area, irrigations are to be given once in 7 days during germination phase (1 –35 days after planting), once in 10 days during tillering phase (36 – 100 days after planting), again once in 7 days during grand growth phase (101 – 270 days after planting)

and once in 15 days during maturity phase (271 days after planting up to harvest) adjusting it to the rain fall pattern of the area. About 30 to 40 irrigations are needed. About 250 tonnes of water is needed to produce one tonne of sugarcane. Methods like alternate furrow irrigation, drip irrigation and trash mulching could be of use to economize irrigation water during water scarcity periods. Foliar spraying of a solution containing 2.5% urea and 2.5% muriate of potash 3 or 4 times at fortnightly intervals during drought periods would help to reduce the impact of drought on the crop. Critical stages are those during which sugarcane is affected severely due to water stress and the loss cannot be restituted by adequate water supply at later stages. These stages are: sprouting (germination), formative stage or tillering, ripening and initiation of sprouting in ratoons. In case of limited water availability, one may sustain sugarcane productivity by irrigating at critical stages of growth.

12. Fertilizer Requirement

The nitrogen requirement of sugarcane depends upon the soil & climate. It ranges from 150 kg/ha in Uttar Pradesh to 270 kg/ha in Tamil Nadu and 300 to 500 kg/ha in Maharashtra & Karnataka. Nitrogen is given in the form of urea applied one-third at planting & the remaining two-thirds in 2 equal splits at tillering & at the commencement of grand growth stage. The fertilizers may also be applied as basal dose through diammonium phosphate to supply full P & part of N.

The phosphorous is required at 40-60 kg of P_2O_5/ha. The response of sugarcane to potassium has been obtained only in localized pockets of light soils. Nowadays deficiency of sulphur is constantly increasing in Indian soils & it has become a limiting factor in sugarcane culture. In marginally deficient soils, the application of 40-60 kg S/ha has been found to be useful. 20-30 kg $ZnSo_4$/ha and FYM/Compost of 10 tonnes/ha may be applied.

13. Weed Management in Pure Crop of Sugarcane

i. Spray Atrazine 2 kg or Oxyflurofen 750 ml/ha mixed in 500 ltr. of water as pre emergence herbicide on the 3rd day of planting, using deflector or fan type nozzle.
ii. If pre-emergence spray is not carried out, go in for post-emergence spray of Grammaxone 2.5 litre + 2,4-D sodium salt 2.5 kg/ha in 500 litre of water on 21st day of planting.
iii. If the parasitic weed striga is a problem, post-emergence application of 2,4-D sodium salt @ 1.25 kg/ha in 500 litre of water/ha may be done. 2, 4-D spraying should be avoided when neighbouring crop is cotton or bhendi.
iv. Apply 20% urea also for the control of striga as direct spray.
v. Pre- plant application of glyphosate at 2.0 kg/ha along with 2% ammonium sulphate at 21 days before planting of sugarcane followed by post emergence direct spraying of glyphosate at 2.0 kg/ha along with 2% ammonium sulphate with a special hood on 30 DAP suppressed the nut sedges *(Cyperus rotundas*) and provided weed free environment.
vi. If herbicide is not applied work the junior-hoe along the ridges on 25, 55 and 85 days after planting for removal of weeds and proper stirring.
vii. Remove the weeds along the furrows with hand hoe. Otherwise operate power tiller fitted with tynes for intercultivation.

Weed management in Sugarcane intercropping system

Pre-emergence application of Thiobencarb @ 1.25 kg ai/ha under intercropping system in Sugarcane with Soybean, blackgram or groundnut gives effective weed control.

14. Sugarcane prevailing cropping system in India:

Cropping system for Sub tropical	Cropping system for Tropical region
Paddy- Autumn Sugarcane-ratoon-wheat	Bajra-Sugarcane(pre-seasonal)-Ratoon-wheat
Greengram- Autumn Sugarcane-ratoon-wheat	Paddy-Sugarcane-Ratoon- Finger millet
Maize- Autumn Sugarcane-ratoon-wheat	Paddy-Sugarcane-Ratoon- Wheat
Kharif Crops-Potato-Spring Sugarcane-ratoon-Wheat	Paddy-Sugarcane-Ratoon- gingelly
Kharif Crops-Mustard-Spring Sugarcane-ratoon-Wheat	Paddy-Sugarcane-Ratoon- urd.
Kharif Crops-Pea/Coriander-Spring Sugarcane-ratoon-Wheat	Cotton-Sugarcane-Ratoon–wheat
Kharif Crops-Wheat-late Planted Sugarcane-ratoon-Wheat	Sugarcane-Ratoon-Kharif rice-Winter rice.

15. Constraints in sugarcane cultivation

a) **Sub-tropical Region**: Long winters, low Sun shine hours, high temperature disparity, lack of early maturing high sucrose varieties, poor ratoon management, late planting, water logging, imbalance use of fertilizer, incidence of disease and pests, inadequate availability of quality seed, etc.

b) **Tropical Region:** Lack of irrigation in many states, inadequate availability of quality seed, incidence of disease and pests, poor ratoon management, etc.

16. Strategies for increasing production and productivity of sugarcane

Sugarcane is long duration crop maturing in 12-14 months. The planting method vary place to place, therefore, the states has to encourage optimum use of water & space. Due to long crop duration inter cropping is a major tool to enhance higher returns to the farmers. The main strategies for increasing production and productivity of sugarcane in the country are as under:

i. Popularization of new varieties by providing support for breeder seed production.
ii. Thrust for transfer of technologies through demonstration and training of farmers and extension workers.
iii. Production of quality planting materials including tissue culture plantlets.

iv. Training to the field functionary & farmers for popularizing various technology including Ratoon Management

v. Demonstration on intercropping

vi. Establishment of bio-agent and tiusse culture labs.

vii. The states have flexibility to take support for sugarcane development for any recommended / proven technology /inputs under RKVY.

17. Researchable and Developmental issues:

Following are the major researchable issues:

i. Development of high yielding & high sugar varieties.

ii. Area specific package of practices for popularizing the intercropping module in sugarcane based cropping system.

iii. Assessment and refinement of agro-techniques for sustainable farming system and management of sugarcane under late planting situation.

iv. Development of module for controlling shoot borers, pyrilla, white grub and mealy bug in sugarcane.

v. Designing, developing, sugarcane harvester suited in Indian conditions particularly economical for small holdings.

Developmental issue:

i. Strengthening of seed production programme.

ii. Cluster approach in Transfer of Technology with modern tools.

18. Technical interventions under Promotion

- On Farm Water Management (OFWM) component of National Mission for Sustainable Agriculture (NMSA) provided support for propagation of micro irrigation system like drip irrigation/rain-gun sprinkler and adoption of improved method of irrigation i.e. furrow and skip furrow irrigation instead of flood irrigation in crops including sugarcane.
- Strengthening of seed production programme through tissue culture, single eye bud and poly bag technology, chip bud method, etc under NFSM.
- Introduction of partial mechanization so as to reduce cost of cultivation under Government of India schemes.
- Popularization of inter-cropping of sugarcane with wheat, oilseeds, vegetables, pulses, etc.

- Transfer of innovative bud chip technology through demonstration on the farmers field, training etc.

19. SUGARCANE DEVELOPMENT PROGRAMMES

a) Background of Sugarcane Schemes:

The Department of Agriculture, Cooperation & Farmers Welfare has implemented sugarcane development programme under Centrally Sponsored scheme of Sustainable Development of Sugarcane Based Cropping System (SUBACS) under the Macro Management Mode in Agriculture (MMA) scheme upto 2012-13. The Scheme was shifted under Rashtriya Krishi Vikas Yojana (RKVY) during 2013-14.

b) National Food Security Mission - Commercial Crops ((NFSM-CC) - Sugarcane

From 2014-15, Government has approved implementation of sugarcane development programme under NFSM-CC in 13 States (Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Tamil Nadu, Telengana, Uttar Pradesh and Uttarakhand). Under this scheme thrust has been given on transfer of technology through frontline demonstrations and training in order to extend benefits to the farmers. From 2015-16, NFSM is being implemented on sharing basis between Government of India and States on 60:40 basis for general category states & 90:10 basis for North East & hilly states. However, the Central Agencies are funded 100% by GOI. Pattern of Assistance under NFSM-CC-Sugarcane is at **Annexure-V**. Allocation of funds under NFSM-Sugarcane is at **Annexure-VI**.

20. Products and by- products of Sugarcane

Sugarcane based Sugar industry is one of the largest and important industry in tropical and sub tropical countries of the world. The Sugarcane plant offers a huge potential, not only as the sucrose of a very important food but also as a source of energy and valuable commercial products from fermentation and chemical synthesis. Sugarcane processing is focused on the production of cane sugar from sugarcane. Sugarcane is considered as one of the best converters of solar energy into biomass and Sugar. Sugarcane is a rich source of food (Sucrose, jiggery and syrups), fiber (cellulose), fodder (green top, bagasse, molasses) fuel and chemicals (Bagasse molasses & alcohol). During the process of sugar production, the main by product of cane sugar industry are Bagasse, Molasses and Press mud. The other co-products and by products of less commercial value are Green leaves, green tops, trash,

Boiler ash and effluents generated by sugar industry and distillery. There are many other industries which are based on sugarcane by diversification and utilization of co-products and by products of the sugar industry, instead of merely depending on production of sugar. Thus the effort should be for integral utilization of sugarcane, its co products and by products to produce many value added products, to derive maximum benefits from sugarcane crop.

Ethanol from Sugarcane

The major source of ethanol production in the country is via sugarcane-sugar-molasses route. This provides better economy by sale of sugar and molasses becomes the by-product of the sugar. A tonne of sugarcane produces 100 kg. sugar as well as 40 kg. molasses; the latter will produce about 10 litres of ethanol. On the other hand, one tonne sugarcane will produce 72-75 litres of ethanol. Likewise, a tonne of molasses produces about 220-250 litres of ethanol.

The 10% blending requires about 266.50 crore litres of Ethanol. If this Ethanol is produced directly from cane juice, around 5.08 lakh ha area under sugarcane is needed. In case (as the case today in the country) Ethanol is produced from molasses route, about 38.07 lakh ha sugarcane area is needed. Under molasses route, it will not affect sugar production as molasses is byproduct during production of sugar.

21. SUGARCANE PRICING POLICY OF THE GOVERNMENT

- For every sugar season, the Central Government fixes the Fair and Remunerative Price (FRP) of sugarcane (earlier called Statutory Minimum Price) having regard to the factors mentioned in clause 3(1) of the Sugarcane (control) Order, 1966, based on the recommendations of the Commission for Agricultural Costs and Prices (CACP) and after consultations with State Governments and other stake-holders.
- The FRP is a benchmark guaranteed price of sugarcane determined by the Central Government below which no sugar mill can purchase sugarcane from cane growers.
- However, the State Governments of States viz. Punjab, Haryana, U.P, Uttarakhand, and Tamil Nadu announce the State Advised Prices (SAP) which is normally higher than the FRP.
- Fixing of SAP at a price higher than FRP compounds the problem of cane price arrears.

- The following table indicates the FRP over the years:-

Sugar Season	FRP in Rs per quintal
2009-10	129
2010-11	139
2011-12	145
2012-13	170
2013-14	210
2014-15	220
2015-16	230
2016-17	230

22. Statistics on sugar

Production, Export, Import & Recovery (%) of Sugar during 2010-11 to 2014-15

Sugar Season (Oct-Sept)	Production of sugar (lakh tonnes)	Export (lakh tonnes)	Import (lakh tonnes)	Sugar Recovery (%)
2010-11	243.50	28.14	3.65	10.17
2011-12	263.43	36.74	1.886	10.25
2012-13	251.83	12.02	17.12	10.03
2013-14	245.54	26.85	10.788	10.23
2014-15	284.63	24.32	12.82	10.37

(Source: Website of Department of Food & Public Distribution, Data on sugar recovery (%) has been taken from website of IISR, Lucknow)

Ex-Mill & Retail Prices of Non-Levy Sugar

Sugar Season (Oct-Sept)	Range of Ex-Mill Prices of sugar (Rs per quintal)	Range of retail Prices of sugar (Rs per kg)
2009-10	2500-4400	25.00-47.00
2010-11	2350-3090	28.00-34.00
2011-12	2540-3735	31.17-43.70
2012-13	2810-3685	32.74-41.00
2013-14	2420-3300	31.00-36.00
2014-15	2050-2860	29.35-35.87
2015-16 (upto March, 2016)	2350-3500	30.55-34.64

(Source: Website of Department of Food & Public Distribution)

Export of sugar to Top 5 countries from India

Country	Unit	Qty	Oct'15 to Sep'16 Value (INR)
MYANMAR	TON	1436289	39792400513
SOMALIA	TON	458633	13118551910
SUDAN	TON	391134	11180187807
DJIBOUTI	TON	207674	6115085538
SRI LANKA	TON	188928	5228528512

Import of sugar from Top 5 countries to India

Country	Unit	Qty	Oct'15 to Sep'16 Value (INR)
BRAZIL	TON	1900986	44930352819
U S A	TON	328	115599163
GERMANY	TON	319	96111692
FRANCE	TON	1016	80432363
U K	TON	1005	63736374

(Source: Directorate General of Commercial Intelligence and Statistics (DGCI&S), Kolkata)