

Status Paper on Sugarcane



By

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Origin of the crop:

Cultivation of sugarcane in India dates back to the Vedic period. The earliest mention of sugarcane cultivation is found in Indian writings of the period 1400 to 1000 B.C. It is now widely accepted that India is the original home of *Saccharum species*. *Saccharum barberi* and *Polynesian* group of island especially New Guinea is the centre of origin of *S. officinarum*. It belongs to family Gramineae (Poaceae), class monocotyledons and order glumaceae sub family panicoidae, tribe Andriopogoneae and sub tribe saccharininea. The cultivated canes belong to two main groups: (a) thin, hardy north Indian types *S.barberi* and *S.Sinense* and (b) thick, juicy noble canes *Saccharum officinarum*. Highly prized cane is *S. officinarum*.

Importance of Sugarcane: In agriculture sector, sugarcane shared is about 7% of the total value of agriculture out put and occupied about 2.6% of India's gross cropped area during 2006-07. Sugarcane provides raw material for the second largest agro-based industry after textile. About 527 working sugar factories with total installed annual sugar production capacity of about 242 lakh tonnes are located in the country during 2010-11.

Scientific name of Sugarcane:

The genus *Saccharum* has five important species viz.,

1. *Saccharum officinarum*, 2. *S. Sinense*, 3. *S.barberi*, 4. *S.robustum*, 5. *S.spontanuem*.

The first three species are the cultivated species and the last two are wild ones.

S. officinarum species is widely cultivated in India because of high sucrose content.

Morphology of Sugarcane: Sugarcane is a tall perennial plant growing erect even up to 5 or 6 metres and produce multiple stems. The plant is composed of four principal parts, root system, stalk, leaves and inflorescence. Sheath is Green with red blotches; moderate to heavy bloom; scarious border prominent; sheath splitting occasional Clasping; Spines present on the middle of the sheath; deciduous. Blade Joint or Transverse Mark is Purplish green; medium: fair bloom. Ligule: Medium;Crescentiform; symmetrical; gradually tapering towards the edges. The inflorescence of sugarcane generally called the 'arrow' is an open panicle. It is long (30 centimeter or more) and tapering. Cane is Medium-thick; slightly staggered; slightly oval in cross section, internal tissue yellow with purple tinge: rind hard; pith present as small cavity. Node & buds are slightly depressed; leaf scar slightly inclined. Buds are medium, plumpy, ovate; occasionally hairs at the tip of the bud noticed; inserted at leaf scar. Sugarcane is a C₄ plant having high efficiency in storing solar energy and most efficient converter of solar energy to sucrose. Sugarcane has essentially four growth phases:

1. Germination phase, 2. Tillering phase, 3. Grand growth phase, 4. Maturity and ripening phase.

http://www.ikisan.com/crop%20specific/eng/links/ap_sugarcaneMorphology.shtml

Nutritional value of Sugarcane: The juice Sugarcane per serving (28.35 grams) contain Energy-111.13 kJ (26.56 kcal), Carbohydrates-27.51 g, Protein-0.27 g, Calcium11.23 mg (1%), Iron 0.37 mg (3%), Potassium41.96 mg (1%), Sodium17.01 mg (1%)

Source: Nutrient Information from ESHA Research

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. However, five agro-climatic zones have been identified mainly for the purpose of varietal development. They are (i)North Western Zone (ii) North Central Zone (iii) North Eastern Zone (iv) Peninsular Zone (v) Coastal Zone.

Tropical region Shared about 45% and 55% of the total sugarcane area and production in the country, respectively along with the average productivity of 77 t/ha (2011-

12). Sub-tropical region accounted for about 55% and 45% of total area and production of sugarcane with an average productivity about 63 t/ha (2011-12)

Tropical Sugarcane region: The tropical sugarcane region consists of sugarcane agro climatic zone 4 (peninsular zone) and 5(Coastal zone) which includes the states of Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat, Madhya Pradesh, Goa, Pondicherry and Kerala.

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.

Crop distribution: Sugarcane growing countries of the world are lying between the latitude 36.7⁰ north and 31.0⁰ south of the equator extending from tropical to sub-tropical zones. In India sugarcane is cultivated all over the country from latitude 8⁰ N to 33⁰ N, except cold hilly areas like Kashmir valley, Himachal Pradesh and Arunachal Pradesh.

Demand and supply scenario of sugarcane produce:

Ssugar is the major produce of sugarcane. The domestic demand of sugar is rotating around 22-23 million tonnes annually, where as the production of sugar in India during last 5 years is rotating around 24.3 to 26.3 Million ton. Maharashtra is the largest producer of sugar contribute about 34% of sugar in the country followed by Uttar Pradesh.

Area, production and yield of sugarcane in major growing states:

In Tropical zone Maharashtra is the major sugarcane growing state covering about 9.4 lakh ha area with production of 61.32 Million ton, whereas the productivity of Tamil Nadu is highest in tropical zones. Uttar Pradesh is the highest sugarcane producing State in sub tropical zone having area about 22.77 Lakh ha with the production of 135.64 Million Ton cane whereas Haryana has highest productivity of sugarcane in Sub tropical zone.

Area, production and yield of sugarcane in major growing countries:

Brazil is major sugarcane producing country with an area about 90.77 lakh ha and production of about 717.46 Million ton followed by India. Sugarcane productivity is highest in Colombia (101.32 t/ha) followed by Philippines (93.71 t/ha). Amongst 10 major producing country Colombia has the highest yield of sugarcane due to the richest biodiversities in the world and has access to multiple climates. The yield gap of sugarcane in India with respect to 10 major sugarcane producing countries during the last 5 years is ranges 1.33 – 31.22 t/ha.

Export import status of sugarcane produce:

Sugarcane as such is neither exported nor imported, however the sugar which is a main produce of sugarcane crop is exported and imported as per the Government policies. As per Cooperative Sugar (Vol.-44 No.4, Dec. 2012) the total export of sugar during 2010-11 is 32.49 lakh ton value Rs. 10.35 thousand crore and import is 10.00 lakh ton for value Rs. 2.72 crore during the same year.

Varietal Development:

Released and notified varieties of sugarcane

Name of variety	Year of release	State(s)for which recommended	Key characteristics (like duration, yield, level, quality characteristics, etc)			
			Maturity	Cane yield (t/ha)	Sucrose(%)	Notification No.
Cos 91230	2000	Punjab, Haryana, Rajasthan, Central and Western U.P.	Midlate	68.2	18.8	821(E) 13.09.2000

		and Uttarakhand				
Co Pant 90223	2001	„	Midlate	73.3	18.5	821(E) 13.09.2000
CoH 92201	2001	„	Early	70.0	18.2	92(E) 02.02.2001
Cos 95255	2004	„	Early	70.5	17.5	642(E) 31.05.2004
CoS 94270	2005	„	Midlate	81.5	17.1	122(E) 02.02.2005
CoH 119	2005	„	Midlate	82.8	17.5	1566 (E) 05.11.2005
Co 9814	2007	„	Early	76.3	17.6	122(E)06.02.2007
CoS 96268	2007	„	Early	69.8	17.9	1178(E)20.07.2007
Co Pant 97222	2007	„	Midlate	88.2	18.2	122(E) 06.02.2007
CoJ 20193	2007	„	Midlate	75.9	17.9	1178(E) 20.07.2007
Cos 96275	2007	„	Midlate	80.8	17.3	1178(E) 20.07.2007
Co 0118	2009	„	Early	78.2	18.45	S.O.449 (E) 11.02.2009
Co 0238	2009	„	Early	81.08	17.99	S.O.454 (E) 11.02.2009
Co 0124	2010	„	Midlate	75.71	18.22	S.O.2137 (E) 31.08.2010
Co 0239	2010	„	Early	79.23	18.58	S.O.2137(E) 31.8.2010
Co 87263	2000	Eastern U.P. and Bihar, West Bengal, and Jharkhand	Early	66.3	17.4	821(E)13.09.2000
Co 87268	2000	„	Early	78.9	17.5	821(E) 13.09.2000
Co 89029	2001	„	Early	70.6	16.3	1134 (E) 15.09.2001
BO 128	2001	„	Midlate	69.2	17.6	92(E) 02.02.2001
CoSe 95422	2001	„	Early	67.8	17.7	1134(E)15.11.2001
CoSe 92423	2001	„	Midlate	70.1	17.5	1134(E)15.11.2001
CoSe 96234	2004	„	Early	64.1	17.9	642(E) 31.05.2004
CoSe 96436	2004	„	Midlate	67.1	17.7	642(E) 31.05.2004
CoLK 94184	2008	„	Early	76.0	18.0	SO 2458 (E) 16.10.2008
Co 0232	2009	„	Early	67.83	16.51	SO 454 (E) 11.02.2009
Co 0233	2009	„	Midlate	67.77	17.54	SO 454 (E) 11.02.2009

The yield gap between the farmers 'field and FLD yield in sugarcane varies from region to region and technology to technology and ranges from 13.95 to 201.95 T/ha in Tropical region and from 4.95 to 53.45 t/ha in sub-tropical region.

Climatic requirement

Temperature for different critical stages of sugarcane:

The different critical stages are germination, tillering, early growth, active growth and elongation. Optimum temperature for sprouting (germination) of stem cuttings is 32° to 38°C. It slows down below 25°, reaches plateau between 30°-34°. Temperatures above 38° reduce the rate of photosynthesis and increase respiration. For ripening, however, relatively low temperatures in the range of 12° to 14° are desirable.

Reduction in yield of sugarcane due to rise in temperature:

The sugarcane productivity and juice quality are profoundly influenced by weather conditions prevailing during the various crop-growth sub-periods. Sugar recovery is highest when the weather is dry with low humidity; bright sunshine hours, cooler nights with wide diurnal variations and very little rainfall during ripening period. These conditions favour high sugar accumulation. The climatic conditions like very high temperature or very low temperature deteriorate the juice quality and thus affecting the sugar quality. Favourable climate like warm and humid climate favour the insect pests and diseases, which cause much damage to the quality and yield of its juice and finally sucrose contents. (www.sugarcane.crops.com).

Recommendation for cultivation of crop in view of climate change : Abiotic and biotic stresses:

In the tropical region, sugarcane gets more or less ideal climatic conditions 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. Floods, water logging, diseases such as red rot, wilt, smut etc. are the main problems for sugarcane cultivation in the region. Moisture stress during the early part of the cane growth mostly during March to June, is an important problem. In the coastal areas, red rot has become a major threat. Among the pests, early shoot borer, particularly in the late planted crops, and woolly aphid are considerably serious in this region. In sub-tropical region, the extreme of climate is the characteristic feature. During April to June, the weather is very hot and dry and the temperatures are extremely high. December and January are the very cold months with temperature touching sub-zero levels in many places. The major portion of the zone *i.e.*, the North-West zone comprising the areas in Haryana, Punjab and Western U.P., has very low temperature in December-January which often causes frost. Because of extremes of weather, the active sugarcane growth is restricted to 4-5 months only. In eastern U.P., Bihar and West Bengal, sugarcane suffers due to floods and water logging during monsoon months. Several pests and diseases, particularly red rot and top borer and pyrilla are common and serious. The cane yields are lower in the sub-tropics due to short growing season, moisture stress, more pest and disease problem, floods and water logging, delayed planting after wheat and very poor ratoons. The management of these stresses will necessitate the development of better cultivation and integrated diseases and insect-pests management modules (Source: Vision-2030-IISR)

Genetic Potentiality advancement

Genetic breakthrough for yield improvement from ICAR / SAUs/ International organizations: There is no commercially grown transgenic sugarcane. Research and development of transgenic sugarcane has been identified in: Australia, Argentina, Brazil, Cuba, Egypt, India, Indonesia, Mauritius, Myanmar, South Africa, USA, Venezuela

Advance tools to be applied if any like transgenic, genomics etc.:

The work on transgenic in sugarcane in India is recently stated at SBI, Coimbatore. "We have used the molecular technologies in introgression of wild species and developed sugarcane transgenics," Dr. V. Nair, Director, SBI, Coimbatore said, and conceded that cane agriculture faced serious challenges in terms of sustainability. High cost of production, depleting natural resources, climate change, non-availability of labour, emerging new pests and diseases have impacted cane productivity and sustainability. He stressed the need for gearing up to meet such challenges – both in technology as well as policy levels. Voicing concern over static cane productivity, the Director said, "varietal decline and depletion of soil fertility have resulted in yield decline". Further studies conducted in India, Mauritius, South Africa and Trinidad showed a 30 per cent and more loss in productivity for every two degree centigrade increase in temperature. Transgenic sugarcane can increase yields, reduce production costs, improve sugar quality and reduce the environmental impact of sugarcane cultivation but each transgenic event must be analysed separately, because the impact (benefit and risk) of each trait will be different. Strong and reliable regulatory agencies are needed.

Seed Scenario

The normal practice in Sugarcane growing States of country is to use commercial crop of sugarcane for seed purposes. Sugarcane is vegetatively propagated and required huge quantity of seed. The accounting of different classes of sugarcane seed i.e. breeder, foundation and certified are not being maintained by the different sugarcane growing States therefore the exact quantum of sugarcane certified seed distributed by different agencies in major sugarcane growing state could not be assessed and resulted in failure of assessment of SRR in sugarcane. The important cane seed production advanced technologies are available as under:

Tissue Culture: The tissue culture technique in sugarcane can be used for rapid multiplication of newly developed high yielding, high sugar, disease resistant varieties and rejuvenation of outstanding varieties under cultivation. The micro propagation technique used in this technology with the advantages of (i) Production of true to type plantlets, rapid multiplication (ii) independent of seasonal constraints (iii) maintaining and improving the productivity of outstanding varieties in the field (iv) production of disease free planting material from apical meristem. Polythene Bag Technology means raising of seedlings through budchip/ single bud technique is the major frontier seed multiplication technique in sugarcane.

Major crop sequences/ rotations followed in various states and suggestion crop sequences by SAUs/ ICAR

Table: Prominent sugarcane based cropping system in tropical and subtropical regions of the country recommended.

Sub tropical	Tropical region
Paddy- Autumn Sugarcane-ratoon-wheat	Bajra-Sugarcane(pre-seasonal)-Ratoon- wheat
Greengram- Autumn Sugarcane-ratoon-wheat	Paddy-Sugarcane-Ratoon- Finger millet
Maiz- 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.

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 planting Seasons of Sugarcane in subtropical regions are September to October (Autumn) and February to March (spring), whereas in tropical regions it is June to August (Adsali) and January to February and October to November (Eksali). Apart from this in some states like Karnataka and Tamil Nadu sugarcane planting continue throughout the year except few months.

Planting of sugarcane crop:

Method of planting: Sugarcane can be planted by improved method of planting like, deep furrow, trench methods, ring pit method and paired row method instead of furrow system.

Resource Conservation Technology in Sugarcane:

Application of nitrogen fixing (*Azospirillum* and *Gluconacetobacter*) and phosphate solubilizing (Phosphobacteria) bio-fertilizers were found to reduce the requirement of chemical fertilizers to the extent of 25%. Reduction in the dose of chemical fertilizers reduces soil degradation (Source: <http://www.sugarcane.res.in>). Trash mulching of dry leaves, drip irrigation for water saving and mechanization through Ratoon management device (RMD), sugarcane cutter planter, trench opener, power weeder etc. are successfully using for saving for man power as well as time.

Seeding technologies –seed rate, distance, depth, plant population

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 35,000 three budded setts per hectares while in southern region it range between 25,000 to 40,000 three budded setts.

Distance: The row spacing in sub tropical part is ranges 60-120 cm whereas, 90-150 cm in tropical regions.

Fertilizer management – recommended dose for different ecologies, micro nutrients, organic manure , application method

An average crop of sugarcane yielding 100 t/ha removes 208kg of N, 53kg of P, 280kg of K, 30 kg of Sulphur, 3.4kg of iron, 1.2 kg of manganese, 0.6 kg of copper respectively from the soil. Hence, soil has to be replenished to maintain the productivity of sugarcane with the said quantities of nutrients. If the soil test value is below the critical value, apply sulphate form of Zn, Cu, Fe and Mn through soil application and foliar spray (The total concentration of salt should be 0.5% for young crop and 2.5% for a grown up crop). The recommendation of NPK for sugarcane crop varies from state to state and varies from region to region. The recommendation of Nitrogen is from 70-400 kg/ha Phosphorus 27-74 kg/ha and Potassium 25-141 kg/ha.

The recommended dose of bio-fertilizers for sugarcane crop is 10-12 kg/ha. Acetobacter, Azotobacter, *Azospirillum* (or *Gluconacetobacter*) and PSB are the major bio-fertilizers which are being used in Sugarcane crop.

Water management: application and conservation methods, their water use efficiency, water requirement of crops, critical stages for irrigation and probable losses if not applied:

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. Whereas in sub-tropical area about 7-10 irrigations are being given to the sugarcane crop.

Sugarcane is a high water requirement crop. 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 (Source: <http://sugarcane.res.in>)

Water requirement and applying irrigation at critical stages of growth:

As mentioned earlier, 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. (Sustaining sugarcane productivity under depleting water resources: (Current Sc 748 IENCE, Vol. 101, No. 6, 25 September 2011 by Ashok K. Shrivastava, Arun K. Srivastava and Sushil Solomon are in the Indian Institute of Sugarcane Research, Lucknow 226 002, India.) Water requirement (WR) in various sugarcane- growing states of India is ranges from 140-350 ha-cm.

Weed Management – important weed flora, herbicides recommended with dose application time, and different methods (mechanical , biological etc.)

In sugarcane weeds have been estimated to cause 12 to 72 % reduction in cane yield depending upon the severity of infestation. The nature of weed problem in sugarcane cultivation is quite different from other field crops because of the following reasons:

- Sugarcane is planted with a relatively wider row spacing.
- The sugarcane growth is very slow in the initial stages. It takes about 30 – 45 days to complete germination and another 60-75 days for developing full canopy cover.
- The crop is grown under abundant water and nutrient supply conditions.
- In ratoon crop very little preparatory tillage is taken up hence weeds that have established in the plant crop tend to flourish well.

The major weeds are Sedges- *Cyperus rotundus*; Grasses-*Cynodon dactylon*, *Sorghum helipense*, *Panicum* spp, *Dactyloctenium aegyptium*, Broad leaved weeds –

Chenopodium album, Convolvulus arvensis L., Amaranthus viridis L., Portulaca oleraceae L., Commelina bengalensis L., Trianthema portulacastrum L. etc.

Integrated weed management

Complete weed control cannot be achieved by using any one method. To have more dependable, economical and desirable weed control without environmental problems, it is advisable to have a proper combination of agronomical, cropping, rotational and biological methods with supplemental use of herbicides.

Weed Management in Pure Crop of Sugarcane

1. 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.
2. 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.
3. 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.
4. Apply 20% urea also for the control of striga as direct spray.
5. Pre- plant application of glyphosate at 2.0 kg ha⁻¹ 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⁻¹ along with 2% ammonium sulphate with a special hood on 30 DAP suppressed the nut sedges (*Cyperus rotundas*) and provided weed free environment.
6. 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.
7. Remove the weeds along the furrows with hand hoe. Otherwise operate power tiller fitted with tynes for intercultivation.

Weed management in Sugarcane intercropping system

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

Plant protection – important insects pests and diseases and their effect on yield loss, chemical, biological and cultural control measures:

Sugarcane is liable to be attacked by a number of insect pests and diseases. According to an estimate, sugarcane production declines by 20.0 and 19.0 % by insect pests and diseases respectively. To increase the crop productivity, management of insect-pest and diseases is of great significance. Due to diversity in agro-ecological conditions the importance of insect pests and disease varies and therefore, management strategy should be adopted accordingly.

Sugarcane is infested by about 288 insects of which nearly two dozen causes heavy losses to the quality as well as quantity of the crop. The scenario of insect pests and diseases varies in sub-tropical and tropical belt of sugarcane. Top borer and stalk borer are found pre-dominantly in sub-tropical areas whereas internodes borer and early shoot borer and among disease rust & eye spot are prevalent in tropical region.

Harvesting: Harvesting and collection of cane should be either mechanical or manual. It has been found that when cane is harvested and gathered mechanically, by combined harvester, or manually cut and collected and then grab loaded into large trucks/ tractor trolley.

Time of harvest: As far as possible harvesting should be carried out avoiding extremes of weather. In sub tropical of India, it has been shown that spring harvested plant crop- would result in a better ratoon then that obtained by harvesting in the autumn. Sugarcane crop is harvested after attending maturity, generally it starts from the month of Oct and continue till the month of May in sub-tropical states where in Tropical states it starts from the month of Dec and continue till the month of May.

Harvesting technique: Harvesting of vegetative stocks, automatically initiates the re generation of ratoon crop, with the removal of apical dominance, the stable is piece is now free to sprout its axillary buds from top downwards. In the manual system of sugarcane harvesting using a straight blade knife at the ground level, then axillary buds which are below the ground level are forced to sprout and rationing. It has been found that knife with a curved blade in much superior to straight knife in harvesting sugarcane sticks in flush with the ground (Meemeduma, 1983).

Use and recommendation of farm implements and machines used for different operations:

Mechanization in Sugarcane Cultivation: Sugarcane is a labour intensive crop and shortage of labour and unavailability of labour at reasonable rate is the major concern in sugarcane cultivation. To combat the paucity of labour, mechanized sugarcane cultivation is the only option to carry out all the operations in time. Automated sugarcane cutter-planter machine, FIRB Planter, trench opener, Ratoon management device (RMD), power weeder, sugarcane setts cutting machine, ring pit digger, trash shredder, tractor mounted ridger, power sprayer equipments are in vague. The sugarcane harvester is also using in tropical parts of the country.

Ratoon Management in Sugarcane: Ratooning is a method where the lower parts of the plants along with the roots are left uncut at the time of harvesting gives sprouting of ratoon. In ratoon crops, there is a saving in cost of cultivation in terms of land preparation, seed canes, etc. If ratoons are well maintained, they give high yields. But, for a better ratoon crop, a better plant crop is necessary. Within a week after harvesting the plant crop, ratoon management practices like stubble shaving, off baring, gap filling, fertigation etc., should be initiated.

Problems in prevalent cropping system, uptake of nutrients, deterioration of soil health, depletion of underground water: The problem poses by the prevalent cropping systems is mainly depletion of ground water, due to continuous adoption of cropping system having no time for summer ploughing resulted in incidence of white grub in sugarcane emerging as serious problem.

Crop products

Industrial use of main product and by product. Products derived from main product and by product and their uses: The main product of Sugarcane is sugar, however, there are many by products of sugarcane industry are bagasse, molasses, press mud and green top, which are used by various industries like Bagasse based industries mainly produce pulp, paper, particle boards using bagasse as a fuel, cattle feed, medium for cultivation of edible mushroom, production of furfural etc., Molasses based industries mainly produce potable alcohol for Distillery, Acetic Acid, Fuel Alcohol, Cattle feed and many Pharmaceutical products etc. Press mud based industries mainly produce fertilizer and the wax and compost industries, as animal feed.

Types of products manufactured in the processing units: To meet the demand of sugar consumption India has started new sugar industries in different states. At present 529 sugar factories are operated in the country with the annual sugar production capacity of 24.85 million ton during 2011-12. The average duration of crushing season in India is about 137 days.

Average sugar recovery in sugarcane: The sugar recovery in sugarcane varies from state to state average sugar recovery in the country is 10.25% (P).

State wise sugar production:

Among the State Maharashtra is the leading state with regard to sugar production followed by U.P. During 2011-12 the sugar production in the country is about 263 Lakh ton. The sugar production in Maharashtra 89.77 lakh ton followed by Uttar Pradesh 69.74 lakh ton, followed by Karanataka 38.72 followed by Tamilnadu 23.79 lakh ton followed by Andra Pradesh 11.35 lakh ton during 2011-12 (P).

Crop Development Programme

Brief description on each important crop development programme- purpose, target, achievement, Critical incentives, constraints and suggestions for improvement:

Since October 2000, the Crop oriented Centrally Sponsored Scheme being implemented in different States subsumed with Macro Management Mode on Agriculture (MMMA) with the approval of planning commission. The main components continued to remain same as it was in the SUBACS **with the flexibility to incorporate new components as per the requirement of the state.** The main component of the scheme are: Field demonstration, IPM demonstration, Farmers Training, State level training, Distribution of implements (Manual/tractor drawn), Seed multiplication, MHAT Plant, Drip irrigation infrastructure, Bio-fertilizer distribution, Biological control etc. The pattern of assistance under the MMMA scheme is now **90:10** between GOI and State Govt. Sugarcane Development Programme under Macro Management Mode during 2011-12 the total financial target was Rs. 2871.88 Lakh and achievement was Rs. 2779.79 Lakh (as per state reports).

Special initiatives taken for encouraging the cultivation of the sugarcane crop Minimum Support Price (MSP) including additional incentives (Bonus) on procurement of crop produce from the states:

The minimum Support Price now Fair and remunerative price (F&RP) in sugarcane is declared by Govt. of India every year to protect the benefits of the sugarcane growers keeping in view the different parameters. The State Government also declared State Agreed Price for Sugarcane over the FRP. During the current year i.e. 2012-13 the F&RP is Rs. 170 per quintal hiked with 9.5% sugar recovery with premium of Rs. 1.29 on every 0.1% increase in sugar recovery.

Workshops, conference and seminars

Outcomes/ recommendations of annual workshop conducted by ICAR/ SAUs:

Recommendations emerged during Pre-kharif DAC-ICAR Interface held on 11th February 2010

Issue	Recommendation made by ICAR
1. To develop a technology	For overcoming this important constraints to productivity of ratoon crops, pre harvest application of the potassium (80 kg K ₂ O/ha) with last irrigation one month before harvesting and foliar pry of 200 ppm ethrel

package for enhancing sprouting in winter harvested cane.	15 days before harvest, improved sprouting and productivity of winter initiate ratoon. Spraying of Glyphosate @ 0.16 kg a.i per ha on to the standing crop 2 months before harvesting improve not only the juice quality of the crop but also improves sprouting of the stubble buds in the succeeding ratoon crop. Post harvest application of Cycocel @ 5 kg ai per ha increased the yield of succeeding ratoon crop by 23%. Post harvest application of the formulation containing Vitamins and Minerals, and potassium also improves sprouting of suitable buds as well as productivity by 22-23% in winter initiated ratoon.																				
2. Development of sugarcane variety suited for water logging condition.	<p>A number of sugarcane varieties have been released and notified for cultivation for different sugarcane growing zones of the country including states of UP and Bihar:</p> <p>List of sugarcane varieties tolerant to water logging are given below”</p> <table border="1" data-bbox="446 661 1250 1291"> <thead> <tr> <th>S.No.</th> <th>Sugarcane growing zones</th> <th>Variety</th> <th>Remarks</th> </tr> </thead> <tbody> <tr> <td rowspan="2">A.</td> <td rowspan="2">North west zone (Punjab, Haryana, Rajasthan, Central and western UP and Uttrakhand)</td> <td>Co-98014 (Karan-1)</td> <td>Early</td> </tr> <tr> <td>Co-pant 97222</td> <td>Midlate</td> </tr> <tr> <td rowspan="4">B.</td> <td rowspan="4">North central zone (Eastern UP, West Bengal and Jharkhand)</td> <td>Cose-96436 (Jalpari)</td> <td>Midlate</td> </tr> <tr> <td>Colk-94184 (Birendra)</td> <td>Early</td> </tr> <tr> <td>Co-0233 (Kamal)</td> <td>Early</td> </tr> <tr> <td>Co-0233</td> <td>Midlate</td> </tr> </tbody> </table>	S.No.	Sugarcane growing zones	Variety	Remarks	A.	North west zone (Punjab, Haryana, Rajasthan, Central and western UP and Uttrakhand)	Co-98014 (Karan-1)	Early	Co-pant 97222	Midlate	B.	North central zone (Eastern UP, West Bengal and Jharkhand)	Cose-96436 (Jalpari)	Midlate	Colk-94184 (Birendra)	Early	Co-0233 (Kamal)	Early	Co-0233	Midlate
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Brain Storming on 24th March, 2009 at IISR, Lucknow:

A brain storming discussion was held in IISR, Lucknow to improve sugarcane production and sugar recovery in India with emphasis on UP and Maharashtra under the Chairmanship of Dr. S.P. Tiwari, DDG (CS & Edn.) on 24th March 2009. In the session the following points were set for low productivity and sugar recovery:

1. Monoculture of sugarcane i.e. lack of crop rotation in some areas, leads to depletion of nutrients in soil and adversely affect cane productivity.
2. Cultivation of rejected and unapproved varieties not only leads to low cane productivity, but also pose a risk to buildup of diseases, particularly red rot.
3. Ratoon crop is generally receives much less attention and care by the cane growers leading to lower cane productivity.
4. Post harvest deterioration in cane quality on account of staling and delayed crushing contribute to low sugar recovery.

5. Inadequate availability of quality seed of new sugarcane varieties and poor seed replacement rate adversely affect the realization of potential cane yield of varieties.
6. Increasing problem of soil compaction/ hard pan coupled with inadequate sub-soiling not only adversely affects plant growth, but also promotes lodging of canes.
7. In U.P. rainfall in the month of May and June 2008, coinciding with the tillering phase in sugarcane, adversely affect tillering which led to lesser number of millable canes. Due to continuous rains, fertilizers could not be applied on time.
8. These factors coupled with shortage of phosphatic and potassic fertilizers, particularly in UP, led to low cane productivity.
9. Relatively higher minimum temperature and higher relative humidity during maturity phase delayed sugarcane ripening resulting in low sugar recovery. Moreover, crushing of immature cane due to imbalance crushing schedule lowered sugar recovery.
10. In Maharashtra, low rainfall and inadequate water availability during grand growth phase together with shortage of fertilizer (DAP), labour and power resulted in reduced cane productivity.
11. Area under early maturing high sugar varieties is very less which led to low average sugar recovery.

Recommendations of the National Seminar on “Mechanization of Sugarcane Cultivation” held at IISR, Lucknow on March 19-20, 2010.

After deliberations, following recommendations/ Action Plan emerged for spread of mechanization in sugarcane cultivation:

1. Plan to be prepared by the sugar mills for mechanical planting in their respective area in the initial stage and subsequently more operation could be included.
2. Identifying the machine and source of supply in consultation with IISR, Lucknow, if required.
3. Manufacturer selected should ensure the quality control for which he shall send prototype to IISR for performance testing, if desired. This quality will have to be maintained by him in future supply.
4. Manufacturer will provide working design of the supplied equipment and will ensure after sale service during the use period.
5. IISR may provide training to the manufacturers and the users at their cost for the proper operation and maintenance of the equipment.
6. Any suitable device pertaining to the sub-soiling through RMD/Sub-soiler should be used to improve soil health and ratoon productivity. For this also sugar factories should plan in advance.
7. Initially, DSCL and Balrampur group of Industries have agreed to initiate this plan in their areas of operations.
8. Group meeting may be arranged in future to take stock of the progress made in this regard.

Important websites:

Name of important national and international organizations involved for crop improvement:

A. National:

1. Vasantdada Sugar Institute Manjari (Bk), Tal. Haveili, Dist. Pune, PIN-412 307 (Maharashtra)
2. Indian Institute of Sugarcane Research, Rae Bareli Road, Post Dilkusha, Lucknow-226 002 (U.P.)
3. Sugarcane Breeding Institute, ICAR Coimbatore-641 007 (Tamilnadu).
4. National Sugar Institute, PO. NSI, Kalyanpur, Kanpur – 208017 (U.P.)
5. U.P. Council of Sugarcane Research Sahjahanpur, U.P.
6. Indian Sugar Mills Association, Ansal Plaza, 'C' Block, 2nd Floor, August Kranti Marg, Andrews Ganj, New Delhi- 110049
7. National Federation of Cooperative Sugar Factories Ltd (NFCSF) Ansal Plaza, Block-C, 2nd Floor, August Kranti Marg, New Delhi.

B. International:

1. International Society of Sugar Cane Technologists, Mauritius,
2. Brazilian Society of Sugar and Ethanol Technologists, Brazil.

National and international Institutions informative for farmers, development officers, policy planners and scientific community.

Indian Sugar Mills Association (ISMA)

Sugar House, 39, Nehru Place,
New Delhi-110 019.

E-mail: sugarmill@nda.vsnl.net.in

National Federation of Co-operative Sugar Factories Ltd., (NFCSF)

Vaikunth (IIIrd Floor), 82-83, Nehru Place, New Delhi-110 019.

E-mail: nfcsf@ndb.vsnl.net.in

All India Distillers Association (AIDA)

805, Siddharth, 96, Nehru Place, New Delhi 110 019.

E-mail: distiler@vsnl.net.in

The Sugar Technologies Association of India (STAI)

21, Community Centre, East of Kailash, New Delhi 110 065.

E-mail: staidel@vsnl.net.in

Indian Sugar and General Industry Export Import Corporation Ltd.,

21, Community Center, East of Kailash, New Delhi 110 065.

E-mail: isiec@ndb.vsnl.net.in

Sugar Technology Mission

D-5 Apartment, Qutab Hotel, New Mehrauli Road, New Delhi 110 016.

Website of advisory services to farmers: The website developed by the Sugarcane Department, Uttar Pradesh www.up.cane.org . This website is providing sugarcane advisory, their marketing, supply ticket, weighment, cane payment to the farmers. This website is very helpful for the sugarcane growers in the state of Uttar Pradesh.

http://www.upcane.org/sis/en/index.asp	www.sugarcane.co.uk
http://www.sugarindia.com/glossary.htm	www.bonsucro.com
http://www.vsisugar.com	www.issct2013.com.br
http://www.fcamin.nic.in/dfpd_html/index.asp	www.sugarcane.res.in
http://www.cogenindia.org/default.asp	www.wsro.org
http://www.staionline.org	www.upcane.org
http://ncdc.nic.in/index.php	www.sugarcane.co.uk
http://www.coopsugar.org	www.vsisugar.com
http://www.indiansugar.com	www.sugarbazar.com
http://www.tifac.org.in/index1.htm	http://www.issct.org
http://nsi.gov.in	

Researchable and Developmental issues:

For crop specific research issues like e.g. varieties, production technologies farm implements, climate change and product development, value addition, marketing etc.

Researchable issue:

1. Development of the varieties capable of giving higher cane yield, sugar recovery along with field stability and good Ratooning ability
2. Assessment and refinement of agro-techniques for sustainable farming system and management of sugarcane under late planting situation.
3. Development of module for controlling whit grub and mealy bug in sugarcane which is emerging as a serious problem.
4. Designing, developing, Sugarcane harvester suited in Indian topographical, cultural and economical conditions.
5. Enhancement of sprouting in winter harvested cane.

Developmental issue:

1. Strengthening of seed production programme at institute or research centre
Simultaneously focusing of rearing of quality seed nurseries at farmers field.
2. Cluster approach in Transfer of technology with modern tools.

Strategies for sugarcane productivity enhancement:

A. Agronomic Strategies:

Adoption of suitable varieties & their blending, Strengthening of seed production programme, Water Management, Integrated Nutrient Management Approach, Integrated Pest Management, Ratoon Management, Adoption of suitable Time and Method of Planting, Promotion of intercropping, Promotion of mechanization, Credit flow and its utilization,

B. Extension Strategies:

Timely and efficient dissemination of the innovative crop production technologies to the farmer's field is very essential for increasing sugarcane productivity through modern tool of TOT like Demonstration, Training programmes at different level, Exposure visits, Distribution of technical literature, Village *Gosthies*, Farmers Field School (FFS), Audio-visual aids/video clippings, Since, the development is a regular feature and joint venture and It should be made with the help of concerned department of State Government extension officials, sugar factories, SAUs, KVK's, Regional *Krishak Sewa Kendra* etc.

Recommendations of Dr. C. Rangarajan committee Report

Prime Minister had set up a committee under the chairmanship of **Dr. C. Rangarajan, Chairman, Economic Advisory Council** to the Prime Minister to look into all the issues relating to the deregulation of the sugar sector. The committee has completed its task, after several rounds of deliberations, consultations with stakeholders, and discussion with Chief Ministers of major sugar-producing states. The report was submitted to the Prime Minister on 10-10-2012.

2. A major recommendation of the committee relates to revising the existing arrangement for the price to be paid to sugarcane farmers, which suffers from problems of accumulation of arrears of cane dues in years of high price and low price for farmers in other years. The existing arrangement comprises a Fair and Remunerative Price (FRP) announced each year by the Centre, under the Sugarcane Control Order and on the advice of CACP, as the minimum price of sugarcane. However, many states in north India also announce a State Advised Price (SAP) under state legislation. Generally, the SAP is substantially higher than the FRP, and wherever SAP is declared, it is the ruling price. Instead of the present arrangement, the committee has proposed that at the time of cane supply, farmers be paid FRP as the minimum price, as at present. Further, subsequently, on a half-yearly basis, the state government concerned would announce the ex-mill prices of sugar and its by-products, and farmers would be entitled to a 70% share in the value of the sugar and by-products produced from the quantity of cane supplied by each farmer. Based on the share so computed, additional payment, net of FRP already paid, would then be made to the farmer. Since the sugar value estimate includes return on capital employed, this implies that farmers would also get a share of the profits. With such a system in operation, states should not declare an SAP.

3. The committee has also recommended dismantling of the levy obligation for sourcing PDS sugar at a price below the market price. States should be allowed henceforth to fix the issue price of PDS sugar, while the existing subsidy to states for PDS sugar transport and the difference between the levy price and the issue price would continue at the existing level, augmented by the current level of implicit subsidy on account of the difference between the levy price and the open market price. This will free the industry from the burden of a government welfare programme, and indirectly benefit both the farmer and the general consumer since the industry passes on the cost of levy mechanism to farmers and consumers.

4. The committee has recommended dispensing with the present mechanism of regulated release of non-levy sugar, as it imposes additional costs on factories on account of inventory accumulation.

5. The committee has recommended that cane area reservation ultimately be phased out and contracting between farmers and mills allowed for enabling the emergence of a competitive market for assured supply of cane, in the interest of farmers and economic efficiency. However, in case some states want to continue it for the time being, they should do so while ensuring that area reservation is done for at least three to five years at a time, so that industry has a stake in its development. Further, wherever and whenever a state discontinues area reservation, the Centre should remove the stipulation of a minimum distance between two mills.

6. On external trade, the committee has favoured a stable policy regime with modest tariff levels of 5% to 10% ordinarily, and dispensing with outright bans and quantitative restrictions. The committee has also recommended dispensing with the mandatory requirement of jute packaging. In respect of molasses, the committee favours free movement and dismantling of end-use based allocation quotas that are in vogue in several states, to enable creation of a national market and better prices for this valuable by-product as well as improved efficiency in its use.

7. Members on the committee were Shri T. Nandakumar, Member, NDMA, Dr Ashok Gulati, Chairman, Commission on Agricultural Costs & Prices, Dr Raghuram Rajan, Chief Economic Advisor, Shri Sudhir Kumar, Secretary, Food & Public Distribution, Shri Ashish Bahuguna, Secretary, Department of Agriculture & Cooperation, and Dr K. P. Krishnan, Convener, as the then Secretary, Economic Advisory Council.
