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RESEARCH ARTICLE

ELEVATING MAXIMUM SUGARCANE AND SUGAR PRODUCTION: OPPORTUNITIES AND CHALLENGES IN UTTAR PRADESH.

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Abstract

Sugarcane is cultivated under wide range of climatic conditions viz., hot weather during summer and very low temperature during winter with different agroclimatic zones in U.P. state of subtropical region. Hot and dry summer months followed by cool, wet and few days of frost in winter month are mainly concern with growth and quality of sugarcane crop. The Indian sugar industry, second largest in the world, is a key driver of rural development, supporting India's economic growth. The industry is inherently supporting over 6 million farmers and their families, along with workers and entrepreneurs of over 550 sugarmills, apart from a host of wholesalers and distributors spread across the country. Contribution of sugarcane to the national GDP is 1.1% which is significant considering that the crop is grown only in 2.57% of the gross cropped area. The industry produces 350 – 365 million tonnes cane, 25-27 mt white sugar and 6-8 mtjaggery and khandsari every year. India occupies better position in the world in area and production after Brazil but the cane yield/ha is generally lower (70 t/ha) than several other countries like Peru (120t/ha), Australia (100t/ha), and Brazil (80t/ha) etc. Uttar Pradesh rank first in the country with regards to cane area (2.1 mha) and also in sugar production (8.75 mt).

Therefore, the northern state particularly Uttar Pradesh plays important role in improving national sugarcane productivity is obvious. Now days improvement in crop yield (72.37 t/ha) and sugar recovery (10.61%) in U.P. stagnation in the factor productivity have needs further improvement for sustainability of crop yield level reached during green revolution period. In order to maintain crop sustainability, applied researches are being conducted in different disciplines and research finding's as well as exercises such as crop rotation, integrated nutrients management strategy and green cane harvesting have been resulted to increase irrigation and drainage efficiency, improvement in organic matter and its better effect on soil properties and sugarcane nutrition. In this aspect an experimental result at sugarcane Research Institute of U.P. Council of Sugarcane Research Shahjahanpur (U.P.) showed that integration of 10t/ha Farm Yard manure + inorganic fertilizer N, P₂O₅ and K₂O on soil test basis + biofertilizers (*Azotobacter* and phosphorus solubilizing bacteria (PSB)) each @ 10kg/ha gave significantly better cane yield of plant and also in their sub – sequent ratoons with trash mulching at the starting of ratoon management.

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Introduction:-

Presently, India contributes 15% towards the global sugar production and 13% towards global sugar consumption. For both sugar production and sugar consumption in country Uttar Pradesh contributes nearly 40 -45%. Uttar Pradesh has ended the sugar season 2016 -17 as the highest sugar producer in the country by leading Maharashtra, resulting production of 8.75 mt, a whopping 22.13% increase as compared to last year. The state also achieved an average yield of 72.37 tonnes per hectare, which is again the highest with an increase in the yield has compared to last year. The increase of 5.9 tonnes yield has translated in to an additional income of Rs 5568.32 carore for the farmers of U.P. Industry is gradually transforming in to sugar complexes by producing sugar, bioelectricity, bio ethanol, bio manure and chemicals. The sector today not only has transformational opportunities that would enable it to continue to service the largest domestic markets but has also emerged as a significant carbon credit and green power producer and has potential to support ethanol blending programme of E 10 and beyond (Soloman, 2016). The sugar industry is gearing upto meet the challenge of 2030 through judicious integrations of agro – technology, improved management practices, diversification and farmer’s friendly policies. The crops besides providing the food and energy needs of the country also contribute to employment and revenue generation, social development and environmental safety. Because of the manifold benefit from the crop and its wide and varied uses, sugarcane agriculture will remain a major contributor to the sustainable development of sugar industry in U.P. as well as in India. Sustainable organic agriculture can be further characterized by a set of principles that include bio diversity, integration, sustainability, natural plant nutrition, natural pest management and integrity. Declining fertilizer use efficiency and organic matter levels have been observed in soils and increasing the area of deficiencies including K, S and micronutrients like Zn and Bo (Swaroup& Ganesh murthy, 1998).

Indian Sugar Industry An Overview:-The current sugar production fulfils the domestic requirements with occasional surplus. Sugarcane is cultivated in 5.0 m ha in India (2016 - 2017) estimates. The mean cane productivity is around 70 t/ha with an average sugar recovery of nearly 10%. Domestic price of sugar in India is lowest among the world. The cost of Indian sugar production is estimated to be in the medium range – higher than Australia and Brazil but lower than that of U.S.A. Uttar Pradesh, Punjab, Haryana, Uttarakhand and Bihar are the major sugarcane growing states of the sub tropical zone while Gujarat, Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh are the major states in the tropical zone. The major sugarcane growing states, viz., Uttar Pradesh and Maharashtra, Constitute approximately 65% of the total area under sugarcane cultivation.

Table1:-Trends in sugarcane area, production, productivity and sugar recovery of U.P. (2006 to 2016).

Year	Sugarcane area (m. ha)	Sugarcane production (mt.)	Sugarcane productivity (t/ha)	Sugar production (mt)	Sugar recovery (%)
2006-07	2.247 (2.25)	133.95	58.20	8.48	9.47
2007-08	2.179 (2.18)	124.67	59.60	7.32	9.79
2008-09	2.084 (2.08)	109.05	57.20	4.06	8.94
2009-10	1.977 (1.98)	117.14	52.30	5.18	9.13
2010-11	2.125 (2.13)	120.55	59.30	5.89	9.14
2011-12	2.162 (2.16)	128.82	56.7	6.97	9.07
2012-13	2.112 (2.11)	132.43	59.60	7.49	9.18
2013-14	2.228 (2.23)	134.69	59.90	6.49	9.25
2014-15	2.141 (2.14)	133.06	60.50	7.10	9.54
2015-16	2.16 (2.18)	145.39	66.46	6.84	10.61
2016-17	2.193 (2.19)	133.70	72.37	8.75	10.61
All India (2015-16)	4.52	348.45	69.40	25.13	10.62
Estimated	Source: Crop. Sugar, vol. 48 No. 8, April 2017				

In Uttar Pradesh total 116 sugar mills including 24 of cooperative sector, one corporation and 91 private sectors are in operation. The plant size of the mills varies from 2500 to 5000 TCD with many sugar mills expanding upto 15000 TCD. During 2016-17, 8.75 mt of sugarcane was procured from farmers by the sugar mills across the U.P. The per

Capita consumption of white sugar in the country is estimated to be around 21kg during 2015-16. Another 5kg/Capita per annum sweetener consumption is from Gur/Khandsari products produced in the decentralized sector.

Geographical location of U.P in the Country:-

Uttar Pradesh states is located in subtropical region of the country and sugarcane planting lie on the latitude of 35° N and 35°S with 45° E (at elevation of 45 to 60 m above sea level).

Weather condition of U.P:-

Daily minimum and maximum temperature averages in December – January and May – June are 4.2 and 40.5 degree centigrade, respectively. Annual evaporation is around 2500 mm, and the minimum of RH (relative humidity) which is a more important factor in day time to protect green cane against hot winds depends upon the field location which is very low and ranged between 20 and 50%. Most of rainfall occurs between July and September with an annual average of about 1000 mm.

Soil characteristics of U.P:-

Texture of the soils which are cultivable in the state differed widely from sandy clay to sandy loam to silty clay loam with some salinity and alkalinity also. pH of the soil ranging from 6.5 to 8.5. Organic carbon of the soil is less than 4 percent. Also, phosphorus and nitrogen are very low but the potassium is low to medium range. Bulk density of the soil is about 1.2g cm³ and the permeability and infiltration rate is slow to medium.

Irrigation:-

Because of hot weather and high temperature with low relative humidity during summer, sugarcane fields are irrigated very frequently during formative (tiller formation) phase upto June. Each plant and ratoon field is required around 6-8 irrigations with two irrigations after rain. In the intensified cropped area ground water table decreasing day by day and reached to 90-150 feet below. Drip and sprinkler system of irrigation have given better results and to save water in the state while surface flood irrigation is common.

Opportunities and limitations:-

Opportunities:-Sugarcane is the basic raw material for sugar production, while molasses and bagasse which are the by – products of sugar industry from the feed stock for ethanol production and cogeneration, respectively. The demand for sugar, ethanol and electricity is increasing due to growing production and rising per capita income. The increased production of cane and sugar particularly this year (2016 - 17) has to be maintained from the existing cane area through improved productivity and sugar recovery since further expansion in cane area is limited. The various opportunities arising out of the inherent situations need to be cashed upon, to bring about a quantum jump in the cane productivity and sugar recovery, resulting in a economically and environmentally sustainable domestic sugar sector.

According to the projected growth in domestic and international markets, the sector would need to produce at least 600 mt of sugarcane by 2030 to meet domestic requirement of sweeteners, bio electricity and ethanol for E 20 blending. The sector has the potential to improve sugarcane yields to 100-120 t/ha and also to improve the recovery to 11.0- 11.5 % by 2030. This would enable the sector to produce additional 6.0 mt of sugar over the domestic requirements. The cane area will remain around 5.0 m ha, and this would also ensure minimal impact on other crops. In order to improve sugarcane and sugar productivity per unit area, greater investments in research and development with respect to improved cane varieties, seed nurseries, biofertilizers and adoption of improved farm practices will be key imperatives. The following key issues have been identified which are being addressed by our research institutions.

1. Low levels of cane yield and static sugar recovery.
2. High cost of cane cultivation.
3. Decline in factor productivity.

The possible scientific and technical interventions to address these issues are listed in Table 2.

Table2:-Strategies to enhance sugarcane and sugar production in India including U.P. also.

Issue	Strategies
(1) Low levels of cane yield and suboptimal sucrose recovery.	Developing location specific, high yielding, high sugar, stress tolerant, good ratooning, input responsive and climate – resilient sugarcane varieties, with particular

	<p>focus on subtropical India.</p> <p>Utilization of diverse genetic resources for introgression of un topped genes into the parental gene pool and biotic and abiotic stress management.</p> <p>Quality seed production in collaboration with sugar mills and state governments.</p> <p>Precision agriculture for improved planting methods, planting geometry, water management modules and integrated nutrient supply system for maximum yield of plant and ratoon crops.</p> <p>Developing holistic integrated pest and disease management modules including biocontrol strategies.</p> <p>Improving sink strength and some efficiency through physiological manipulations.</p> <p>Eco- friendly approaches to curb post harvest sucrose losses.</p> <p>Harnessing the potential of genomics, biotechnology, bioinformatics, nanotechnology etc. in sugarcane to improve sucrose content, agronomic traits related to productivity and abiotic and biotic tolerance.</p>
(2) High cost of cane cultivation	<p>Precision farming and thrust on bio intensive sugarcane agriculture</p> <p>Enhancing nutrient use efficiency through INM technology and recycling of crop residues.</p> <p>Improving water use efficiency through micro irrigation and water use efficient varieties.</p> <p>Enhancing the land use efficiency through companion cropping including sugarbeet.</p> <p>More focus on bio intensive IPM and IDM</p> <p>Gradual mechanization of sugarcane farming, especially on smaller farms</p> <p>Crop improvement strategies with suitable agro-techniques for energy cane development</p>
(3) Arresting decline in factor productivity	<p>Augmenting soil nutrient availability dynamics through carbon sequestration , residue recycling, bioremediation, soil amelioration through native and engineered microbial consortium</p> <p>Adopting suitable cropping systems for enhanced carbon sequestration.</p> <p>Improving resource use efficiency (land, water, nutrient) through innovative management practices</p>

Limitations/major constraints in sugarcane and sugar production:-

There are two distinct tropical and the subtropical zones in India. The tropical zone accounts for nearly 44% of sugar productivity zones viz. the area and the subtropical zone occupies 56% area. The tropical zone have very favourable weather conditions for the luxurious growth of the crop, with well distributed even sunshine throughout the year. In the subtropics, the crop experience pronounced winter, which adversely affects sprouting and growth and also erratic rainfall, drought and low/ high temperatures during late season. Consequently, the productivity in the subtropical regions is relatively low (60t/ha) compared to the tropical regions (80 t/ha). In subtropics, in U.P. average sugar recovery is 10.61% while in tropical, Maharashtra state produced highest sugar recovery of 11.30% mostly due to the ideal climatic conditions for sucrose accumulation.

- (1) **Wide gap in cane productivity:** The major factors contributing to the static or low productivity are varietal imbalance, decline in soil productivity and biotic stresses, climatic vagaries etc. However, the existing varieties and technologies developed by research organization have helped in getting record yields of 280 t/ha in tropical and 220 t/ha in subtropical at farmer's field.

- (2) **Subtropical sugar recovery:** Cultivation of rejected varieties by the farmers has invariably led to reduced productivity and low sugar recovery. Some varieties with poor productivity and low sugar content still occupy a sizeable area in northern states. The climatic aberrations during the ripening and crushing period, like western disturbances, increase in temperature and relative humidity also bring about a fall in sugar recovery in different parts of country.
- (3) **Low productivity of ratoon crop:** The ratoon crop occupies upto 50% of cane area in subtropical states like Uttar Pradesh. The major advantages of ratoon like in its early maturity, lower cost of cultivation and high sugar recovery during early period of crushing. The yield are reduced due to several factors like use of poor ratooning varieties, improper ratoon management practices, poor crop stand, deteriorating soil health.
- (4) **High cost of sugarcane production:** Sugarcane is a labour and input intensive, long duration crop. Cost of production in different regions varies from Rs. 70,000 to Rs. 1, 80,000 per hectare. Harvesting operations accounts for more than 25% of the total cost of production mainly due to high productivity per unit area are possible only through mechanization and adoption of cost effective technological interventions in cane agriculture.
- (5) **Cyclicity in cane production:** It has been the bane of Indian sugar sector. The Indian sugar industry lacks the flexibility of the Brazilian sugar industry, where the processing of cane for sugar or alcohol depends on the prevailing market trends.
- (6) **Declining soil health:** The soil carbon content and other nutrients going down (<0.3%) at an alarming rate in many sugarcane growing regions with deficiencies in micro nutrients also being prevalent in many soils. Practice of green manuring intercropping, use of organic manures, trash mulching, INM etc. may check the declination in soil health.
- (7) **Depleting water resources:** Continued mono cropping, furrow/flood irrigation and changes in precipitation patterns, the crop faces a water deficit. The total consumptive use of water varies from 200 to 250 cm for sugarcane during crop period. A part of this is met through rainfall and the remains through irrigation. Adoption of micro irrigation and water management technologies are the need of the hour, since water is becoming a limited resource.
- (8) **Other constraints:** Abiotic stresses such as salinity, alkalinity, drought and water logging and biotic stresses like diseases and pest like red rot, smut, wilt and sett rot (fungal), leaf scald disease and ratoon stunting disease are found to cause considerable yield loss in northern regions. Increased incidence of other diseases like yellow leaf disease (YLD), Pokka-boeng is being reported. Incidence of borer, *pyrilla*, termite, white grub and mealy bugs has also increased. Change in climate, erratic rainfall, high temperature, increase in atmospheric CO₂ concentration, soil moisture depletion etc. will invariably lead to a decline in sugarcane and sugar production. Sugarcane agriculture could be sustained only if profitability can be assured by reducing the cost of cultivation and improving the productivity area.

Sustainable sugarcane and sugar production is possible through new research innovations in cane agriculture. Keeping in mind the food, energy and development efforts on sugarcane are utmost importance, especially in subtropical region where cane yield and sugar recovery need to be improved substantially.

Conclusions:-

Because of climatic conditions in subtropical regions especially in U.P. sugarcane and sugar production needs more special attention. Maintaining soil health, rising water table, mechanization in cultivation, INM and IDM, better ratoon management, intercropping and improved agronomic practices with development of improved varieties for the particular zone etc. are of great importance for sustainable sugarcane and sugar production.

Sugar production vision 2030:-

With a vision for achieving high economic growth, improving cane productivity along with sustainability and contributing to the nation's food and energy needs, the industry explores all available option to realize this vision. Sugar consumption in the next 5 years is expected to touch 30 mt due to improved domestic supplies and strong demand. The population in the country is set to reach 1.50 billion by 2030 at the present compound growth rate of 1.6% per annum. The projected requirement of sugar for domestic consumption in 2030 is 36 mt which is about 50% higher than the present production. To achieve this target, the sugarcane production should be about 500 mt from the current 350 mt for which the production has to be increased by 7 -8 mt annually. The increased production has to be achieved from the existing cane area through improved productivity (> 100 t/ha) and sugar recovery (> 11%) Since, further expansion in cane area is not feasible. The energy demand in India is estimated to grow by 200% or more by 2030 (Nair, 2010).

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