**BIOCHEMICAL STUDY OF SUGARCANE:**

**An Economic Approach**

**INTRODUCTION:**

Sugarcane(*Saccharum officinarum)*crop occupies a very important position in the economy of many developing countries including India and has been used for sugar production since time immemorial. However, the comprehensive use of sugarcane through its by-product and other value add-products is one of the principal lines of action that sugar producing countries are attempting these days. The concept of cane diversification involves its agro-industrialisation utilization; viz, paper, alcohol derivatives, animal feeds, anti-biotics, boards, environmentally safe alcohol fuel and residue recycling for sustainable agriculture to maintain an eco-friendly environment. The Indian sugarcane not only serves millions of farmers directly but also plays creative role for a fast agro-economic transformation of the nation.

Sugar or sucrose is a soluble substance capable of crystalisation of saturation, of caramillization, of peptization and preservative action. When a pinch of sugar is cooked into the mouth it passes into the stomach without chemical changes. During digestion it is broken up into equal portions of glucose and sucrose which enter the blood stream through the small intestinal walls. The blood carries these sugars and their compounds to the tissues and the liver where excess. If any, is removed and stored as glycogen, a starch like compound. When more energy is needed the liver converts glycogen into glucose which is conveyed to the muscle or organ where the energy is required. Body cells break down this blood sugar into carbon dioxide and water and energy is released.

There can be no substitute for sugar. Saccharine is no doubt much sweeter than sugar but this synthetic product when taken by mouth is eliminated unchanged through urine and therefore no food value. Its use is confined to diabetic patients. Moreover, it is injurious to human health in the long run. Besides, being a sweetening agent, sugar represents 1/7th of the energy intake of human food. It is used in manufacture of confectionary pharmaceuticals plastics dairyproducts and pickles.

It has been found that the amplitude of fluctuation of area as well as production was less in the tropical belt than in the sub-tropical belt. Extension of cultivation to the peninsula has therefore serve the purpose of stabilizing output to some extent. It has also contributed to higher productivity because both per acre yiled and sugar contents of cane in these areas are higher than in the north to which about 3/4th of crop was confined in the past.

Another important factor that determines the sugarcane quality is availability of healthy, disease free seed to the growers. This is only possible if the sugarmeals have their own farms, sufficient enough to supply seeds to the growers in such a manner that the entire seed if, changed in a period of three years.

**REVIEW OF LITERATURE:**

Sincere attempt has been made in the present study to have a brief review of relevant studies and research findings of eminent scholars and researchers on the various aspect of sugarcane and its economic importance related to production, marketing & cost-benefit analysis. Available literature relating to the present study is too vast and it is impossible on the part of the researcher to make an exhaustive study.

* ***Soloman***(2000):

It is imperative that in order to get quality sugar regular and effective cane and mill sanitation programme should be implemented. This will help in boosting the quality and quantum of the end product-sucrose.

* ***Shahi***(2000):

The main objective of sugarcane is to obtain maximum possible recoverable sugar and the minimum possible as loss in extracting juice from sugarcane during milling. The quantitative sugar losses reported in a sugar factory are in bagasse, press cake and molasses. The short fall of recoverable sugar as finished product from input interms of sugarcane actually crushed is reported as unknown sugar losses. The sugar recovery percent cane is thus calculated after deducting total sugar losses percentage cane.

* ***Gupta***(2000):

The sugar industry bye-product are vast potential reserves for human and animal consumption as well as capable of providing energy as renewable source.

* ***Sarmah & Bordoloi***(2008):

In India apart from making 5% blending of ethanol with petrol mandatory, the government has allowed sugar mills to produce ethanol directly from sugarcane juice rather than the conventional method of producing ethanol from molasses.

* ***Ahirrao***(2008):

Ethanol is a bio-fuel produced from the fermentation of sugar or sugarcane. It can be used as an automotive fuel by itself or it can be mixed with petrol. Ethanol has been made since ancient times by the fermentation of sugar. Simple sugar are the raw material of ethanol. Ethanol is also considered as a renewable fuel. It has atleast two direct benefits. Firstly, it will give a boost to the agricultural sector by stabilizing sugar prices and enhancing buffer stock to ease worries of factories being burdened with huge stock. Secondly, it will also connect farmers in a more inclusive way to the economy as they would have another outlet for their sugarcane production.

* ***Jain***(2008):

Indian sugar economy suffers due to sharp variation in sugar productions in the range of about 20 to 22% in a span of 4-5 years as against normal variation in other countries in a range of 3-4% based on climatic condition alone.

* ***Pandey et.al***(2000):

Sugarcane is cultivated in more than 20 million hectares in tropical and sub-tropical regions of the world producing upto 1.3billion metric tons of crushable stems. It has served as a source of sugar since 100 year represents an important renewable bio-fuel source which could turn into a global community and important energy source.

* ***Paiva et.al….,2004;Han & Wu,***(2004):

It is expected that enzymatic & hydraulic process that allow the bagasse carbon units from cellulose and hemi-celluloses to be fermented for ethanol production, turning sugar cane into an efficient crop for energy production as well.

* ***Xiong et.al***,(2002):

Abiotic stress is the primary cause of crop loss world wide reducing average yield for most major crop plants by more than 50%. Low temperature drought & high salinity are common stress condition that adversely affects plant growth and crop production.

* ***Shannon***(1998):

Salinity in soil or water is one of the major stresses especially in arid and semi-arid regions severely limiting crop production.

* ***Hasegawa et.al***(2000):

The cellular and molecular responses of plants to environmental stress have been studied intensively.

* ***Amtmann et. al***(2005):

The capacity to sequence genomes & the availability of novel molecular tools have now captured biological research into eras of genomics and post genomics, creating an opportunity to apply genomic techniques to extremophile models.

* ***Zhu*** (2001):

Sugar cane being a glycophyte shows high sensitivity to salinity at various growth stage. As for glycophytes sodium toxicity represents the major ionic strss associated with high salinity, enforcing ion imbalance or disequilibrium, hyper ionic and hyper osmotic stress, thus disrupting the overall metabolic activities and causing plant demise.

* ***Jain et al…,***(2007):

Moreover in India 3.3 millions hectare of 2.46 million hectare of land is affected due to salt and water logging condition respectively.

* ***Tester & Davenport,***(2003):

Salt stress creates both ionic as well as osmotic stress on plants on these stress can be distinguished at several levels.

* ***Selvam et al***(2009):

A novel draught resistance gene was identified by comparing the gene expression profile.

* ***Creste et al***(2010):

The choice of molecular marker is considered carefully, based on the purpose of the application in the bleeding programme, as it is not possible to select a marker system that fit the entire requirement for germplasm characterization.

**OBJECTIVES:**

* To find out the prospect and potentiality of sugarcane cultivation.
* To analyse the structure and bio-chemical nature of canes i.e. just compatible with the soil available in the Indian context.
* To find out the quality of sugar of different species & its applicability in different areas.
* To trace out the new avenues for the plantation and use of sugarcanes.
* To re-generate new breeding varieties by using cross pollination techniques.
* To develop transgenic canes for profitable exploitation.

**METHODOLOGY:**

As a part of the methodology, both inter temporal and cross sectional approaches are used in evaluating the impact of the production of sugarcane and sugar in this state. In the inter temporal approach the level of crossing pattern, occupational pattern, status of farmers, techniques of production used byproduct of sugarcane extracted and used, methods of cultivation of cane and etc have been taken for analysis purposes. Incross sectional approach the situation of a sample borrower, households from different categories are also compared. This part of the study presents a broad outline of the methodology and tools of analysis used in this study on the basis of sample survey.

In order to pursue the cited objectives, appropriate statistical tools like sampling, collection of data, classification & tabulation of raw data, averages, percentage, correlation, regression, diagrammes, testing of hypothesis, deflating index number, probability of happening of an event, time series analysis, dispersion, etc. have been used. It is not out of place to note that some other meaningful and authenticated statistical devices have been used for cost-benefit analysis of sugarcane in Odisha. Besides, mostly stratified random sampling method have been used, as it ensures better participation of attributes of informants from all categories.

1. **SAMPLING:**

Sampling is a device for learning about large masses by observing the characteristics of few. A true representative sample provides a valid generalization from the known part to the unknown characteristics of the aggregate. Hence it is scientific device to collect the required representative data of the whole population. There are different types of sample design of which random sampling and non-random sampling is commonly used. Random sampling is one where each item in the universe has an equal chance of known opportunity of being selected.According to Harper, “Random sample is a sample selected in such a way that every item in the population has an equal chance of being included”.

Non-random sampling comprises many types, depending upon the determination of the statistician. However, most of the statisticians divide the entire non-random sampling into three main types like Judgement sampling, Quota sampling & convenience sampling.

1. **COLLECTION OF DATA:**

According to basic source of collection, data may be classified into:

* Internal & External
* Primary & Secondary.

Primary data are those which are collected for the first time and they are original in character. If an individual or an office collects the data to study the problem directly from the field under study, such data are termed as primary or original data. Primary data can be collected by any one of the following methods:

* Direct Personal Investigation.
* Indirect oral investigation.
* Information through Local Agents/ Correspondents.
* Mailed Questionnaire method.
* Schedules sent through enumerators.

Among all these methods, direct personal investigation method involves greater degree of accuracy. However, the most common method practiced today in the real world is the schedules sent through enumerators.

1. **CLASSIFICATION & TABULATION:**

Classification is a process by which data are arranged according to resemblance, affinities, internal homogeneity & common characteristics. This process is a forerunner to the tabular, geographical and diagrammatic representation of data. Classification brings a simple look to the data by grouping voluminous and heterogeneous data into homogenous groups and by putting it in an order, data become more explicit. Classification facilitates comparison among different groups and drawing of inference about the problems. Classification according to geographical areas is called special classification, under which country wise, state wise, district wise, block wise, classification of food production, literacy rate etc. may be done. Classification of raw data may be made according to different time periods and such classification is called as chronological classification. Classification according to class intervals shows frequency in each class and such classification is known as quantitative classification. Under this classification quantitative data such as height, weight, production, income etc. can be classified according to class intervals.

1. **AVERAGES:**

Averages are determined by the different methods of measurement of central value of a distribution. Hence, averages are alternatively termed as measures of central tendency, measures of location or measures of position. It locates that typical value of the distribution around which most of the items are rotating or concentrating. Therefore, the average carries maximum number of attributes of the distribution. The most commonly used averages in statistics are mean, median, mode, GM & HM.

1. **DIAGRAMMATIC REPRESENTATION OF DATA:**

The representations of statistical data with the help of diagrammes have great attraction to a layman. Like graphs, this provides another alternative technique of visual representation of statistical data in a summary or condensed form. Diagrammes are easy to understand and they enable to grasp the data quickly and facilitated ready comparison over time & space. A large varites of diagrammes are used of which bar diagrammes, and pie diagrammes are more common.

1. **DEFLATING:**

It is the adjustment, correction or reduction of a value which is inflated. Hence by deflating the price index number means adjusting them after making allowance for the effect of changed price levels. This is particularly desirable in the case of an economy which has inflationary trends.

1. **DISPERSION:**

Dispersion is an important measure sought for describing the character of variability in data. It is known by averaging the deviation of individual values from some representative value and therefore called an average of second order. The researcher uses this weapon to judge the reliability of measures of central tendency and to compare two or more series with regard to their variability.

1. **CORRELATION:**

It is a statistical technique which measures and analyses the degree or extent to which to or more variables fluctuate with reference to one another. Correlation thus denotes the interdependence among variables.The degree are expressed by coefficient which ranges between -1 to +1. The direction of change is indicated by +ve or –ve signs; the former refers the sympathetic movement in the same direction & the later in the opposite direction. An absence of correlation is indicated by zero.

1. **REGRESSION ANALYSIS:**

Regression analysis has been used by the researcher for deriving an appropriate functional relationship between variables. It is mathematical measure expressing an average of relationship between two or more variables in terms of the regional units of data. In regression analysis there are two types of variables. The variable whose value is influenced or to be predicted is called dependent variable and the variable which influences the value or used for prediction is called independent variable.

1. **TESTING OF HYPOTHESIS:**

The test of hypothesis is a process of testing of significance regarding parameter of the population on the basis of sample. In it, a static is computed from the sample drawn from a population and on the basis of this it is seen whether the sample so drawn belongs to the parent population with certain specified characteristics. The computed value of the statistics may differ from the hypothetical value of the parameter due to sampling fluctuation.

1. **COST-BENEFIT ANALYSIS:**

The most popular method of project evaluation is to consider the cost-benefit analysis of different projects and then to select involving lesser cost yielding greater benefit. Te role of cost-benefit is explained by Prof. Marglin as “The prospective and 5-year plans determine the broad strategy of growth by allocating resources among sectors. But the strategies of growth embodied in the plans leaves many tactical questions unsolved, and it is these tactical decisions that are the province of cost-benefit cost analysis”.

1. **MEASUREMENT OF TREND:**

As a usual practice, a polynomial of suitable degree is selected for determining the trend. The choice of appropriate polynomial in inferred from a graphic representation of the data. In the present study it is observed that a linear trend is appropriate for determining the trend.

1. **PROCEDURE MAINTAINED:**

Selection of samples of sugarcane producing villages has been done randomly and the procedure of stratified random sampling method has been introduced by the Principal Investigator. The study is based on two types of data, i.e Primary & Secondary. Primary data are collected from sample cane growers of different villages which are selected at random. The data are collected through a structured questionnaire. The field survey is organized through mutual discussion with the people related to this affair. During direct interview it is found that few literate informants failed to provide any information about their credit requirements, quantity of production, actual expenditure incurred for producing a given amount of cane, techniques relevant in different areas of production, suitability of seeds, marketing system, actual amount of benefits received etc. Such information gap is possible to field up by collecting required data from their relations and neighbours. It is further noticed that some of the informants have furnished inflated figures of the information sought for. Therefore utmost care and sincerity has been taken to collect requisite information from the informants regarding their socio-economic status & production habits through a structural questionnaire designed for the purpose concerned. The number of samples taken differs from person to person and place to place.

The data available from the survey method are then designed in tabular form through a proper classification. Estimation and comparison has been made with utmost caution and adequate accuracy. In order to cover a wide range of population spread over the area of investigation, a multi-stage sampling design has been used. The statistical analysis has been done strictly on the basis of experience gathered during the process of investigation and the evaluation of the past works in this contest.

Secondary data collected from various published and un-published sources are presented through well designed tables, pie-charts, diagrammes etc. to explore the objectives of the study. The inferences of the study have been done strictly on the basis of the primary as well as the secondary data after testing their level of significance.

1. **PERIOD OF STUDY:**

The present study is a micro-level sample survey covering 1.5 years. The cultivators donot keep their operational records atall, if some cultivators maintain their records; they are very unsystematic and haphazard. Therefore, the study period for field survey is intentionally kept short to avoid loss of memory of the sample cultivators. But the relevant data collected from secondary sources have been referred for a couple of years for the assessment of cost of cultivation, production of sugar, and effective and optimum use of by-products in subsidiary units.Data relating to socio-economic conditions of cultivators, their economic status, availability of employment opportunities, income propagation, occupational pattern etc. have been collected by survey method.

1. **METHODOLOGICAL LIMITATIONS:**

* Primary data have been collected by using sampling technique. Te short comings of random sampling techniques such as Sample may not represent the entire universe, Heterogeneity of the sample from the universe;inadequate sample and personal bias may be the shortcomings of the study.
* Secondary data have been collected from different published and un-published sources. The short comings of secondary data cannot be defined in this study.
* Assessment of cost benefit analysis over the data incurred is a difficult task, because measurement of social cost and benefit from sugar industry and cane production is highly tedious, hence approximation measures have been taken.
* Fertility of soil, process of cultivation, cropping pattern, irrigational facility, seeds used in different areas differs in grater intensity. So the average has been taken by the investigator to analyse the cost factor of cane production which may hold some sorts of shortcomings.
* The price paid by different sugar factories for the purchase cane and other inputs are not equal, hence the average of costs for production of sugar may be entitled with shortcomings.
* Heterogeneity in installing capacity of different sugar mills may create limitations.
* The number of samples taken may not be appropriate for deriving the concrete inference.
* The use of by-products by different firms is highly confusing, so a specific amount of benefit derived from these may not be right.
* Statistical analysis is an approximation and not the exact.
* With ample scope and opportunity desired chemicals have not been used sufficiently to meet greater degree of accuracy.

**ANALYSIS:**

Sugarcane is constituted of three main parts like cellulose, hemi-cellulose and lignin-which together sum upto 90% of total mass. Xylose is the main carbohydrate found in the hemi-cellulose fraction representing around 80% of the total sugar.

**SWEETNERS FROM SUGARCANE – SUCROSE:**

* Jaggery: A major portion of sugarcane crop 45-50% is diverted for the production of jaggery and brown sugar (khandasari). Jaggery is prepared from clarified juice of sugar cane, by heating & concentrating in open pans. It is used as sweetening agent by the rural masses for stock feeding, sweetmeat making and medicinal purposes.
* Khandasari: Khandasari or brown sugar is obtained from sugarcane juice by open pn process. It may be crystalline or in a coarse powder form. It is used mainly for preparing sweet meats.
* Liquid Jaggery: This is a very popular sweetening agent in the rural areas of many states in India. It contains water, sugar, and non-sugar and is collected in a semi-liquid state from boiling sugarcane juice at a particular temperature and can be preserved for a year or more. It is very popular all over the sugar cane growing areas and has a potential up becoming a major cottage industry since it has nutritive value.
* Rab: This is a semi-liquid form of jiggery obtained by concentrating sugarcane juice to the lower brix as compared with jiggery. It is stored in fresh earthen pitchers, crystals developed on storage. These are used are sweeteners and the remaining part is used as cattle feed, in alcohol making and tobacco curing.
* Bura: It is a product made by recrystallistion of any kind of sugar or khandasari sugar and made into a fine, free flowing product; it is mainly used as a sweetening agent.
* Misri: It is product made by re-crystallization of any kind of sugar. It is conglomeration of crystals of irregular shape and sizes. It is used as a sweetener on special occasion, as delicacy such as Prasad and also many culinary uses.
* Shakkar: Shakkar or powdered gur is produced by concentrating sugar cane juice to a higher degree of brix as compared to solid gur and made into powder, brownish in colour.

Table-1

Chemical composition of the extracted samples of sugar cane

|  |  |  |  |
| --- | --- | --- | --- |
| Chemicals in % | Water | Ethanol | Water & Ethanol |
| Cellulose | 42.50 | 45.25 | 46.82 |
| Hemi-cellulose | 24.88 | 27.29 | 26.84 |
| Lignin | 20.90 | 18.93 | 19.76 |
| Ash | 1.64 | 1.64 | 1.64 |
| Extractives | 5.83 | 5.64 | 9.38 |
| Sum | 95.75 | 98.75 | 104.44 |

Source: From the sample survey conducted by the researcher on primary data.

**CHEMICAL COMPOSITION OF BAGASSE:**

* Pith: Chemically pith of bagasse resembles fibre but physically it contribution to paper making is nil as it does not have the basic structure of fibre and mainly consists irregular cells which swell and have marked absorbent characteristics.
* Pentosans: The pentosan content of bagasse and its fractions are quite high being 50% higher than the tropical hard woods and 3-4 times higher than the typical soft woods. The high pentosan content can be expected to remain to a considerable degree in bagasse pulp, especially when derived by alkaline pulping.
* Lignin: Lignin content in bagasse is about 75% of that of soft wood and about equal to that of hard woods. This low lignin content or bagasse makes it amenable for easy pulping and bleaching with lower chemical inputs.
* Cellulose: The holocellulose content of bagasse is notably higher than average soft woods and therefore, yields of pulp will be good if cooked properly, after complete depithing. The fibre portion of bagasse is 20% richer in alphacellulose than pith fraction, which makes the major difference chemically of fibre and pith. However, the actual alphacellulose content in fibre portion of bagasse is about 41% as compared to 34% of the pith portion, which suggests its unsuitability for acid pulping as well as for dissolving great pulps.
* Ash: Most of the ash content in bagasse is extraneous in nature and small portion is inherent. However, the ash content is lower as compared to materials like bamboos etc.

**SUGARCANE CROP FEATURES**:

Sugarcane is a tropical crop grown in a frost free and warmed climate. The crop grows for 8-24 months, depending on the the climate. It grows best on medium heavy soils, but can also be raised on lighter soils and heavy clays, provided there is adequate irrigation available in the former type of soil and drainage is good in the latter type of soils. Thecrop grows best in the tropical region receiving a rainfall of 750-1200mm.

Sugarcane is planted vegetative, where in a one metre piece of sugarcane is laid end to end in a row, with plants forming on the nodes of the sugarcane. In order to facilitate cultivation and easy use of herbicides for early weed control, the planting is done in rows about six feet apart. With plants becoming taller, the lower leaves along the stem ultimately drop up and only leaves towards the top remain green and active. The stems have a hard thin outer tissue or rind and a softer centre between the nodes. The high sugar containing juice is in these centres whose sweetness is measured by sucrose content of the cane.

Table-2

Essential elements for sugarcane growth.

|  |  |  |  |
| --- | --- | --- | --- |
| Macro elements | | Micro elements | |
| Calcium | Ca | Copper | Cu |
| Magnesium | Mg | Manganese | Mn |
| Potassium | K | Zinc | Zn |
| Nitrogen | N | Iron | Fe |
| Phosphorus | P | Boron | B |
| Sulphur | S | Molybdenum | Mo |

Source: Agro-management Techniques in Sugarcane Production, S. Solomon, 2000edn.

**BY-PRODUCTS:**

The main by-products of sugarcane are :

1. Bagasse
2. Molasses.
3. Filter Cake or Press mud.

Besides, this various forms of crop residues and effluents are produced continuously during different stages of cane processing. A larger number of products are being manufactured from these by-products of sugarcane and quite a number of value added products can be further develop.

**BAGASSE**:

It is used for generation of steam and power required for processing of sugarcane, refined paper is the best product to be extracted from bagasse. In Odisha, proper uses of bagasses are not seen anywhere, these are used only for the combustion purposes in different sugar firms. This by-product bagasse is nearly 1/3rd of the weight of the sugarcane crushed. The bagasse after coming out of the last mills is nearly 45-50% wet and the moisture content in it needs removal before it can be utilized for burning efficiently. In a well balanced sugar factory the bagasse produced by the factory should not only be sufficient for the boilers but some bagasse could even be saved for allied industries depending upon the fibre percent of the cane. Normally consumption of any extra fuel is not considered wise and as far as possible crushing rate should be adjusted such that bagasse produced meets the requirements of the boilers. By doing so, milling efficiency or sugar quality might have to be sacrificed a little depending upon the equipment of the plant. In case, there is shortage of bagasse extra fuels like coal, fire wood and ground nut husk and furnace oil is used while starting the plant.

Table-3

Composition of dry bagasse

|  |  |
| --- | --- |
| Composition | Percentage |
| Cellulose | 45.0 |
| Pentosans | 28.0 |
| Lignin | 20.0 |
| Ash | 2.0 |
| Sugar | 5.0 |

Source: Alternative products from sugarcane.. Industrial and agricultural uses..G.B Singh & S. Solomon-2000

It is the cellulose content of bagasse that is responsible for its use in all the fibre based industries. The rind portion of bagasse consists of high quality cellulose and is important in all industries which require cellulose. The internal portion os sugarcane is known as pith which is not of any use in the manufacture of pulp, paper and other cellulosic products. The cellulose content of bagasse is useful as a fibrous raw material in the paper industry whereas the pentosans content of bagasse is used in the manufacture of furfural.

**MOLASSES:**

It is a prime input for the manufacture of alcohol and alco-chemicals like acitic acid acitic, anhydride. It is also an important constituent for the production of compound cattle feed. It is the mother liquor left over after the crystallization of sucrose from which further quantities of sucrose cannot be recovered economically.

The production of molasses depends upon the quantity of cane crushed as well as the crushing season. The yield of molasses per tonne of cane is influenced by many factors and may vary within a range of 2.2 to 3.7%. Grading of molasses is based on the total sugar content, which are about 50% and an important factor for calculating the yield of ethyl alcohol. In many countries a large production of molasses produced is used for the manufacture of livestock feeds and a meager amount is used for the production of ethanol. In India, 400 sugar factories produce about 55.3lakh tones of molasses per annum, out of which 80-90% of total produced is used for the manufacture of ethyl alcohol & about 7-8% is being used for the production of animal feed as molasses based feed are still not popular in India.

**PRESS MUD:**

It is rich source of manure for crops. In Odisha the press mud is distributed among the registered cane suppliers. The production of press mud or filter mud in India ranges from 4.3 to 4.6 million tonnes annually, which is about 1/5th of the total global output. In the manufacture of cane sugar the impurities of cane juice are precipitated either through sulphitation or carbonation process. The amount of filter mud or percent cane and its composition varies greatly with the locality, variety of cane, milling efficiency and method of clarification etc.

In developing countries press mud is largely used as a fertilizer and in the wax and compost industry. Press mud is soft, spongy, amorphous, dark brown material containing sugar, fibre and coagulated colloids which includes wax and other products.

**SUGARCANE BIOMASS & BY-PRODUCTS:**

Pachauri et.al, 1986 reported the chemical composition of late harvested whole sugarcane as dry mater 45 to 50%, crude proteins 2.69%, ether extract 0.98%, crude fibre 34.47%, nitrogen free extract 45.41%, Neutrol detergent fibre 80.98%, acid deergent fibre 51.83% and total ash 16.45%. The chemical composition indicates that whole sugarcane is low in nitrogen. The nutritive value of sugarcane increases with maturity and for all practical purposes can be linearly related to the sugar content of the juice. Removal of rind from sugarcane leads to increased digestibility but decreased animal performance unless roughage and /or by-pass nutrients can also be given.

Table-4

Chemical composition of whole sugarcane.

|  |  |  |  |
| --- | --- | --- | --- |
| Constituents | Whole cane (%) | Cane tops (%) | Bagasse (%) |
| Nitrogen | 0.4 | 0.9 | 0.4 |
| Total Sugar | 48.0 | 25.0 | 3.0 |
| Crude fibre | 28.0 | 35.0 | 48.0 |
| Cell wall | 79.0 | 65.0 | 82.0 |
| Ash | 6.0 | 8.0 | 3.2 |
| Hemicellulose | 26.0 | 20.0 | 30.0 |
| Cellulose | 36.0 | 38.0 | 40.0 |
| Lignin | 10.0 | 7.0 | 12.0 |
| Silica | 3.0 | 1.8 | 2.0 |
| Calcium | 0.3 | 0.1 | ---- |
| Phosphorus | 0.3 | 0.1 | ---- |
| Sodium | --- | ---- | ---- |
| Potassium | 2.8 | 2.3 | ---- |

Source: Rangnekar (2016)

**DEVLOPMENT OF MOLASSES & ALCOHOL BASEDCHEMICALS:**

The development of co-generation facility in the sugar factory will further enhanced the economic variability and overall efficiency of the sugar complex. Among these the molasses and alcohol based chemicals are in great demand and have multiple utility and highest industrial profitability.

Molasses based Chemicals: Molasses contain about 25-30% sucrose and 20-25% reducing sugars i.e about 40-50% total sugar content. The industrial value of molasses for any purpose is on account of its total sugar and fermentable sugar content, which is being use to produce many products of great economic value. Some molasses based chemicals are:

* Citric Acid: It is manufactured from cane molasses, using sub-merged fermentation technique.
* Lactic Acid: It can be produced from cane molasses on large scale under suitable technology.
* Tartaric Acid & Oxalic Acid: These can be produced simultaneously from cane molasses by employing almost similar technology. There seems to be a good scope for exporting oxalic acid.
* Fumaric Acid & Malic Acid: These acids are produced from cane molasses by fermentation with *Rhizopus nigricans*. Fumaric acid can alsobe prepared by isomerisation of malic acid, using amine bases, heavy salt etc. as catalyst at 40 to 60 degree centigrade in a 10-20% hydrochloric acid solution.
* Glutamic Acid & Monosodium glutamate: These two products especially monosodium glutamate could be prepared from cane molasses. The salt is white, crystalline powder, highly soluble in water and used as flavor improver in various foods.
* Oil & Fat: It has been made feasible to produce oil and fat by growing certain microbes on cane molasses. The oleaginous strains of eukaryotic micro organisms feed on molasses and produce oil, the qualityof which is similar to that of oils of plant origin.

**Alcohol based Chemicals**: Molasses is mostly converted into new products via ethanol, which is the most convenient route. During fermentation process, on the undesirable ingredients of molasses are passed off in the distillery spent wash or slops & clean processes can be operated with refined alcohol as raw material. In alcohol based industry, investments are comparatively lower than naptha based feed-stock plant. Today, ethyl alcohol is being used as a raw material for a large number of chemical products. There are two main routes for the conversion of alcohol into various derivatives.

* Via ethylene by dehydration.
* Via acetaldehyde either by oxidation or by dehydration.

The ethylene route hard always been of doubtful viability because of the sanding competition from petrochemical ethylene which has the advantage of scale, but with the advancement in the technology, this route has also now become more attractive. However, the acetaldehyde route is simpler and has the advantage that even small plants can become viable producers of alcohol by-products.

**CHEMICALS OBTAINED FROM FERMENTATION OF SUCROSE:**

A large number of chemicals can be produced from sucrose by fermentation, viz. ethanol, butanol, acetone, acetic acid and lactic acid. However, they are commercially produced from molasses – a sucrose rich by-product of sugarcane.

1. Ethanol: The most well known chemical produced from sucrose is ethanol or ethyl alcohol (C2H5OH) either as rum, fuel or industrial alcohol. Because ethanol can be converted into ethylene, almost all petrochemical products could be synthesized through this route. Sugarcane is therefore considered as a renewable source that can supply almost all the product of the oil industry, including fuel. The initial reaction begins with the hydrolysis of sucrose through glucose and fructose and their conversion into ethanol with the help of yeast.
2. 2,3-Butylene glycol : It is produced from sucrose by *Acetobactar aerogenes* . The diacetate of butylene glycol can be converted into butadiene by pyrolysis which is widely used in the rubber industry. The esters of butylene glycol are good plasticizers. It is also used as anti-freeze and in the production of alkyd resins.
3. Penicillin: It is produced by submerged culture of *penicillium* c*hrysogenum*, a mixed substrate of carbohydrates, organic acid & special precursors of nitrogen sources.
4. Aureomycin: It is produced on a medium containing 46% sucrose with the help of *Streptomyces aureofacines* .
5. Terramycin: Oxytetracycline production is based on *Streptomyces rimosus* on a sucrose rich medium. These broad spectrum antibiotics are used widely for therapeutic puposes and also in animal feed.
6. Erythromycin: It is a marolide antibiotic with a macrocyclic lactone ring. The media used for its industrial production consists of carbohydrate, soybean meal, corn-sleep solids, yeast, sodium chloride, calcium etc. The carbohydrate of choice is sucrose, as the rate of hydrolysis to the constituent monosaccharides tends toregulate its availability.It is used popularly for therapeutic purposes.
7. Riboflavin: It is produced on a sucrose rich medium by the action of ascomycete *Ashbyagossypii*. Deficiency of riboflavin causes dark red tongue, dermatitis and cheilosis. It is an important vitamin for poultry raised in batteries and has a significant effect on hatchability.
8. Cobamide: Cobamide or vitamin B12 is the antipermicius anaemiafactor and has great importance for clinical as well as animal feeding purposes. This is required for the development and maturation of red blood cells.
9. Dextran: The term dextran is generally used for a class of D-glucose polysaccharides produced by bacteria growing on sucrose substrate. Dextran is produced from sucrose only, not from monosaccharides, by the organism *Leconostoc mesenteroides* which contains an extra cellular dextransucrase enzyme that produces a very soluble polymer of glucose.
10. Xanthan gum: It is a polymer of glucose, mannose and glucuronic acid was produced from sucrose by the bacterium *Xanthomonas manihotis* . It is used as a viscocity and gelling agent in foods. However, its major use is as a lubricant for oil-well drilling and muds.

**PRODUCTS OBTAINED FROM THE DEGRADATION OF SUCROSE:**

There are many products which are formed through hydrogenation and oxidation of sucrose such as sorbitol, mannitol, propylene, glycol, glycerol, oxalic acid etc.

1. Sorbitol & Mannitol: Sorbitol is produced industrially by the catalytic hydrogenation of glucose in presence of copper or nickel or chromium at 1000C and 70-150atmospheric pressure. It is mainly used in the production of ascorbic acid (vitamin-C) and also used in diabetic food.

Mannitol is produced simultaneously with sorbitol, generally in the ratio of 1:3 and recovered by crystalisation. Mannitol is a white crystalline solid, non-hygroscopic acid has a pleasant taste. It is mainly used in pharmaceutical industry.Mannitol hexanitrate is a well known detonator which is safer to handle than mercury fulminate.

1. Glycerol: It is a colourless, syrupy and odourless liquid with a sweet warm taste. It is soluble in water and alcohol. It is used in estergum, for surface coating, platicisers, and in the drug and cosmetic industry.
2. Propylene glycol: It is generally produced either via chlorohydrine intermediate or directly from prophylene oxide. Prophylene glycol is a colour less oil soluble in water and alcohol and used extensively as an anti freeze, as a lubricant and as a humectants etc.
3. Methylpiperazine: It is produced when sucrose is heated at 2000C with ammonia and hydrogen under pressure in presence of a catalyst.
4. Oxalic acid: It is produced by the nitric acid oxidation of sucrose in presence of vanadium pentaoxide catalyst. It is used extensively in the pharmaceutical industry.
5. Fructose: It is produced from sucrose in presence of immobilized glucose oxidase. It is now being commercially used in the carbonated soft drinks, salad, ice-cream and in many confectionary and dairy products.
6. Lactic acid: It is an important chemical intermediate used in the food, pharmaceutical and leather industry. It is produced by heating sucrose with lime at 2400C. Lactic acid ester is becoming important in plastic manufacture.

**PRODUCTS OBTAINED FROM THE SYNTHESIS OF SUCROSE:**

A wide variety of sucrose esters, from mono to octa substitutes, most usually with fatty acids have been synthesized. The major esters in commercially production are mono ester of long chain fatty acids which are approved as food adhesive in some countries.

Sucrose being a hydrophilic molecule could be converted into a product having both hydrophilic and lipophilic groups by esterification reaction with fatty acids. There are a number of processes described in the literature for the production of sucrose monofatty acids ester. In the first process the Nebraska snell process sucrose reacts with a triglyceride in N. N-dimethylformamide in the presence of a basic catalyst at 900C. The reaction product is a mixture of mono and di-glycerides and sucrose esters.

Recently a semi-continuous process has been developed, the Wormshaft process, in which sodium stearate, potassium carbonate, methylpalmitate and sucrose are first fed through a worm shaft reactor at high temperature and pressure. The resultant mass is thenextruded into a reactor where it is further reacted at 1500C under reduced pressure for 90 minutes. Some useful products synthesize from sucrose are as follows:

Table-5

Products of synthesis from sucrose

|  |  |  |
| --- | --- | --- |
| Sl | Product | Uses of the product |
| 1 | Fattyacids esters of sucrose | Food and feed improvers surfactants and viscosity improvers. |
| 2 | Sucrose Acetate Butyrate | Surfactants, viscosity improvers. |
| 3 | Sucrose octaacetate | Resin intermediate, plasticizer. |
| 4 | Sucrose octabenzoate | Resin intermediate, plasticizers etc. |
| 5 | Sucrose polycarbonate | Resin intermediate, plasticizer. |
| 6 | Heptacyano ethyl sucrose | Surface coating dielectrics. |
| 7 | Polyhydroxy allylsucrose. | Surfactants viscocity improvers. |
| 8 | Sucrose polyurethane | Resin intermediates plasticisers. |
| 9 | Sucrose xanthate | Surfactants viscocity improvers. |
| 10 | Tetra chlorogalacto sucrose | Food & feed improvers. |
| 11 | Organotin sucrose pesticides. | Surface coatings, dielectrics |

Source: Findings of Researcher.

* **Sucrose Polyesters**: These esters contain 6-8 fatty acid ester groups per molecule with structure of the fatty acids determining the physical properties of the resulting fat which varies from a solid to liquid. The viscocity of sucrose polyester is slightly higher than the triglyceride with the same fatty acids. These polyesters are not hydrolised by pancreatic lipases and therefore passes unmetabolised. The absence of hydrolysis on absorption makes sucrose polyesters a low calorie fat.
* **Sucrose polycarbonate**: Sucrose reacting with ethylchloroformate in the presence of alkali producers the mixed polycarbonate. This has been found to be potential resin intermediate.
* **Sucrose octaacetate**: This derivative is widely used as de-naturant for alcohol, for sucrose, for bee feeding, and as an ingestion deterrent in lead based paint finishers due to its extremely bitter taste. It is also used as an addition for adhesive and has hardening agent in the production of laminated glass in the combination with glucose pentacetate, because of its transparency. It is also used as a glossing agent for paperand as a plasticizer for phenolic resins, alkyeds etc.
* **Sucrose octabenzoate**: It is generally used for water resistant coatings. This compound has produced many system such as nitrocellulose lacquers, polyacetate coatings and acrylic lacquers.
* **Sucrose ethers**: Sucrose ethers are widely used a surfactants and detergents as also in the polyurethane homes where they enhanced its higher resistance properties.
* **Sucralfate**: It is a derivative of sucrose ester of chlorosulphonic acid. It is used as anti-ulcerative medicine.
* **Polymers from sucrose**: Sucrose cannot be used directly in the manufacture of polyurethane, because it leads to brittle products. The poly hydroxypropyl ether of sucrose which confers miscibility with the blowing agent and impacts strength and flexibility to the finished foam, is used. The use of sucrose in the polyurethane provides one its important industrial outlets. It was estimated that upto 20% of this material could be derived from sucrose, provided it can compete in price and performance with those of petroleum chemicals, starches, sorbitol etc.
* **Polyhydroxybutyrate**: PHB is a polyester produced by micro organisms. Sucrose can be converted to PHB in 70% yield by weight, by the organism *Alcalgenes eutophus.* It takes 3.5 tonnes of sucrose to produce 1 tonne of PHB. The compound is used in surgical pins and sutures.
* **Sucrose xanthate**: This is produced when the aqueous solution of sucrose reacts with carbon disulphide in presence of barium hydroxide as catalyst. On further reaction, alkylhalide, S-alkyl sucrose xanthate is obtained which is a potential surface acting and chelating agent.
* **Organotin sucrose pesticides**: It is biodegradable product which offers a promising avenue of sucrose utlisation in pesticide industry.
* **Allyl sucrose:**It is amber coloured viscous liquid obtained by the reaction of sucrose with allyl chloride in alkaline aquous medium. It is used as coating material and as an adhesive.
* **Hyprose SP 80**: Hyprose is produced by the reaction of propylene oxide with sucrose. It is a viscus amber colour liquid with properties which makes it useful as a cross linking agent for polyurethane foams prepared from poly glycols. Hyprose can also be used as a plasticizer for cellulosic, phenolic resins glue starch etc. and it is not susceptible to moisture or loss of strength through aging. It can be esterified with fatty acids to yield very good surfactants. Esters of hyprose are non-toxic and are potentially useful in food and cosmetic products.
* **Resins:** Sucrose is extensively used in the preparation of urea, phenol and melamine- formaldehyde resins. Thee resins are used as adhesive for ply wood and ceiling tiles and as binders for glass fibres.

**SUGARCANE BY-PRDUCTS AND CROP RESIDUES IN INCREASING SOIL FERTILITY & CROP PRODUCTIVITY**:

Sugarcane is valued very much as energy crop, fibre crop, or as 3F chain- food, fodder and fuel. These by products are used in agriculture mainly either as a source of organic fertilizer, as manure, as a mulching material or as a soil ameliorating agent with a view to increase soil fertility and ultimately the crop productivity.

The organic matter in the soils and the use of organic manures are traditionally associated with soil fertility. Continuous organic manuring results in getting a soil with lower bulk density and more pore space than the soils having repeated dressings. Severalgood properties of soils are attributed to their organic matter content. Level of organic matter content of a soil is the characteristic property f the soil. Degradation of the added organic matter in the soil is mainly biochemical in nature and ultimately leads to the formation of relatively very slow degradable compound known as humus, which is highly colloidal substance. The humus form is mainly responsible for imparting good physical, chemical and biological properties of soil.

Decomposing organic matter affect the nutrient balance of the soil. The rapid evolution of CO2 by proliferating organisms improves soil phosphate availability and the sequestering and chelating compounds produced during the decomposition affect the availability of many nutrient cations. From the physical point of view the beneficiary effects of organic matter application to soil are attributed to the production of stable soil aggregates by water soluble high molecular weight materials formed from the organic matter by the soil micro organisms. The improved aggregation enhances the soil physical condition such as aeration and water movement and thus allows better root development and therefore, results in better plant growth.

**BAGASSE COMPOST**:

Bagasse can also be used profitably as a carrier for phosphate in soil application. The importance of phosphorous is next to nitrogen in Indian agriculture. The calcareous clay soils have a very high phosphate fixing capacity which renders single superphosphate applied to calcareous soils unavailable to crop to a great extent. A remedy to this problem is to apply super phosphate through organic carriers, i.e mixing it with compost or animal dung or bagasse.

**BAGASSE ASH**:

The quantity of bagasse are produced comes to 0.3% on cane weight basis. Thus, a sugar factory crushing 3 lakh tonnes of cane per annum is required to handle about 100 tonnes of bagasse ash. Spreading in the field as fertilizer has been the usual practice of its disposal as it is a rich source of silica, potash, iron oxide and lime.

**MOLASSES AS RECLAIMING AGENT**:

When molasses is added to the soil, carbon dioxide and many organic acids such as acetic, propionic, butyric and lactic acids are produced in the early stage of the decomposition and oxidation of carbohydrates. This combined with the acidic nature of molasses neutralizes the soil alkali and renders the soil physically porous. Calcium present in the soil replaces exchangeable sodium ion from the clay complex. Te fertility of the soil is also raised simultaneously due to higher bacterial activity and addition of molasses. For very bad alkali soils, 5 tonnes of molasses plus 5 tonnes of PMC are adequate enough to reclaim the soil completely. It should be applied 3-4 weeks before planting of cane followed by flood irrigation.

**PRESS MUD**:

The current production of press mud in India amounts to more than 3.6 million tonnes annually. During the last three decades the PMC is being used as source of organic matter because of its high organic carbon content and as a soil ameliorating agent. It is also rich source of phosphorus in organic form. Besides this PMC also contains N, Ca, Fe & Mn etc.

**APPLICATION OF PMC ON SOIL PROPERTIES**:

Press mud cake is rich in its content of organic carbon as well as P2O5 & when it is applied to soil as organic manure, it is bound to increase the status of organic carbon or available P2O5 in the soil. When compared with trash compost it was observed to be much better in improving the organic carbon status of the soil, water dispersion coefficient and water stable aggregate. As an ameliorating material, PMC was observed to be as effective as gypsum in increasing the cane yield in an alkali soil. As a source of P carrier when phosphate was applied on equal basis, the application of PMC in comparison with single super phosphate has no distinct effect on the fertility status of the soil.

**COMPOST FROM PRESS MUD CAKE**:

Chemical fertilizers give excellent results only in the presence of the large quantities of organic matter added to the soil. Realising the importance of humus in the soil, attempts were made to supply it through application of FYM, green manuring, sheep folding, application of town compost etc. However, adequate quantities of these are not available for large scale application in sugarcane cultivation. Composting of cane trash and its application as manure is a most convenient source of large scale humus application to soils under sugarcane cultivation. Attempts have been made to prepare compost from PMC and test its utility in increasing the soil fertility or crop productivity.

**INFERENCE:**

About 80% of global sugar production is from sugarcane. It has been clearly established that sugarcane is the cheapest source of sugar, the cost of sugar production through the cane route can be as low as 40% of that of sugar from the sugar beet route. After a thorough investigation in different sugar mills of Odisha, the researcher hold a good variety of idea on the issue of biochemical nature of sugarcane and its economic importance that are helpful in deducing inference on the topic concerned. Some of them are derived as follows:

* The sugarcane cultivation is diversified in Odisha. However, yield of sugarcane is more in coastal belt as a result more sugar industries are established in these areas.
* It has been reported that there is a greater time lag between harvesting and milling which causes greater loss in sugar recovery.
* Management of by-products of sugarcane and their proper utilisation is not satisfactory. The by-products are not stored properly and specific attention is not given for their effective recovery.
* Bagasse, being a rich source of cellulose and hemi-cellulose is one of the best substances for cultivation of edible mushrooms.
* Bagasse- a by-product of sugar industry is used in paper production.
* People of rural areas of Nayagarh and Baragarh district used sugarcane by-product as raw material of biogas plant.
* The quality of sugarcane of southern region and western region is found better as the cane provides more sucrose in comparison to other regions.
* Ethanol production is regulated by sugar industry and useful in various industrial and laboratory purposes.
* Ethyl alcohol is by-far the largest product made from cane molasses. Besides these molasses are excellent raw material for a very large number industry including cattle and animal feed, Baker’s yeast, ethanol, lactic acid, tartaric acid, oxalic acid, glycerol, glutamic acid, fats and oil, butanol-acetone, malic acid, fumaric acid, citric acid, ingredient in microbiological and tissue culture media.
* In Odisha gur is popularly used as a sweetener agent for the production of cakes and other food items.
* Synthetic seeds or artificial seeds are produced from sugarcane stem by the application of chemical substance-calcium alginate. It helps the cultivation of isolated plants & tissue through organ culture.
* Many products are formed through hydrogenation and oxidation of sucrose these are sorbitol, mannitol, propylene glycol etc.
* Food adhesives are obtained from synthesis of sucrose.
* Sucrose is extensively used in the preparation of urea, phenol and melamine- formaldehyde resins. These resins are used as adhesive for plywood and ceiling tiles and are binders for glass fibre.
* Sucralose is high intensity sweetener produced from sucrose through chlorination process.
* Neo-sugar is produced through micro bial conversion of sucrose using fungal enzyme.
* Bagasses are used as soil conditioner due to its slow rate of decomposition. It is applied to the soil in purely physical nature. It is also useful as a carrier of phosphate in soil application.
* Composting of bagasse by mixing it with press mud cake produced a compost of good quality within 12 weeks.
* Molasses is the residual syrup from which further recovery of sucrose is not possible by simple means.
* Addition of molasses to a medium black soil under laboratory condition revealed that the acidity increased in the initial stage only. This increased was not prominent latter.
* When molasses is added, CO2 and many organic acid such as acetic acid, propionic acid, butyric acid, and lactic acid are produced at the early stage of decomposition and oxidation of carbohydrates.
* The PMC is used as a source of organic matter because of its organic carbon content.
* At present molasses is mainly used in the production of ethanol for industrial and potable purposes. A small amount is used for the processing of animal feed.
* PMC is used to improve soil fertility and crop productivity. Its use in crop yield is a common practice by plant cultivators.
* Sugarcane residues have high CN- ratio substance. Trash (dried leaves after harvest) is a potential source of organic matter in sugarcane cultivation and it is capable of adding much nitrogen to the field.
* A new technique of seed multiplication through spindle bud in polythene bags have developed in the state. It has good scope for multiplying the breeder seed material of newly developed genotypes. Some disease resistant high sugared and high yielding somaclones have also been developed through tissue culture. These may yield promised rich sugared high yielding varities with red-rot resistance in future.
* Spraying of Gibberelic acid @ 100ppm or cycocel @200ppm after stubble saving have been found effective in improving cane yield. It is GA3-a PGR capable to increase sudden stem elongation.
* Cane yield progressively improved with spindle bud technique as against conventional planting. Significantly higher cane yield from autumn, spring and late spring crops of sugarcane was obtained by harvesting them during January, March and April respectively.
* Since the main raw material is produced in the field of farmers there is no scope for erosion of natural resources.

**SUGGESTIONS:**

* The farmer and the miller need to work jointly towards increasing vertical productivity of sugarcane farms and restricting horizontal growth.
* Sugarcane should be categorized at par with all agro-products like paddy, pulses and vegetables and thus be exempted from all kinds of taxes.
* Development of quality infrastructure for industrial growth has been given the highest priority through joint participation.
* Central /state government may launch a study and make a survey of the growth of the rural economy in the area during functioning and closure of sugar mill so that impact of this agro-industry could be appreciated.
* Bagasse based paper production should be deemed as export promotion units and all available to exporters should be made available to bagasse based paper units.
* The productions have to encourage the growers to cultivate sugarcane and at the sme time the government has to provide different types of incentives to accelerate the production of sugarcane in the state.
* Irrigation facilities, high yielding varities of seeds, up-to-date knowledge of the economic process of cultivation should be provided to the needy growers of the state.
* For those agro-based industries carrying on high capital intensive activities, the government may consider introducing a soft loan credit support with affordable rate of interest.
* To encourage total capacity building up-gradation, the state government may prepare compendium of required technology, in the areas of sugar engineering, processing technologies and other related areas of alcohol techonologies for imparting training and education among the rural youth by arranging techno centres either within the state or outside the state.
* Atleast one research centre should be opened in each sugar factory area as a result of which farmers will be encouraged to know about the latest technology.
* Farmers should be trained regularly by agriculture department for cultivating improved sugarcane.
* Proper sanitary conditions in the milling house are essential for checking bacterial fermentation resulting in loss of sugar.
* To prevent the chemical loss of sugar in the boiling houses proper maintenance of temperature, PH and correct methods of clarification, dosing of line etc are important.
* Automation and micro-processor based process controls would ensure optimum performance. It is envisaged that modern sugar mill will be the latest in design, be fully instrumented, energy efficient and retrieve all by-products optimally.
* The plant and equipment must have to be planned for the targeted efficiency as also automation and instrumentation for ensuring operational ease. The elimination of human element error is necessary for achieving better overall performance.
* There is a need to transfer the technology from the research institution to the farmers. In addition to the normal extension programmes to cane development personnel, bringing out publications on improved technologies, utilisation of mass media for transfer of technologies and maintenance of exhibitions should be promoted.
* Cultivated sugarcane belong to *Saccharum officinarum* and *S.sinensis* or their inter specific hybrids with wild species of the genus will provide better result.
* Improvement of crop needs constant evolution of new improved varities.
* Some of the high yielding varieties of sugarcane developed in Inda like CO.419, CO.622, CO.658, CO.712, B.14, H.M320 may be introduced.
* Cultivation of polyploid varities of sugarcane may be developed by use of alkaloid like colchicines.
* Genetically modified cane may solve various problems of production amount of sugar.
* Gaseous pollutants can be removed by using three methods like absorption, adsorption and combustion method. In combustion method the pollutant emission should be brunt at high temperature by using wet scrubber.

**QUESTIONNAIRE**

1. Name of the Sugar Factory:………………………………………….
2. Address…………………………………………………………………..

E-mail ID…………………………………………………………………

Web………………………………………………………………………..

1. Crushing capacity……………………………………………………..
2. Total amount of sugar recover………………………………………
3. Rate of sugar recovery…………………………………………………
4. Total amount of by-products during the whole year:
5. Molasses…………………………………………………………….
6. Bagasse……………………………………………………………..
7. Press Mud Cake…………………………………………………..
8. Rate of recovery:
9. Molasses……………………………………………………………
10. Bagasse……………………………………………………………..
11. Press Mud Cake…………………………………………………..
12. Total amount paid by the factory for the purchase of cane during the season ………………………………………………………
13. Total quantity of cane purchased by the factory for extraction of sugar ……………………………………………………………………
14. Percentage of capacity utilisation …………………………………..
15. Sugar stock position:
16. Total bags produced……………………………………………
17. Opening sugar stock…………………………………………..
18. Closing sugar stock ……………………………………………
19. Revenue record of the factory from the sale of sugar:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sl | Category of sugar | Quantity in Bags | Rate per Bag | Value in Rs. |
| A | Levy Sugar |  |  |  |
| B | Free Sugar |  |  |  |
|  | Total |  |  |  |

1. Total value of the by-products and revenue received:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sl No | By-products | Quantity in tonnes | Rate per tonne | Value in lakh Rs. |
| 1 | Molasses |  |  |  |
| 2 | Bagasse |  |  |  |
| 3 | Press Mud Cake |  |  |  |
|  | Total |  |  |  |

1. Total amount of revenue received (Sl No 12 + Sl No.13)

Rs……………………………………………….

1. Surplus /Deficit revenue earned : Rs……………………………….
2. Financial assistance received from:
3. Private non-registered bodies: Rs…………………………..
4. SDF( Sugar Devt. Fund) : Rs…………………………………
5. Bank loans: Rs…………………………………………………
6. Govt. Loan: Rs …………………………………………………

Total : Rs ……………………………………………………….

1. Total amount of chemical recovered during the whole year :
2. Ethanol ……………………………………………….
3. Oranic Acid……………………………………………
4. Glycerol ………………………………………………..
5. Are food adhesive synthesise fro sucrose: Yes/ No.
6. Is Neo-sugar produced through microbial conversion of sucrose using fungal enzyme: Yes/ No.
7. Are bagasse used as soil conditioner: Yes / No.
8. Time period required (in weeks) for composing of bagasse by mixing with PMC: ……………………………………………..
9. Chemicals produced from sucrose by fermentation are: ………

………………………………………………………………………………

1. Do you require PGR( GA3) for stem growth: Yes/ No.
2. Is role of bio-tech essential for scientific growth, cultivation and production of sugarcane: Yes/ No.
3. Name of HYV seeds used: ……………………………………………
4. Essential measures taken to control pollution:
5. Name of the respondent :

Investigator













