

# Trend of Sugarcane and Jaggery Production in Assam and Associated Problems and Prospects

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## Abstracts

*Sugarcane is one of the important cash crop of Assam occupying an area of about 29 thousand ha with an average productivity of 37 t/ha. Poor yield of the crop is mainly due to some abiotic and biotic stress conditions, social and technical constraints and poor mechanization. Major reasons for low yield are heavy monsoon rainfall, reduced sunshine hours, high incidence of insect pests, lack of irrigation and low input use. The crop is grown in almost all the districts of Assam under varied soil and climatic conditions. Major sugarcane growing districts are Karbi-Anglong, Nagaon, Dima Hasao, Sonitpur and Golaghat. Almost all the cane produced in the state is utilized for making of jaggery except in places near city areas where the cane is used for raw juice during summer season. However, cane growers earn less income due to lack of adequate market facility and absence of proper marketing channel. The state has tremendous scope of enhancing the cane productivity through development of high yielding and pest and disease resistant varieties, development of abiotic and biotic stress management modules, adopting integrated nutrient supply system and sustaining its productivity by following suitable cropping systems.*

**Keywords:** Sugarcane, jaggery, status, problems, future strategy, cane production.

## I. INTRODUCTION

The total geographical area of Assam is 78,520 Sq. km out of which 54.11% area is occupied by Agriculture sector alone. Agriculture and its allied activities played an important role in the socio-economic development of the State. Economy of Assam is based mainly on Agriculture and among all the productive sectors agriculture makes the highest contribution to its domestic product, accounting for more than a third of state income and employing 69% of total workforce. About 90% of the farmers belong to small and marginal groups with average operational holding being 1.55 hectares and agriculture is the main source of their livelihood. There are a number of crops grown by the farmers. These include different food crops, commercial crops, oil seeds etc. The principal food crops produced in the state are rice maize(corn), pulses, oilseed, potato, wheat, etc. and tea, jute, oilseeds, sugarcane are the important cash crops grown in the state.

The cropping intensity of the state is 152.43 percent. Rice is the major crop grown mainly during kharif season which dominates the agriculture scenario in Assam occupying an area of 17 lakh ha. Although rice is the principal crop dominating the cropping pattern of the state, sugarcane is one of the important commercial crops grown in Assam which contributes 1.36 per cent of gross cropped area. It is interesting to know that while the overall gross cropped area has decreased in last decades the area under sugarcane is increasing at the rate of 1.08% per annum which is possibly due to growing demand for molasses and

sugarcane juice in city areas. Sugarcane is the raw material for the production of white sugar, jaggery (gur) and molasses. It is also used for chewing and raw cane juice purpose. The sugarcane cultivation plays a vital role in rural economy by mobilizing rural resources and generating high income and employment opportunities. A large numbers of agricultural labour are involved in sugarcane cultivation and other ancillary activities. Major sugarcane growing districts in the state of Assam are Karbi-Anglong, Nagaon, Dima Hasao, Sonitpur and Golaghat where sugarcane is grown on a large extent of area under upland condition. There are a number of varieties that are grown in Assam depending on the suitability of the soil. In recent time sugarcane area is declining in some districts as a consequence of replacement of sugarcane area by tea crop owing to greater influence of large tea industries. Switch over from sugarcane to tea cultivation is caused by high labour requirement in sugarcane cultivation, shortage of agricultural labour due to rapid urbanization and migration of labour to urban areas. However, rising demand for gur in village as well as city areas has prompted many sugarcane growers to revert back to sugarcane from tea cultivation resulting in marginal increase in sugarcane area.

## II. PRESENT SCENARIO OF SUGARCANE PRODUCTION IN ASSAM

Sugarcane is grown more or less in all districts of Assam (Table1). However, major sugarcane growing areas are located in Karbi Anglong, Nagaon, Dima Hasao, Sonitpur and Golaghat districts. The highest

area was found in Karbi-Anglong district (7639 ha) and Sonitpur (2452 ha). followed by Nagaon (6124 ha), Dima Hasao (3420 ha)

**Table 1: District Wise Area, Average Yield And Production of Sugarcane For The Year 2013-2014**

Districts	Area under crop (ha)	Average Yield		Total Production	
		Cane (kg/ha)	Gur (kg/ha)	Cane (tonnes)	Gur (tonnes)
DHUBRI	145	36969	3630	5361	527
KOKRAJHAR	261	36969	3630	9649	948
BONGAIGOAN	191	36969	3630	7061	693
CHIRANG	209	36969	3630	7727	759
GOALPARA	249	36969	3630	8910	875
KAMRUP (R)	982	40464	3974	39736	3902
KAMRUP (M)	107	36969	3630	3956	388
NALBARI	250	34029	3342	8507	835
BARPETA	364	36969	3630	13457	1322
BAKSA	325	18787	1845	6106	600
SONITPUR	2452	38039	3735	93272	9160
DARRANG	527	41774	4102	22015	2162
UDALGURI	692	37085	3642	25662	2520
NAGOAN	6124	35792	3515	219193	21525
MORIGOAN	950	33296	3270	31361	3106
JORHAT	829	28703	2819	23795	2337
GOLAGHAT	2040	35062	3443	71526	7024
SIVASAGAR	81	36969	3630	2995	294
LAKHIMPUR	310	46754	4591	14494	1423
DHEMAJI	113	36969	3630	4178	411
DIBRUGARH	89	36969	3630	3290	323
TINSUKIA	205	36969	3630	7579	745
CACHAR	126	33829	3322	4263	419
HILAKANDI	175	36969	3630	6470	635
KARIMGANJ	236	35672	3503	8419	827
K. ANGLONG	7639	39506	3879	301787	29636
DIMA HASAO	3420	36296	3564	124132	12190
<b>ASSAM</b>	<b>29083</b>	<b>36969</b>	<b>3630</b>	<b>1075171</b>	<b>105586</b>

Source: Statistical Hand Book Of Assam, 2014

**Table 2: Production Scenario Of Sugarcane In Assam In Last Few Years (1994-2015)**

SI No	year	Total Area ('000 ha)	Avg. Productivity (ton/ha)	Total Production (Lakh MT)
1	1993-94	36	38.4	13.74
2	1994-95	36	42.3	15.05
3	1995-96	36	41.5	14.90
4	1996-97	36	41.5	14.90
5	1997-98	31	41.1	12.88
6	1998-99	31	40.0	12.24
7	1999-2000	29	39.8	11.55
8	2000-01	27	36.6	98.80
9	2001-02	27	37.3	10.11
10	2002-03	25	36.4	91.60
11	2003-04	25	38.59	9.81

12	2004-05	24	36.92	8.84
13	2005-06	23	37.19	8.71
14	2007-08	26	38.07	9.80
15	2008-09	29	38.38	11.00
16	2009-10	27	39.11	10.62
17	2010-11	30	36.19	10.76
18	2011-12	28.4	37.05	10.53
19	2012-13	28.8	35.61	10.28
20	2013-14	29	37.06	10.75
21	2014-15	29.9	36.76	10.99

Source: Directorate of Agriculture, Assam

In all the districts sugarcane is mainly grown for production of jaggery.

### III. SUGARCANE PRODUCTION IN DIFFERENT AGRO -CLIMATIC ZONE OF ASSAM

Based on the rainfall pattern, terrain and soil characteristic, Assam has been divided into six agro-climatic zones viz. a) North blank plain zone comprising Darrang, Sonitpur, Lakhimpur, Dhemaji and Udalguri districts, b) Upper Brahmaputra valley Zone comprising Golaghat, Jorhat, Sivsagar, Dibrugarh and Tinsukia districts, c) Central Brahmaputra Valley Zone comprising Nagaon and Morigaon districts, d) Lower Brahmaputra Valley Zone comprising Goalpara, Baksa, Dhubri, Kokrajhar, Bongaigaon, Kamrup, Nalbari, Barpeta and Chirang districts, e) Barak Valley Zone comprising Cachar, Karimganj and Hailakandi districts and f) Hill Zone comprising Dima Hasao and Karbi Anglong districts.

#### A. Distribution of sugarcane area zone wise

- 1. North Bank Plain zone:** This zone comprises of a total 4094 ha of land under sugarcane cultivation. Sonitpur is dominating sugarcane growing district with a total sugarcane area of 2452 ha.
- 2. Upper Brahmaputra Valley zone:** This zone comprises of a total 3244 ha of land under sugarcane cultivation. Golaghat is dominating sugarcane growing district with a total sugarcane area of 2040 ha
- 3. Central Brahmaputra Valley zone:** Major sugarcane growing district in this zone are Nagaon and Morigaon with a total sugarcane area of 7074ha.
- 4. Lower Brahmaputra Valley zone:** Area under sugarcane is very negligible in this zone. Sugarcane is grown in few pockets mainly for chewing and raw juice purpose.

- 5. Barak Valley zone:** Area under sugarcane is very negligible in this zone and estimated at a total of 537 ha.
- 6. Hills zone:** This zone comprises of a total 11059 ha of land under sugarcane cultivation. Karbi-Anglong is dominating sugarcane growing district with a total sugarcane area of 7639 ha

### IV. STATUS OF JAGGERY IN ASSAM

#### A. Traditional uses of sugarcane in Assam

In Assam sugarcane is used both as raw (juice) and post harvest products. There is a high demand of raw cane juice in city during hot summer season. Gur (Jaggery) and molasses are the two principal post harvest products frequently used in various occasion for making some traditional food items such as til-pitha, laddo, rice cakes etc. In village areas gur is taken along with tea instead of sugar. Jaggery is also used as sweetening agent for making sweets and other food items. Molasses is mainly used for manufacturing of liquor.

#### B. Status of jaggery production in Assam

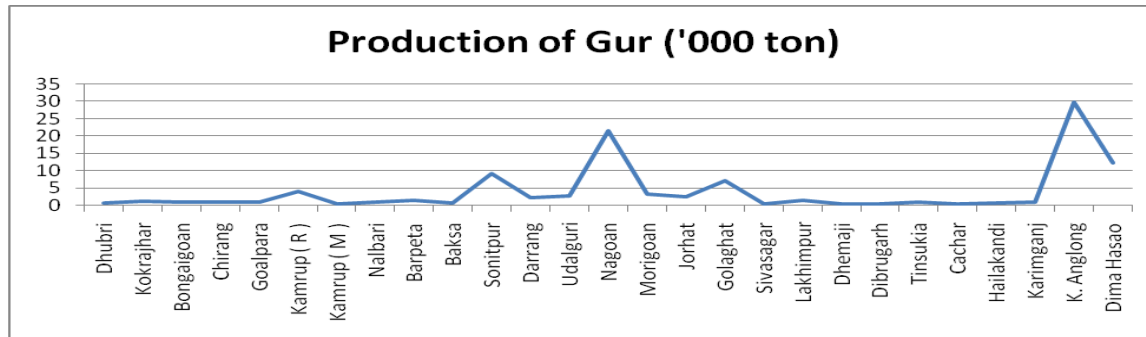
In Assam sugarcane is grown in 29.09 thousand ha area of land with total cane production of 10, 75,171 tonnes and estimated 1, 05,586 tonnes of gur. The highest quantity of jaggery is produced in Karbi Anglong district (29.64 thousand tonnes) followed by Nagaon district (21.52 thousand tonnes), Dima Hasao district (12.2 thousand tonnes) and Sonitpur district (9.2 thousand tonnes). Major portion of sugarcane produced in the state is utilized for jaggery manufacturing. Jaggery production is at very low level in other parts of the state. Almost all the sugarcane farmers in these areas produce jaggery from their produce. Jaggery (Gur) manufacturing starts from last part of December and continues up to March/ April. In general jaggery is marketed through middle man resulting in poor return to the farmers.

**Table 3: Status Of Jaggery Production In Assam**

Sl No	Year	Jaggery production (MT)
1	2012-13	100966
2	2013-14	105586
3	2014-15	107942

X axis: all sugarcane growing districts of Assam

Y axis: production of Jaggery (gur) in ‘000ton’



**Fig1: District wise production of gur ('000ton) in Assam during 2013-14**

**V. MAJOR CONTRIBUTING FACTORS AFFECTING SUGARCANE PRODUCTION**

In Assam sugarcane is grown mainly grown in sandy loam to clay loam soil under upland condition. Typical clay or sandy soil is not preferable for its cultivation. The crop performed well in medium to high fertile soil as the nutrient requirement of the crop is very high consequent upon its large biomass production. Sugarcane is grown mainly in upland soil with good drainage facility. Poorly drained soil is not suitable for its cultivation. In the flood affected districts e.g., Lakhimpur, Dhemaji, Morigaon sugarcane is mainly grown in flood free uplands only. Now -a -days in char areas (river bank) sugarcane is grown as autumn crop after recession of flood. The crop is mainly grown under rainfed condition. Often sugarcane planting has to be delayed til April/May due to high moisture stress in early period.

As the sugar yield is directly related to photosynthesis, the crop may also suffer due to cloudy weather during peak monsoon period mainly in June-July. High wind during later stage may cause lodging of the plant which affects the quality of the Juice and its products. The crop is also affected seasonal drought in the later stage of the crop growth. In Assam rainfall ceases during September/ October resulting in a drought like situation especially in upland which restricts the crop growth and ultimately results in poor yield. Cane is harvested during winter period mainly in December-January. Low winter temperature coinciding with cloudy humid weather often result in poor juice quality.

There is significant influence of Pest and disease in sugarcane production. Among the different pests occurrence of woolly aphid, early top borer, top borer, stem borer, plassy borer is common. Attack of early shoot borer is found during the early stage of crop growth during March-April. Whereas attack of stem borer is found throughout the crop growth period but cause a major damage during June to September both in the early and late stage. Top shoot borer cause a major damage to the cane crop from the beginning of May up to the end of September. The borer cause severe damage to canes only in the early stages in June- July when nodes have not been formed.

Different diseases such as red rot, grassy shoot, pokah boeng, leaf spot, mosaic disease and wilt are found to infest the sugarcane. However, the intensity of the diseases varies from place to place and year to year. Red rot is one of the most serious which cause almost 100% crop failure if it infest at early stage of its crop growth. From survey conducted at different locations of sugarcane growing districts of Assam it is found that intensity of leaf spot disease is more as compared to other diseases which varies from 45-60% and common leaf spots diseases are cercospora leaf spot, ring spot, eye spot and brown spots.

Weed is also an obstacle for sugarcane growers in Assam which infest both plant as well as ratoon crop. The main predominant weed species in sugarcane are *Borreria articularis* (L.f.) will, *Ageratum houstonium* L, *Setaria palmifolia*, *Calocasia spp*, *Dicanthium annalutum*, *Melochia corchorifolia* L. *Anoxopus compresus*, *Convolvulus arvensis* L, *Sida rhombifolia*, *Brachiaria remosa*, *Cyperus pilosus* L and

*Commelina spp.* Weeds compete with the sugarcane crop for the applied fertilizers, water, sunshine and hence crop growth suffers. In the first one or two months of sugarcane planting weeds do the maximum loss to the crop. If more weeds are there in sugarcane field the number of tillers will be less and Sugarcane crop will be weak due to weed competition.

It was found that weed infestation resulted in 12 to 83% loss in cane yield. In sugarcane crop keeping the field weed free up to 30 days from germination is essential to minimize the loss due to weed. Lack of timely weeding is one of the major causes of yield reduction in sugarcane crop. Weeds can be easily removed in between rows but removing of weeds within the rows is difficult. Non availability of labour for the weeding at the right time, higher expenditure and lack of mechanization in weeding are the major problems faced by sugarcane grower.

Sugarcane ratoon is highly remunerative and it is found that up to 3-4 ratoon can be grown successfully. Management of ratoon crop is another problem for sugarcane growers. In Assam generally ratooning is followed up to 2-3 years. Ratoon crop occupies about 40-50% of total sugarcane area in Assam. One of the major problems of growing ratoon crop in the entire state is the poor plant population due to lack of adequate shoot sprouting in dry winter months. There may be up to sixty percent mortality of tillers in ratoon crop and thus resulting in poor cane yield at harvest. Ratoon crop also requires a higher dose of nitrogen than the plant crop. An extra dose of 25% nitrogen is recommended for ratoon crop. The crop is however neglected and total lack of fertilizer use and lack of other maintenance operation leads to poor yield. In almost all the places the ratoon crop receives neglected attention. Such crops are also prone to pest and diseases. The cane yield also declines in successive ratoons in most of the sugarcane growing areas due to lack of maintenance of adequate plant population.

Sugarcane grown in char areas of Kamrup, Lakhimpur, Dhemaji, and Majuli district is affected by water logging during peak monsoon period. Flash flood and silt deposition in the river bank areas poses a serious problem of sugarcane grown in these areas. Water stagnation generally occurs in last week of July and continues until the end of September. Stagnant water in these areas affects the crop growth and reduces the crop yield.

## V. SOILS AND CLIMATIC CONDITION FOR SUGARCANE CULTIVATION

### A. Soils of sugarcane growing areas of Assam

Major sugarcane areas are located in upland situation in the districts of Golaghat, Jorhat, Karbi Anglong, and Dima-Hasao in the southern bank of river Brahmaputra. The upland soils are silty clay loam to clay at surface and their sub-soils have heavy texture. Surface soils of hilly areas comprising Karbi Anglong and Dima Hasao districts are generally lighter in texture. They are mostly loam to clay-loam or sandy loam. A large extent of sugarcane growing areas are located in the medium land situation of Nagaon and Morigaon district, river bank areas of Golaghat and Jorhat district and in the river island Majuli. These soils are predominantly sandy loam to silt clay loam. In the northern bank of Brahmaputra sugarcane soils of Darrang and Sonitpur districts texturally vary from sandy to clayey. Soils of sugarcane growing areas in Cachar and Karimganj districts in the Barak valley have silty loam to clayey soils. Bulk density of soils ranged from 1.36 to 2.10 g/cm<sup>3</sup>, saturation values from 25.7 to 54.7% and field capacity from 3.1 to 29.2% in the soils of southern valley of river Brahmaputra. The soil pH of the sugarcane growing areas in the southern part of Brahmaputra varies from 5.5 to 7.6. In Karbi Anglong and Dima Hasao, soil pH varies from 4.90 to 6.65 while in Barak valley it ranges from 4.6 to 5.7. Soils of tilla land are markedly acidic. The organic matter content of soil varies from 0.72 to 4.60% with an average of 2.3% in Karbi Anglong and from 1.27 to 4.50% with an average of 2.94% in Dima Hasao. The soils of Barak valley have high organic matter content. In Brahmaputra valley the average organic matter contents of sugarcane soils ranged between 1.02% and 2.70%. In general, organic matter and N contents were higher in red loam soils. In Barak valley total N content is high (0.09 – 0.15%). While it N varies from 0.034 to 0.22% in upland soils of soils of Brahmaputra valley.

Deep soils in the foot hill region and the old alluvial upland soils in the districts of Karbi Anglong, Dima Hasao, Golaghat, Darrang, Sonitpur and Cachar with depth of water table >2 m up to 10 m and good drainage are suitable for sugarcane crop. Sugarcane is also grown in the medium land situation of Nagaon, Morigaon, Darrang, Sonitpur and Jorhat districts with depth of water table ranging between 1 to 2 m.

### B. Climatic conditions:

Sugarcane is grown successfully under varied soil and climatic condition. Cane production and cane juice quality differs due to variation in soil and climatic condition and crop varieties grown there on. Among all meteorological parameters temperature and rainfall plays a major role in cane production. In Assam the maximum temperature goes up to 35-38<sup>o</sup>C in summer and minimum up to 6-8<sup>o</sup>C during winter. Crop duration of sugarcane is 10-12 months and it requires a warm



humid weather during active growth phase. Sugarcane growing areas in Assam experiences moderate to high temperature in the range of 30-38°C and high humidity (80-95% RH). Prevalent temperature during February to April and September- October is suitable for bud germination prompting planting of setts for spring and autumn season, respectively.

Sugarcane is mainly grown as rainfed crop in Assam as well as other north eastern states. Monsoon shower received in this region during June- September is sufficient to meet the water requirement of the crop. Premonsoon showers during March/April and post monsoon residual moisture helps to maintain adequate soil moisture for sett germination and planting. For an optimum crop growth requirement of water inclusive of rainfall has been assessed at 1000-2000mm. Assam receives on an average about 2200 mm rainfall per year, but the distribution is very erratic and irregular in nature within the state. The highest rainfall is received during April to August after that rainfall decreases gradually.

Moreover, average annual temperature of the region with minimum temperature not less than 7°C is suitable for sugarcane crop ripening and sucrose accumulation. Drier and cooler climate during winter months help in growth cessation and encourage sucrose accumulation in the stalk. A temperature range of minimum 18°C and maximum 29°C at the onset of fall causes restricted vegetative growth and diversion of energy in favour of cane maturity and accumulation of sucrose. Crop maturity is attained during the months of November, December, and January depending on the type of variety and plant type.

## VI. GROWING SEASON

Assam belongs to subtropical region having warm humid summer and cool dry winter. The growing season is confined to one year, due to short growing season the productivity is less as compared to tropical region. Sugarcane is grown as rainfed crop in Assam. It is planted mainly in March –April with the Premonsoon shower. Harvesting of the crop starts from the month of December-January when the night temperature falls.

## VII. SUGARCANE BASED CROPPING SYSTEM

Sugarcane is mainly grown in upland areas as monocrop. It takes about 10-12 months from planting to maturity depending upon the variety. It is planted in March-April and harvested in December-January. Therefore it is not possible to fit a second food crop in the spring planted crop. Monocropping of sugarcane is generally followed in Assam due to long growing

season. However, in case of autumn planted crop in char and river bank areas of Sonitpur, Dhemaji, Lakhimpur and Majuli crops such as potato, rapeseed is raised as intercrop.

## VIII. CONSTRAINTS IN SUGARCANE CULTIVATION IN ASSAM

### A. Biotic and abiotic stress

#### 1. Heavy weed infestation

The high humid condition of Assam favors the weed infestation in sugarcane field. Weed is an obstacle for sugarcane growers in Assam which infest both plant as well as ratoon crop. The main predominant weeds species such as *Borreria articularis* (L.F) Will, *Ageratum haustonianum* Mill, *Setaria palmifolia* spp (J.Koenig) stapf, *Dicanthium annulatum* (Forssk.)stapf, *Melochia corchorifolia* L, *Axonopus compressus* (SW.) P.Beauv, *Convolvulus arvensis* L, *Sida rhombifolia* L, *Brachiaria amosa* (Sm).Griseb., *Cyperus pilosus* Vahl, *Commelina Spp*, and *Mimosa invisa*. Out of all these weed species, the problem of *Borreria articularis* (L.F) Will, *Ageratum haustonianum* Mill, and *Mimosa invisa* is serious.

#### 2. Draught in later stage of crop growth

In Assam rainfall ceases from October month onwards. The state receives very less amount of rainfall during October to February. As a result drought like situation prevails in later part of crop growth stage.

#### 3. Flood or water stagnation during peak monsoon period

In Assam the monsoon period starts from June and ends in September. During this period the state receives the highest amount of rainfall of 1702 mm. Therefore water stagnation in standing crop is main problem in certain areas during peak monsoon period. Sugarcane grown in char areas of Kamrup, Lakhimpur, Dhemaji, and Majuli is affected by water logging during peak monsoon period. Flash flood and silt deposition in the river bank areas poses a serious problem of sugarcane grown in these areas. Water stagnation generally occurs in last week of July and continues until the end of September. Stagnant water in these areas affects the crop growth and reduces the crop yield.

#### 4. Damaged by animals and other pests

Damage by monkey, rodents to the sugarcane crop is very extensive and is a problem in many sugarcane fields. Although rodent is a major problem in almost all the places of Assam, damage by monkey is creating havoc in some places of Golaghat district of Assam.

### 5. Heavy incidence of pests and diseases due to high humidity

Among the insect pest early shoot borer, top borer and plassey borer is the regular pest in sugarcane growing areas of Assam. Out of these, plassey borer is the major one followed by early shoot borer and top borer. The intensity of attack of plassey borer ranges from 26% to 40% in unmanaged sugarcane field. The attack is around 12-15% in managed field. In case of early shoot borer and top borer the infestation per cent varied from 10-12. Moreover, out of different sucking pests of sugarcane leaf hopper (*Pyrilla perpusila*), mealy bug (*Saccharicoccus sacchari*), and wooly aphid (*Ceratovecuna lenigera*) are very common in sugarcane growing areas of Assam and NER.

### 6. Low light intensity during kharif season

Low light intensity due to cloudy weather during kharif season affected the crop growth.

### 7. Poor germination

The crop is mainly grown under rainfed condition in the entire state. The erratic and uneven distribution of rainfall delayed the timely planting of crop and affected germination resulting in poor plant population.

### 8. Lodging due to wind:

Occasionally high wind speed causes heavy damage to the crop in the way of crop lodging during post monsoon period.

### 9. Erratic and uneven distribution of rainfall

This is the major climatic factor which affects the sugarcane crop growth. Assam belongs to high rainfall area with average rainfall of about 2200 mm per year but rainfall distribution is very erratic and irregular in nature within the state. Premonsoon shower is received during March to May with normal rainfall of 648mm. Monsoon occurs during June to September receiving the highest rainfall in the range of 1800 mm. Post monsoon period from October- November receives average rainfall of 167.4 mm. Winter months receives scanty rainfall with an average of 66.25 mm. Besides this, distribution of rainfall is not uniform throughout the state. Barak valley zone receives much higher rainfall as compared to other parts of the state during monsoon. On the other hand a rain-shadow belt Karbi-Anglong and Nagaon extending partly to Golaghat district receives scanty rainfall.

### B) Technological Constraints

- 1) High labour intensive crop and shortage of labour during peak period of operation.
- 2) Lack of modern implements such as trench makers, cutter cum planter increases the labour cost in field operation.

- 3) The crop mainly grown under rainfed condition. Therefore lack of assured water supply often limits the crop production. Improper water management resulted in poor crop stand and low yield.
- 4) In many places still some poor yielding variety is grown.
- 5) The state receives high amount of rainfall during monsoon period. Due to poor drainage facility the crop suffers from water stagnation during this period. As a result quality of product is reduced.
- 6) Imbalance or low use of chemical fertilizer due to high price.
- 7) Lack of proper management practices often hinders the crop growth.
- 8) Lack of proper spacing (closure) resulted in poor tillering, growth and yield.
- 9) Proper ratoon management practices are seldom followed resulting in poor crop stand.
- 10) Low awareness among farmers to use improved cultivation practices.
- 11) Negligence in plant protection.

### C) Social Constraints:

- 1) Capital deficiency: commercial capital, i.e., loan from banks or other credit agencies is not easily accessible to farmers in Assam.
- 2) Fragmented land holding.

### D) Poor Mechanization:

All the farm operation starting from planting to harvesting of sugarcane is mainly labour dependent. Generally mechanization is followed in land preparation. During land preparation MB plough, disc plough, disc harrow, rotavator, power tiller with cage wheel, tractor with cage wheel, mini tractor etc are used in sugarcane cultivation. Sugarcane growers are mostly marginal to small farmer. Majority being in the lower income group growing their crop in marginal and fragmented lands. So the demand as well as capability of farmers to introduce heavy machinery is still a remote possibility. Besides this lack of sugar mill in the region and absence of efficient market system for sugarcane and its product are very discouraging for the cane growers. Therefore, they will be hardly interested to go cost effective mechanization of sugarcane cultivation. However, in some areas particularly in Nagaon district, where sugarcane is grown in large areas by large farmers and groups of farmers mechanization in sugarcane planting, weeding and sugarcane harvesting is in the need of the hour. There is also need for improved mechanization in sugarcane processing and jaggery making.

## IX. CONSTRAINTS IN JAGGERY PRODUCTION

- a) Farmer mostly uses vertical crusher which is either bullock drawn or machine operated. Farmers with higher acreage and production use machine. Crushing efficiency of mechanical crusher is slightly higher (40-50%) and requires less time in crushing.
- b) Conventional single pan furnace is commonly used for juice boiling which requires about 2.5 -3.5 hrs for boiling. Therefore conventional method of jaggery production is time consuming and resulted in low output per day (30-40 kg).
- c) Both solid and semi-solid jaggery is produced. Solid jaggery is dark colored and soft to semi hard in hardness which is not preferred by customer.
- d) Packeting of jaggery in different shapes and sizes is not practiced. Jaggery is produced in bulk volume or weight size for sale in local market. In retail market the large volume lumps is kept open exposing to dust, which is not a hygienic practice and this may deter a section of conscious consumer. Besides this, while selling the produce from the large lumps a considerable amount of loss of the product may occur.
- e) Earthen pot and metal tins used for storing of jaggery are not convenient and cannot store for long period. Therefore the product has to be sold immediately due to storage problem.
- f) Losses of jaggery occur in the range of 2-6% due to damage by rodents, late crushing and in storage and transportation. Major losses occur due to damage by rodents during storage.
- g) Marketing channel for inter district and interstate marketing is not well established. Therefore the product is mostly sold in the local market and has to be disposed to the hoarders.

#### X. FUTURE STRATEGIES FOR SUGARCANE IN ASSAM

- Developing high yielding, disease resistant and pest tolerant, good ratooning, input responsive sugarcane varieties.
  - Development of biotic and biotic stress management modules and integrated nutrient supply system for maximizing yield of plant and ratoon crops.
  - Evaluation of genetic resources in sugarcane for sustainable sugar yield under biotic and abiotic stress.
  - Improving quality seed production
  - Developing integrated pest and disease management modules.
  - Minimizing post harvest losses in sugarcane
- Use of biotechnology, bioinformatics in improving the genetic stock
  - Providing training, consultancy and advisory services to farmers, industries and other stockholders.
  - Improved post-harvest processing of sugarcane and develop alternative use of cane juice and other by-product in the context of dwindling market scenario of sugarcane and jaggery.
  - Mechanization in sugarcane cultivation and post-harvest operation
  - Enhancing the storability of Jaggery using low cost methods.
  - Development of suitable bio-control measures against prevalent pest and diseases of sugarcane.
  - Sustaining soil health and sugarcane productivity through organic means.
  - Develop suitable organic cultivation practices for high cane yield and sugar recovery.
  - Enhancing input use efficiency
  - Sustaining crop productivity and soil health through suitable cropping system

#### CONCLUSION

Sugarcane is an important cash crop of the NE region particularly in the state of Assam which occupies 1.36% of the gross cropped area of the state. However, there is a decline in the sugarcane area as a consequence of closure of all the sugar mills in the state and due to lack of adequate market facility for the crop and its products. In recent years there is a marginal increase in the sugarcane area obviously due to growing demand and increased price for jaggery. Soil, climate and other conditions of the region being suitable for the crop there is possibility of good harvest. Thus, there is ample scope for increasing acreage under sugarcane and subsequently its industrialization with strategies being adopted.

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