Evaluation of RKVY project on Establishment of Jaggery Park in Southern Karnataka by the Department of Agriculture (Period 2008-09- to 2012-13)

External Evaluation

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Karnataka Evaluation Authority

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AND

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BY

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Final Report

Evaluation of RKVY project "Establishment of Jaggery Park in Southern Karnataka" by the Department of Agriculture.
(Period 2008-09 to 2012-13)

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Abbreviations

AGMARK: Agriculture Marketing Information System Network

AOAC: Association of American Chemist

CFTRI: Central Food Technological Research Institute

CJ/CFJ/ NCJ: Chemical Jaggery/Chemical Free Jaggery/Non Chemical Jaggery

FAO: Food and Agriculture Organisation

FAPRO: Farmer's Produce Promotion Society

FSSAI: Food Safety and Standard Authority of India

ha: Hectare Measurement Of Land (10000 sqm)

ICAR: Indian Council of Agricultural Research.

ISO: Indian Standard Organisation

HACCP: Hazard analysis and critical control points

HKCAL: Hyderabad Karnataka Centre for Advance Learning

JP/JT/JF/JC: Jaggery Prcessor/Jaggery Traders/Jaggery Farmers/Jaggery Consumers

KSDA: Karnataka State Department of Agriculture

KEA: Karnataka Evaluation Authority

OAA: Over All Acceptance

PDS: Public Distribution System

PPP: Public Private Partnership

R&D Work: Research and Development Work

RKVY: Rashtriya Krishi Vikhasa Yojana

RSJRS: Regional Sugarcane Jaggery Research Station Kolhapur

SG: Sugarcane Growers

SHGs: Self Help Groups

SWOC: Strength Weakness, Opportunity and Challenge

ToT: Transfer of Technology

UAS B : University of Agricultural Sciences (Bangalore)

UAS D : University af Agricultural Sciences (Dharwad)

VC Farm: Vishweshwaraiah Canal Farm Mandya

ZARS: Zonal Agricultural Research Station

Preface

India is world’s largest producer of sweeteners when all the sweetening agent like jaggery and Khandsari are considered. Of the total world production, more than 65-70% of jaggery produced in India. The production f jaggery is an old age practice in India and still continuing, despite being unorganized sector. This unorganized sector employee more than 25 Lakhs rural worker in various operations. The per capita consumption of jaggery is about 5kg which has declined in last one decade in spite of its nutrition and medicinal values. The production of jaggery requires low capital compared to white sugar. The machineries needed for jaggery processing is locally fabricated and indigenous one which generally yields very poor efficiency.

Despite of low cost production and resplendent nutritional potential, the industry has witness down swing in consumption pattern, poor acceptability and productivity over the past years may be attributed to unhygienic processing poor presentation, poor shelf life and lack of government support for modernization and marketing of produce. All the three categories of jaggery manufacturers (Small, Medium and Large) face common problems like low profit, poor efficiency of processors, transportation, high raw material cost and lack of R&D Support in the Cauvery Command area. This cottage industry is having significant impact on rural mass in terms of employment, nutrition and export potential which needs proper attention and care from the researches, engineers, manufacturers, traders and Exporters. Besides, improving hygiene condition, the jiggery Park may be useful for large scale production of jaggery for bigger formers and may give flat form to small former to come together for corporate production and sale.

The Karnataka Evaluation authority has taken of evaluation of RKVY project on establishment of Jaggery Park in Southern Karnataka by the Department of Agriculture from 2008-09 to 2012-13. The KEA assigned this evaluation study to M/S. Hyderabad Karnataka Centre for advanced learning, Gulbarga. The evaluation report submitted by Evaluation Consultant Organization is approved by 35th Technical Committee Meeting

I am sure the benefits of findings of the evaluation study and recommendations will be useful in fine tuning the programmes of Department of Agriculture, other concerned departments and all the Agricultural Universities in the state of Karnataka.

The study received a constant support and guidance from the additional Chief Secretary and the Secretary Planning, Programme Monitoring and Statistics, Government of Karnataka. The evaluation study was actively supported by the officers of the Department of Agriculture providing useful data and information for this evaluation study. The evaluation report has been reviewed by members of the Technical committee of KEA, and an Independent Assessor, who provided suggestions and inputs to improve it from its draft form. I duly acknowledge the contribution of all who were involved in the study and contributed directly or indirectly.

13th June, 2017

Bangalore

Shiv Raj Singh
Chief Evaluation Officer
Karnataka Evaluation Authority

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The evaluation of RKVY project on establishment of Jaggery Park in Southern Karnataka was evaluated through desk research, factual data collection and perceptual survey along with appropriate analysis of data and final recommendations were derived. In this contest the HKCAL evaluation organisation desires to place on record their heartfelt thanks and indebtedness to Shri Shivaraj Singh, IFS, Chief evaluation officer and additional Principal Chief conservator of Forest and Karnataka Evaluation Authority, Commissioner of Agriculture, Director of agriculture and Consultant Shri Ranganna (KEA) and other officers and staff of the Karnataka Evaluation authority, for their constant technical support and guidance during the course of evaluation process of the study.

Further, we would like to express our sincere thanks to the Director of Research of UAS (B) and UAS(D), Head of AICRP Jaggery, Head PI of RSJRs Kolhapur, Associate Director of Research, Mandya, Heads of the Jaggery Parks and other Scientists at Mandya, Mudhol, Sankeshwar, The farmers of Mandya, Mudhol and Kolhapur (Maharastra) for their invaluable technical support in delivering the required information on various aspects of jaggery processing besides technically fine tuning the road map for preparation of final report with regard to jaggery processing, for which HKCAL expresses its gratitude and indebtedness.

Director

HKCAL, Kalaburagi

I. Executive summary:

Jaggery is a traditional, concentrated product of cane juice without separation of the molasses and crystals and varies from golden brown to dark brown in colour (FAO). Jaggery industry is one of the largest agro – based cottage industries, managed by unorganized sector in India. Prior to twentieth century, entire sugarcane was utilized for jaggery and Khandsari production. This cottage industry remains neglected due to adoption of traditional system of sugarcane crushing, juice clarification, heating, boiling without any suitable technological advancement. Lack of Government policy and a meagre financial support from financial institution add to the vows of the industry.

Jaggery production depends on various factors such as cane price arrears paid by sugar mills during previous crushing season, profitability and solvency status, beginning of crushing operation of sugar mills, sugarcane price fixation, supply – demand scenario during early crushing phase and jaggery product price and demand scenario in local market.

The factors responsible for rapid down fall of jaggery sector were poor technological interventions for juice extraction, heat utilization, furnace inefficiency, jaggery storage and packaging, quality control interventions due to paucity of infrastructural development funds and inadequate extension supportive mechanism. Therefore, it is very much essential to revive the jaggery processing sector to safeguard the economic interest, minimize dependence on sugar mills, of millions of sugar cane farmers and rural workers for their livelihood security and prosperity besides prevention of migration.

In light of the above facts, the state government has financially supported setting up of a jaggery park under the jurisdiction of university of agricultural Science, Bangalore. The main objective of the jaggery park is to cater to the needs of jaggery farmers through technological innovations and dissemination of information on all spear heads of chemical free jaggery preparation during the years 2008-11 with a financial out lay of about Rs. 8 Crores.

As on date, the center has developed sugar rich variety VCF 0517 besides have screened several verities like Co86032, Co62175, etc, suitable for jaggery processing. The center has so far developed and standardized different agronomical practices viz wider spacing, drip irrigation, INM, IPDM management techniques, intercropping and farm mechanization. However, these technologies though highly beneficial and profitable in enhancing the yield and quality of cane suitable for jaggery processing, their spread or acceptance by the farmers is only to the tune of 15-20 per cent and there is a gap of 80-85 per cent. It is notable that the spread of variety VCF 0517 is very good and is fast spreading but still there is gap of 65-75 per cent.

The centre has created an opportunity for more scientific method of chemical free jaggery processing techniques for meeting the demands of growing population compared to chemically processed jaggery, which is not suitable for human consumption. But still, there is a greater demand in the market for chemical jaggery only because of its bright colour. While the chemical free jaggery is dull and golden brown colour, has no demand, on the contrary is priced higher because it has a selective buyers as it has high nutricical and medicinal value for human and also for animals consumption. The entire traders know the ill effects of chemical jaggery on Human health, they have failed to push the sale of the product i.e., chemical free jaggery only because of colour. Hence, there is a need for government intervention to ban the processing of chemical jaggery in the state of Karnataka keeping in view the health of the consumer.

The park has provided more importance on processing of the chemical free jaggery for its potential nutritional status and hygiene in processing of jaggery, which do fetch competitive price both in local and international markets which in turn facilitates to earn higher foreign exchange. The park scientists have extensively trained about 141 farmers and broadcasted 12 All India Radio Programmes in the area of sugarcane cultivation (Agro-technique) post-harvest management of cane, juice extraction, processing of juice and hygienic jaggery processing without chemicals which has adequate demand from the farmers from almost all Taluks of Mandya district. However, the acceptance of Agro - techniques are highly encouraging as the majority of the farmers have seen the benefits of technology but they are slow moving. On the contrary, they have been well educated on the improved method of processing chemical free jaggery. Further, the acceptance of the technological innovations, starting from extraction, use of herbal clarificants, modernized and fuel efficient furnace, steel boiling pans to prevent caramalization, cooling pits with granite slab flooring and steel moulds etc,. Though accepted the benefit of these technologies their adoption is very low because of infrastructure development cost is very high.

Besides, they have also imparted training to departmental officials, college students and Farmers (1500) of southern Karnataka on all aspects of sugar cane cultivation for chemical free jaggery processing.

The Steam boiling unit (Fig -5.18.1) established recently for processing of chemical free jaggery at a cost of about Rs. 35 lakhs is yet to be standardized for processing of jaggery. The scientists of Jaggery Park should immediately should standardize and activate at the earliest without any further delay for its utility for the betterment of farming community, which is a unique one in processing high quality jaggery in meeting the international standards besides fuel efficiency (20%) and labour efficiency (50%).

The park has initiated a process of popularizing the chemical free jaggery technology through public private partnership (PPP) model. It is a good effort in right direction, for utilizing the infrastructure created by Government of Karnataka for the benefit of jaggery farmers as well as growing population for providing sweetener. However, the project is still at infancy and needs more time to assess the impact of such a model, because of three years consecutive drought in Cauvery command area leading to drop in production and productivity of sugarcane.

As of today, the existence of park is highly relevant to Mandya because of following reasons viz., consequent to urbanization and industrialization of Cauvery command area, unstabilized market for cereals, pulses and vegetables leading to indebtedness of the farming community besides non availability of farm labour and erratic electricity supply, the farmers have shifted from cultivation of food crops to a commercial crop like sugarcane in order to improve their economic status and livelihood security. Consequent of non-availability of improved technology in the field of sugarcane research and jaggery processing to the farming community, the jaggery processing and production has comedown drastically. Therefore, this is the only institute specifically meant for carrying out above said research. In addition, the park has a potential to develop appropriate Standard technologies to harness off seasonal jaggery processing in the Cauvery Command area which is unique in entire Southern Plateau and needs to be enchased.

The jaggery park established by UAS (Dharwad) at Mudhol and Sankeshwar are the replica of jaggery park of Mandya. The technological interventions and dissemination made by this center with regards to sugarcane varieties, agro techniques to enhance sugar recovery and cane yield, farm mechanization and exportable organic jaggery processing techniques have been ably demonstrated to the farming community of Northern Karnataka. The public private partnership (PPP) Model adopted at Mudhol is also a good model and continued its growth as long as was supported by RKVY funding (Subsidy). No sooner, the RKVY support was withdrawn, the progress of the PPP model has come to stand still or moving at a low profile.

The park at Mudhol and Sankeshwar, though have developed good Agro-techniques, the adoptability of the technology by the stake holder is only to the tune of 15-20 per cent except the technology of organic jaggery processing which has been scaled up not only in meeting the local needs and demand but also resulted in increased exportability of organically processed jaggery to many countries. Here too, the park has inadequacy of technical manpower in respect of jaggery processing and post-harvest management which was observed during our visit to the park which was managed by only 2 semi-skilled field assistants who did not have any required qualification on the issue relating to organic jaggery processing and post-harvest management on scientific basis, but with only mear experiences and observations of the skilled labour . Hence, there is need for rejenuvating the activities at the earliest by the university authorities for benefits of farming community of Northern Karnataka.

The survey information compiled reveals that (more than 50%) of farmers are small and marginal with land holding of 5 acres and 90% of them are living in Kaccha houses, almost all the farmers are well aware of the suitability of soil for cultivating sugar cane. They grow sugarcane and supplied to jaggery units because they get quicker and high price for sugarcane than sugar factories. Further, they have also expressed that the area of sugarcane cultivation though did not increased due to training program undergone by the farmers at park but there was a definite and significant improvement in the productivity of sugarcane. However, more than 50% of the farmers have expressed their dissatisfaction for non-availability of soil testing facilities at Jaggery Park, though the jaggery park has the excellent laboratory facilities established by utilizing RKVY fund for soil, sugarcane, and jaggery. About 63% of the farmers they stated that they select the verity, fertilizer application and chemicals based on their own experiences and only about 11% carry out scientific method of sugarcane cultivation, indicating a gap in extension. More so training on sugarcane cultivation, jaggery processing in context of today's demand.

It is a well-known fact that the jaggery quality is also dependant on sugarcane verities they cultivate and the survey has revealed that verity Co 62175, Co86032, are the best verities with regard to tonnage and jaggery recovery. A sugar rich verity which has both tonnage as well as highest sucrose which is being forcefully recommended as a high potential for cultivation of this verity. As on today only (16%) the farmers have adopted this technology and needs to be up scaled as the earliest.

About 65% of the farmers have expressed that they are in need of financial assistance for cultivation of sugarcane. Further, it is known that 60% of the farmers transport the cane to the jaggery units through bullock carts leading to tonnage loss deturation in Juice quality and poor recovery, these needs to be looked into.

In principle, the juice extraction processing, furnace, chimney, boiling pans and moulding units play a phenomenon role in jaggery quality and yield. It is about 95-98% of jaggery processors do not possess any improved equipments of jaggery processing and are out-dated models and unhygienic. Hence, there is a greater and urgent need for modernization of scientific chemical free jaggery processing, should be the one of the mandate of Industries and Commerce Department besides, Agriculture Department.

The juice requires clarificants agents to get colour, crystallize structure, hardness, hygienic jaggery. The same can be obtained by using organic clarificants and calcium (Annexure) on the contrary it is observed that the processors are using chemical clarificants though not recommended at a particular level wherever necessary (Annexure) but are being used liberally or indiscriminately only to get the bright colour for which there is a market demand. Besides, 93% processors are also using industrial chemicals **(Sodium Formaldehyde Sulphoxylate (Sulpholite/decolite)** an industrial textile bleaching agent (Annexure. 4) for bleaching the jaggery which has quick disposal in the market but it is highly deterimental to the health of the consumer and should be banned with immediate effect.

The study also revealed that both the institutes (UAS B and (UAS D) have not made much progress with regard to diversifying the jaggery products except restricting themselves to three major products like jaggery solid, liquid and powder forms. However, the diversified product of jaggery has great potential for export, the outcome of these institutes are not proportionate to the amount spent on research.

About 54 per cent of the consumer are employed and 30 per cent are agriculturist almost all the consumers are well aware of the knowledge on chemical free jaggery but preferred to buy the chemically processed jaggery because its price is low in the market besides it has attractive bright colour, which is not desirable in health point of view in addition they have also revealed that they know only one type of jaggery i.e. solid jaggery but not the other forms jaggery (Liquid and powder) indicating a gap in transfer of knowledge to the consumer by the jaggery park Scientists in the study area. Further, it is not worthy to state that on an average 10 to 20 kg of jaggery is consumed in a year by spending of Rs. 500-1000 annually which indicates a good market potential.

Hence, it is essential to modernize and to develop organic clarificants ready to use vegetable clarificants for quality of jaggery production to meet the consumer demand, export potential and health.

It was observed that jaggery is marketed in APMC yard, Mandya, is exclusively meant for disposing jaggery. The APMC yard is monopolized by traders and middlemen. As of today, there is no exclusive market for chemical free jaggery. The jaggery is being disposed based on colour and not on quality parameters. However, there exists a better scope if a separate provision is made for chemical free jaggery which is having high sucrose besides medicinal value, keeping quality and export potential. The same was expressed by the traders (**95%**) themselves. To encourage this, there is need for e-marketing, though this system was introduced earlier, the concept has been withdrawn with greater protest from the traders as it was evident during the survey. The traders (**90%**) are also well aware of the ill effects of chemical jaggery and they too encourage chemical free jaggery but for the consumer's preference for bleached white colour jaggery rather than golden yellow colour of chemical free jaggery.

The socio-economic impact of jaggery cottage industry may not be ruled out easily because of its contribution in rural development and monitory benefits to cane farmers. It is a labour intensive cottage entrepreneurship managed by semi and skilled workers at cheaper wages, providing employment avenues to number of rural workers and also restricts urban migration. The growers may harvest sugarcane crop as per their own convenience for its supply to jaggery units, get early payment and plan for next crops. If cane farmer are willing to supply it to sugar mills they depend on cane supply indent availability (cutting order). On the other hand they get payment immediately for cane supply to jaggery units. This cottage industry does not require sophisticated technologies as it uses indigenous processing equipment. They make diversified products such as solid jaggery, liquid jaggery and powder jaggery as per market demand and price by utilizing same machinery. The jaggery product helps in fulfilling the food and nutritional requirements in rural areas. Hence, it is paramount to develop efficient techniques for modernization of jaggery as a cottage industry to make them economical and profitable enterprises to face monopolistic challenges of sugar lobby and safeguard interests of millions of cane farmers.

Technological innovations for resurgence of jaggery would definitely have to go a long way in strengthening rural economy. Its resurgence would be essential for minimizing sweetener sole dependency on white sugar production. Besides, it is growing awareness amongst the consumers towards nutritious food items in our society which may reverse the currently rising trend of sweetener consumption in the form of refined sugar and declining trend in jaggery demand. Its creativity processing, hygiene, quality control, innovative packaging and storage may have some momentum and open additional income and employment avenues to rural youth. The technological advancement in juice recovery, heating and organic clarificants has scope for improving the efficiencies and address the issues of optimal by products utilization.

Table 01: Evaluation questions and sub questions:

SI	***Evaluation questions (Inclusive and not exhaustive):***	***Findings***
1.	Has the chemical free Jaggery preparation unit, the Jaggery Park V.C. Farm, Mandya and the trainings provided by it in making chemical free Jaggery made any impact on Jaggery unit owners, APMC Merchants and consumers with regards to going in for only chemical free Jaggery production, Marketing and consumption?	**Yes.** About 95% of traders state that chemical free jaggery though dull in colour, tastes good while chemically processed jaggery is having salty with lesser sweetness besides sulphur smell and poor keeping quality.
2	Are the Jaggery sellers and its consumers aware about the fact that chemicals are used in making Jaggery? Are they aware of the chemicals used and/or its ill effects on human health?	Jaggery sellers know the fact of liberal use of chemicals during the processing of jaggery to impart white colour which is market driven. While majority of consumers do not know about the use of harmful chemicals in processing of jaggery. The traders are fully aware of ill effects of chemicals used in jaggery processing. On the contrary the consumers do not know the ill effects of chemically processed jaggery thus, there is an urgent need to bring awareness to the public through mass media. (Doora Dharshan, All India Radio, News Paper etc.)
3	Does chemical free Jaggery have a different taste or appearance than usual Jaggery prepared with the usage of chemicals? (perception of Jaggery users may be used to answer this)	Yes. Chemical free jaggery taste is liked by the consumers which has good taste but dull golden colour which do not attract the consumers but still fetches higher price in the select markets compared to chemically processed jaggery which has attractive white colour with high demand in APMC market in spite of its ill effects on human health.
4	Are the Jaggery sellers and its consumers paying or willing to pay a higher price for chemical free Jaggery? If no, why not? If yes, what percentage more than the price of usual Jaggery are they paying, and what is the scope further in willingness to pay, for	**Yes.** Both sellers and consumers are ready to pay higher price for chemical free jaggery because of its chemical free nature, high quality, taste and keeping quality. On the contrary the jaggery to the market is

	chemical free Jaggery?	in short supply and needs to be up scaled.
5	What are the hygiene issues in the Jaggery making units existing in the surroundings?	At present the jaggery units of farmers engaged in preparation of jaggery are producing jaggery under most unhygienic conditions. The units have kaccha housing with mud flooring and tiled house with opening from all ends. As a result, insects (ants, cockroach, honey bees and wasps), rodents etc., will invade into the units making the jaggery so prepared unfit for consumption. The juice conveyance is in the open ducts which attracts insects and microbes. Overall ambience is under most unhygienic condition which is prone to easy contamination besides jaggery moulding units that is in the cooling pit the maintenance is unhygienic
6	Is hygiene in the Jaggery Park certainly and surely better than the Jaggery making units existing in the surroundings?	**Yes.** Jaggery park maintenance is highly hygienic. Indeed, the park is having food grade steel crusher, food grade stainless steel tank and food grade stainless steel boiling pans besides, a cooling pit with granite flooring. In addition, only organic clarificants are being used to remove the scum and improve the quality of jaggery.
7	What are the views of Jaggery making unit owners on using chemical clarificants vis a vis herbal clarificants in Jaggery processing?	At present, the jaggery prepared in the farmers jaggery unit is sold through APMC. The demand is for pure white bleached jaggery in APMC. As a result, the farmers prefer to prepare white bleached jaggery which can be done only through the use of chemicals. Use of unripe, over aged and lodged sugarcane for jaggery preparation which necessitates the use of chemicals for easy removal of scum to give a bleached colour to jaggery. That is why farmers prefer to use chemicals in jaggery processing. Some farmers also use herbal clarificants in addition to chemical clarificants.
8	What are the opinion of Jaggery sellers and consumers of Jaggery about using herbal clarificants in Jaggery processing?	Jaggery sellers as well as consumer strongly recommend only for use of herbal clarificants which is good for health point of view.

9	Does chemical free Jaggery have a longer shelf life than usual Jaggery prepared with the usage of chemicals? If yes, how much longer or shorter and why?(perception of Jaggery users may be used to answer this)	**Yes.** Use of chemicals like sodium hydrosulphite (hydros), sodium formaldehyde sulphaxilate (safolite), sodium bicarbonate (baking soda) sodium carbonate (washing soda) by virtue of sodium chemicals makes the jaggery more hygroscopic. Depending on the season and relative humidity in the atmosphere jaggery absorbs moisture which makes it watery as a result of inversion of sucrose. Hence, the shelf life of chemical jaggery (30-45 days) is less than chemical free jaggery (90-100 days).
10	What has been the production, sale and utilization pattern of powdered Jaggery, Liquid Jaggery and Jaggery made into unique shapes and sizes?	Though the products like liquid jaggery, powder jaggery are having high quality with higher sugar content, the cost of production is on the higher side. However, due to its good keeping quality and ease of the usage, products need to be encouraged through proper extension methodologies and government incentives.
11	Which States and districts (outside Karnataka and in Karnataka) are the main purchasers of chemical free Jaggery produced in the Jaggery Park?	The major states procuring chemical free jaggery from jaggery park are Rajasthan, Gujarat, Maharashtra, Kerala, Andra Pradesh, West Bengal and Orissa.
12	Which Sugarcane varieties are better for Jaggery making from the point of view of Jaggery yield and quality as per Jaggery making unit owners of Mandya?	The varieties viz., VCF 0517, Co 86032, Co 8371 and Co 92005 have been found to be suitable for jaggery preparation from the point of view of jaggery yield and quality.
13	Is there a control mechanism (legal and procedural) for checking the usage of harmful chemicals in the making of Jaggery and the hygiene aspect in the process of making Jaggery? If not, what mechanism can be suggested? Please elaborate.	Yes. Food safety and Standards Authority of India (FSSAI) under the Ministry of health Government of India is authorized to make inspection to jaggery units on hygiene aspects and take legal action if units do not comply.
14	Please detail a few tests that can be done at home to check whether the Jaggery one is using is chemical free or not.	1. While preparing coffee or tea, during boiling of milk if chemical jaggery is added to milk, it will spoil the milk whereas in chemical free jaggery this will not happen. 2. If jaggery is of pure bleached white colour, apparently it is chemical jaggery.

		3. If jaggery is tasted, chemical jaggery will give salty taste. 4. Chemical free jaggery will emanate good flavour while chemical jaggery will give off flavour 5. Chemical free jaggery attracts small ant species (ನಚ್ಚಿರ) 6. If jaggery is stored for a month or so, chemical jaggery is likely to be watery. 7. Laboratory test (chromatography) can reveal the actual chemical/s present in jaggery 8. Jaggery if immersed in water, if impurities are there in jaggery it will settle at the bottom or float on the surface. This is a simple test to know the inert matter present in jaggery
15	Has the present Jaggery Park fulfilled its objectives? Is a good case made out for having a few more Jaggery Parks in Karnataka? If no, Why not? If yes, what further inputs need to be provided?	The establishment of jaggery parks in the Southern ZARS, V.C. Farm, Mandya under UAS, Bengaluru and Northern Mudhol & Sankeswar under UAS Dharward. parts of Karnataka are highly relevant to meet the farmers requirement of research related issues of sugarcane cultivation and jaggery processing. These institutes have met their objectives partially when compared to the amount spent on infrastructure and technology development. Both the institutes have failed in outreach activities to farmers for transfer of technology developed at the respective institutes. However, efforts should be made to activate these institutes by strengthening the initiated PPP Model for further up scale is the need of the hour. In addition, based on the facts and figures available, it is felt that there is no need for having another jaggery park in the state instead, the present parks may be strengthened with technical and financial support. in order to make use of huge infrastructure for benefit of farming community

II. Introduction

Sugarcane (*Saccharum Officinarum*) is in important commercial crop of India and it is grown in an area of over 5.1 million hectares (2015) for production of sugar, jaggery and khandsari to meet the sweeteners demand of the country. India is producing over 362 million tonnes of sugarcane with an average yield of 71.5 t/ha. and happens to be the second largest sugar producing country (After Brazil 73.7 million tonnes) during 2014, accounting to 20-25 % of white sugar production. About 50-55 per cent of the cane produced in the country is used for production of sugar 30-35 per cent for jaggery processing and about 10-15 per cent for seed and chewing purpose. The major sugarcane growing states in India are Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andra Pradesh, Gujarath, Haryana, Punjab and West Bengal. Indeed, sugarcane cultivation is highly labour and energy intensive crop involving human drudgery and higher cost of production. As a matter of fact globalization and population growth put greater demand for sugar and jaggery sweetener across the world. Of the total world production, more than 58 per cent of the jaggery is being produced in India, in addition, Colombia (14%), Myanmar (9%) are the other major jaggery producers(Anon 2015).

Karnataka is one of the major sugarcane growing states in the country producing about 44 million tons of cane annually. The state ranks 3rd in the area (4.8 lakh hectare) and fourth in the productivity (91.2 t/ha) with a recovery of 10.89 %. Karnataka has been playing a key role in sugar industry since 1930's with rapid expansion during later part of 1990's (Table 1).

Table -2.1 Progress of Sugarcane in India& Karnataka 1980-81 to 2014-15

Sl. No.	Particulars	1980-81	2014-15	% increase over 1980-81
	No. of Sugar mills in India	314	558	71
	No. sugar mill in Karnataka	23	66	187
	Area under sugar cane hectare in India (m ha.)	2.65	5.01	91
	Are under sugarcane hectare in Karnataka (m ha.)	0.16	0.48	2.08
	Cane yield in India (ton/ha)	48	71.56	49.0
	Cane yield in Karnataka (ton/ha)	66	91.2	38.0
	Sugar recovery % India	9.98	10.37	3.9
	Sugar recovery % Karnataka	10.37	10.89	5.0

However, there are many constrains on the field and off the field with respect to Stagnated production and productivity, processing of sugarcane in the state i.e. Lack of high yielding differential maturity varieties of cane to replace the existing ones and to suit different planting date /time. Use of low cost agricultural inputs, frequent biotic and abiotic stress, improper agronomic practices, imbalanced application of fertilizers, faulty irrigation practices, inadequate skill labour and farm mechanization in all aspects, low sugar recovery, earlier delayed harvesting of canes, low crushing capacity of mills to absorb excess cane due to doubled area and production, crusher with obsolete technology, leading to high cost of sugar/ jaggery production. In addition, lack of timely technical knowhow on value addition of sugar/ jaggery by products increase in the cost of inputs including manpower, total absence of marketing strategy overcrowding of sugar mills/ jaggery units in the sugarcane belts across the country have been responsible for unhealthy competition for sugarcane leading to high cost of sugar as well as jaggery production in the country as well as in state expect in the state of Maharashtra.

In light of the above facts, the industry, regardless of sugarcane or sugar/ jaggery production warrants a complete over hauling and need adoption of mechanized / advanced technology in every step starting from cultivation to production, transportation, processing and marketing of product so that the production costs are brought down and profits are increased in order to boost rural economy and employment.

2.1 Jaggery Industry in India:

Jaggery processing is one of the largest agro- based cottage industries of unorganized sector in India. It is a traditional form of sweetener produced and utilized in rural villages since time immemorial. Prior to introduction of modern sugar industry in the beginning of 20th century, entire sugarcane was utilized for jaggery making in rural areas. This unorganized cottage industry remained neglected due to inadequate cane crushing efficiency, juice clarification technological development, inefficiency in open pan heating and boiling system, meagre financial and policy support to jaggery sector. Therefore, it remained virtually static during rapid growth phase of Indian sugar mills. The number of sugar mills has increased form one in 1902 to 526 in crushing season 2013-14, (Solomon and Gangwar 2014). Jaggery is still popular in some sugarcane producing states of U.P., Karnataka, Tamil Nadu, Maharastra and A.P. These five states contribute 80-90% of jaggery production. However, proportion of sugarcane utilized for sugar production has increased from 33.5% in 1980-81 to 72% in 2013-14. In contrast, sugarcane utilized for jaggery has declined from 8.52 to 4.47 MT during last three decades. Its per capita availability has also reduced from 12.5 to 3.7 kg/year during this period. It reveals that the jaggery production and consumption have declined significantly. There were nearly 23,000 jaggery processing operational units in U.P during crushing season 2013-14. The average crushing capacity of these units varied from 5 to 15 TCD. These units crushed 35-40 MT sugarcane and in contrast sugar mills crushed 80-85 MT for sugar and other co-product production in U.P. during same season. The jaggery production depends on various factor such as cane price arrears to be paid, sugar mills profitability and solvency position, beginning of crushing operation in sugar mills, cane price fixation, supply – demand mismatch during early crushing phase, jaggery product price and market demand. The major factors responsible for jaggery sector downfall have been poor technological intervention for juice extraction, open pan furnace inefficiency, jaggery moulding and packaging, quality control and hygiene issue, lack of technical skill, meagre financial support etc, (Gangwar et al,, 2014)

Hence, it is very much essential to revive the jaggery processing sector to safeguard the economic interest, minimize dependence of millions of sugarcane farmers and rural workers on sugar mills for their livelihood security and prosperity for which the jaggery products should improve the quality of jaggery production,keeping hygienic and clean processing conditions without using chemicals in view of the national and international standards, demand and supply.

2.2 Jaggery Industry in Karnataka

Sugarcane is a predominant crop in the southern districts of the state with an area of 1.3 lakh hectares and an average productivity of 100 tons/ha across Mandya, Mysuru, Chamarajanagar, Hassan, Shimoga and Davanagere districts which happens to be the domain of Jaggery Park. In southern Karnataka, out of the total sugarcane produced, around 60 per cent will be utilized for sugar extraction in the sugar mills and 30-35 per cent for Jaggery making. At national level, 25 per cent of the total sugarcane produced is utilized for Jaggery preparation indicating the importance of Jaggery industry in the region. As such, Jaggery preparation is an important cottage industry of Karnataka. However,, sugarcane & jaggery industry is confronting major production constraints like lack availability of good quality seed material (10%), weed management (15%), water management (20%), plant protection (15%) and sugarcane varieties (20%). (Shankar et al, 2015).

In simple terms, Jaggery is the solidified mass after boiling and condensing sugarcane juice in open pans by removing the impurities. Jaggery is an important natural sweetener widely used in confectionaries, culinary preparations and Ayurvedic medicines. Jaggery has got nutritive as well as medicinal values unlike white sugar and is much sweeter than white sugar, by virtue of its higher content of reducing sugars.

Cauvery & Bhadra command areas in southern Karnataka are important sugarcane growing areas, with over 5000 Jaggery boiling units under operation during 1999-2000. However, the number of Jaggery boiling units has been reducing gradually because of market price fluctuations, highly labour intensive, energy intensive, low yield (recovery), difficult in maintaining skilled manpower in off season and cost of inputs, reduced quality cane supply due to drought over the years. The APMC market in Mandya is the major Jaggery market in the Cauvery command area.

It’s estimated that over 42 % of the sweetener used in rural area is from jaggery produced from unorganized decentralized sector in the country besides providing employment to over 25 million people (Alam, 1999). Further, jaggery is considered as best base material for preparation of several ayurvedic medicines. It is therefore, imperative to expand the jaggery industry in Karnataka due to the following reasons viz, it creates employment opportunities all-round the year in the villages, higher food value of jaggery at low cost, strengthen rural economy, decentralized production of jaggery utilization of indigenously made equipments and machinery, saving on transportation cost on sugarcane, ready market and investment is within the capacity of farmer/entrepreneur.

To give a fillip to the jaggery industry in the Southern parts of Karnataka state, RKVY under the Ministry of the Agriculture and co-operation, Government of India through Karnataka State Department of Agriculture (KSDA), has made financial sanction for commissioning of Jaggery Park at ZARS, V.C. Farm, Mandya. Since its inception in 2011, Jaggery Park has been engaged in production of chemical free jaggery (Annexure III and VI).

The **Karnataka Evaluation Authority (KEA),** Government of Karnataka has entrusted the evolution of economic activities of Jaggery Park to **Hyderabad Karnataka Centre for Advanced Learning (HKCAL), Gulbarga** through its approved Terms of References (ToR) and Inception report from KEA**. HKCAL** has undertaken the evaluation work with the following specific objectives.

2.3. Specific Objectives of Evaluation

i) To assess the relevance of crop production, processing and value addition technologies in attaining the objectives of the jaggery project for getting chemical free jaggery.

ii) To know the impact of knowledge of chemical free jaggery technology dissemination to the farmers, consumers and traders.

iii) To assess the potentiality of chemical free jaggery solid and liquid form for its export potentials.

iv) To assess the strength and weakness of technologies involved in chemical free jaggery production and its refinements.

v) To document the overall progress of the objectives of the jaggery park envisaged in the final report.

vi) To study feasibility of e-market initiatives and PPP models under taken by the implementation agencies.

vii) To assess the economic viability of the project.

Note: After a detailed study of the final project report submitted by the Scientist of Jaggery Park and the survey conducted by the evaluation team, it was decided to restrict the study up to the sixth objective only. Further, based on the recommendation of the Karnataka Evaluation Authority (KEA) it was suggested to include one more objective that is comparative performance of similar jaggery units in Northern parts of Karnataka and Neighbouring state Maharashtra viz, Kolhapur (Comparative performance of both Public sector units and Private sector units i.e. farmer units).

2.4. AGRICULTURAL CHARACTERISTICS OF MANDYA AND RAINFALL PATTERN

2.4.1 District Agriculture profile: MANDYA

Agro-Climatic/Ecological Zone	
Agro Ecological Sub Region (ICAR)	Eastern Ghats And Tamil Nadu Uplands And Deccan Plateau (8.2)
Agro-Climatic Region (Planning Commission)	Southern Plateau and Hills Region (X)
Agro Climatic Zone (NARP)	Central dry zone, Southern dry zone, Southern transition zone (KA-4, KA-6, KA-7)
List all the districts or part thereof falling under the NARP Zone	Mandya, Maddur, Malavalli, Srirangapattana, Pandavapura, Nagamangala and Krishnarajapet

Geographic coordinates of district	Latitude	Longitude	Altitude
	12º31'21.94"N	76º54'24.16"E	729 m

Name and address of the concerned ZRS/ ZARS/ RARS/ RRS/ RRTTS	Zonal Agricultural Research Station, V.C. Farm, Mandya – 571 405, Karnataka

Rainfall	Normal RF (mm)	Rainy days (No.)	Normal Onset	Normal Cessation
SW monsoon (June-September):	285.1	14	2nd week of June	4th week of September
NE Monsoon(October-December):	214.1	10	2nd week of October	2nd week of December
Winter (January- February)	5.5	00		
Summer (March-May)	158.0	07		
Annual	**662.7**	**31**		

Land use pattern of the district (latest statistics)	Geographical area	Cultivable area	Forest area	Land under non-agricultural use	Permanent pastures	Cultivable wasteland	Land under Misc. tree crops and groves	Barren and uncultivable land	Current fallows	Other fallows
Area ('000 ha)	498.2	225.0	24.8	60.9	38.0	42.0	3.4	21.5	30.7	43.0

Major Soils (common names like shallow red soils etc.,)	**Area ('000 ha)**	**Per cent (%) of total**
Red gravelly soils	125.4	60
Red sandy loam soils	64.6	30
Red sandy soils	21.4	10
Agricultural land use	Area ('000 ha)	Cropping intensity %
Net sown area	225.0	116.8 %
Area sown more than once	37.9	
Gross cropped area	262.9	

2.4.2. Red loamy soils with rainfall of 650 – 750 mm

Delineation and Composition: This situation exists in all most all taluks. Taluks belonging to this situation are,Mandya:Nagamangala, Srirangapatna, Malavalli, Maddur, Mandya and K.R.pet.

Physiography: This situation has an elevation of 650 to 800 mts. There are small to medium hillocks and hills in this track. The upland area is plain to slightly undulating with slope up to 2.5 per cent. There are thick forests in Malavalli taluk and very limited forests in K. R. Pet. This situation has a large uncultivable area, which is highest in Nagamangala and K. R. Pet.

Climate: We note arid and dry climate for most of the year except during winter which is slightly cool but mild. It experiences bimodal rainfall with one peak at may/June and the other in September/October. Nagamangala and Srirangapatna receive lowest rainfall. South west monsoon showers occupy the major part of annual rains. They are very much erratic and scanty. Dry spells prevails from the 2nd week of July and extend up to end of August, sometimes even up to first fortnight of September. This causes severe moisture stress to early sown crops and affects the crop growth and yields.

Mean minimum temperature ranges from 14^{o} to 30^{o} C, but occasionally touches 11^{o} C during December. Mean maximum temperature ranges from 27^{o} to 39^{o} C which is mostly noted in May month. This track has relatively low humidity. Wind velocity is high during July/August and February/March months

Soils: Soils in this track are shallow to medium in depth. There are coarse to very coarse sandy loams and loamy sands, which are red to light red in colour. Soils are neutral in reaction with calcareous kankar in deeper layers and non-saline. Soils are highly permeable and well drained with low water retentive capacity. These soils are generally low in organic carbon and are deficient in P and Zn in general.

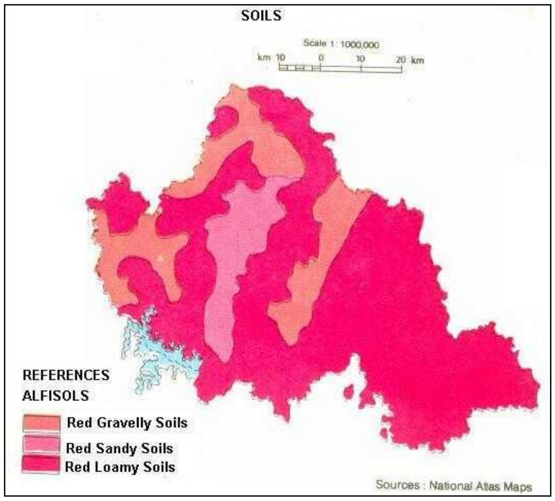


Fig. 2.1.1 Soil map of Mandya district.

2.4.3 Red sandy loam soils with rainfall above 750 mm

Delineation and Composition: Pandavapura taluk of Mandya district falls under this category.

Physiography: There are small hillocks, hills and scattered rocky portions in patches. The land is flat and plain in most of the parts of the taluk. Still there exist slightly undulating lands with slope values ranging from 0.5 to 2 per cent. Elevations are around 800 to 900 mts.

Climate: South west monsoon showers occupy the major part of annual rains and it forms the major source in kharif season. Rainfall is distributed between May and October months. April/May receives thunder showers, which is of much help for taking short duration crops before main crop. Up to September this track receives 65 per cent of rainfall while 25 per cent in September and October months. This excess rainfall within short period causes water logging condition, inundation and floods affecting the yield. Long dry spells prevails from the 2nd week of July and extend up to end of August, sometimes even up to first week of September. This causes severe moisture stress to early sown crops and vegetative stage of normally sown crop growth. It has an adverse effect on rained crops. In addition, to this there will be wind with high velocity during July to august causing desiccating effect either affecting germination or crop growth if normal rains are not received.

Mean minimum temperature ranges from 12^o to 28^o C and mean maximum temperature ranges from 28^o to 30^o C. During summer temperature may rise up to 40^o. Winters are moderate and cool for shorter period during December and January months.

Soils: Soils are sandy loams with course to very sandy loams, light in texture with neutral pH. They are low in organic carbon, medium in available P, high in K content and varied fertility. It is deficient in Zn and Fe. As they are shallow to medium in depth, they have poor water holding capacity, but the soils are well drained and often prone to run off and erosion. Lime concentration and quartzite fragments are spread on surface with rock in the profile.

2.4.4. Categorical Spread of Monthly rainfall over 114 years in Mandya District

Categorical Spread of Monthly rainfall over 114 years in Mandya District is presented in Table-2. Latest fourteen years average values show change in normals when compared to the past 100 years(Tab-2 & Fig-7). Three categories of rainfall situation is developed by grouping years with rainfall less than 1.5 times the standard deviation as low while above 1.5 times the standard deviation as high and the rest being medium. Along with mean rainfall in these categories, the range of rainfall experienced in each month is mentioned.

Rainfall is well described by Incomplete Gamma distribution. Using its density function, we have made an attempt to provide the probable values of rainfall with 75 per cent chances and 65 per cent chances. It means when IMD says an year is expected to be drought then September month may receive rainfall in range of 40 to 104 at 75 per cent chances while around 53 to 90 at 65 per cent probability. This concludes that with no doubt around 72 mm rainfall is sure to be received. Similarly values in High category are to be referred when year is predicted to receive above normal rainfall.

Monthly normal rainfall for the stations located in Mandya district is presented in Table-3. Table very clearly shows the existence of notable variability in the rainfall over different hoblis in same taluk and among taluks in same district. Monthly normals over the period of 1901 to 2014 and 2001 to 2014 clearly depicts there is shift in rainfall in April and May months.As the last decade was in increasing phase, mean values are above the values of medium category and 108 years. It is expected that in the near future, rainfall would be in medium category. May and October months remained the highest rainfall receiving months.

2.4.5 Seasonal rainfall over 114 years in Mandya district

Trends in Seasonal rainfall and annual rainfall for the period 1901 to 2014 is presented in figure-7. Pre monsoon rainfall of Mandya district has shown decreasing trend whereas an increasing trend in south west monsoon is observed. Lower R^2 values indicate no much significant in trend values. Shift among months has nullified the seasonal shift. However, annual rainfall remains almost same. Variations and chances of extreme situations have remained almost same in all three seasons.

Statistics on seasonal rainfall in Mandya district as a whole is presented in table-4. Normal seasonal rainfall and rainy days for different stations of mandya district is presented in Table-5. Though there does not exist much difference among seasonal average for different periods, for sure there exists significant variation in annual rainfall among different stations of the district.

Table-2.4.5.1: Seasonal and Annual rainfall (mm) distribution in Mandya District.

Description	PM	SWM	NEM	Annual
Mean	172	273	222	667
Range	44-325	98-534	29-463	282-1151
Drought (%)	15	19	12	11
Excess (%)	12	17	13	9
2001-2014				
Mean	181	291	224	696
Range	98-325	156-452	117-427	486-1071
Drought (%)	10	10	10	10
Excess (%)	20	20	20	30

Table-2.4.5.2: Seasonal Rainfall of different stations in Mandya district

STATION NAME	Mean rainfall					Rainy days				
	Annual	SWMS	NEMS	Winter	Summer	Annual	Winter	Summer	SWMS	NEMS
AKKIHEBBAL	633.5	267.1	219.0	3.8	143.6	46.6	0.3	9.9	23.3	13.1
BINDIGANAVOLE	625.1	299.6	196.0	4.5	125.0	33.7	0.2	6.9	16.5	10.0
HALAGUR	732.9	347.7	210.5	6.4	168.3	45.8	0.3	10.4	22.6	12.5
KIKKERI	671.0	305.7	210.8	4.5	150.1	44.2	0.4	9.9	22.0	12.0
KOPPA	820.7	405.3	252.0	8.3	155.1	43.3	0.3	9.1	21.3	12.5
KOWDLE	770.8	348.6	247.8	4.6	169.8	45.1	0.4	10.5	21.3	12.9
KRISHNARAJPET	768.2	329.3	247.7	9.5	181.8	50.6	0.4	11.2	25.4	13.6
KRISHNARAJSAGAR KRS	746.9	330.6	232.5	10.0	173.8	50.1	0.6	10.7	25.8	13.0
MADDUR	770.5	352.8	249.0	5.6	163.1	47.7	0.4	10.2	23.4	13.7
MALAVALLY	687.7	322.3	201.1	5.2	159.2	45.9	0.4	9.9	22.6	12.9
MANDYA TQ OFFICE	683.0	317.0	214.7	6.0	145.3	46.3	0.4	10.2	22.5	13.2
MELKOTE	797.1	345.6	241.6	7.4	202.5	40.6	0.3	9.4	19.8	11.2
NAGAMANGALA	785.3	347.9	247.3	11.7	178.5	45.8	0.6	10.4	21.1	13.7
PANDAVAPURA	708.1	295.0	231.2	10.2	171.8	44.7	0.4	9.6	21.7	13.0
SRIRANGAPATNA	683.3	300.4	200.3	7.6	175.0	47.4	0.4	10.5	23.6	13.0

2.4.6 Rainfall of V. C. Farm, Mandya

Annual rainfall of V. C. Farm is depicted in the graph along with its trend line. Negative trend values (-2.97) of the equation depicted in the graph is of no much meaning because the equation has low R^2 (0.01). Indicating that the soils are becoming dry and drier in moisture because of inadequate rainfall and unable to support the crop productivity, more so in sugarcane cultivation which demands high water requirements.

2.4.6.1 Rainfall Data of V.C Farm, Mandya

Years	Actual Rainfall (mm)	Years	Actual Rainfall (mm)
1991	804.60	2004	888.50
1992	425.80	2005	1211.70
1993	716.90	2006	485.60
1994	630.40	2007	709.40
1995	618.50	2008	691.20
1996	1096.60	2009	677.50
1997	898.30	2010	883.30
1998	775.00	2011	664.00
1999	935.80	2012	447.00
2000	1182.00	2013	569.00
2001	758.00	2014	782.00
2002	462.90	2015	795.00
2003	623.00		

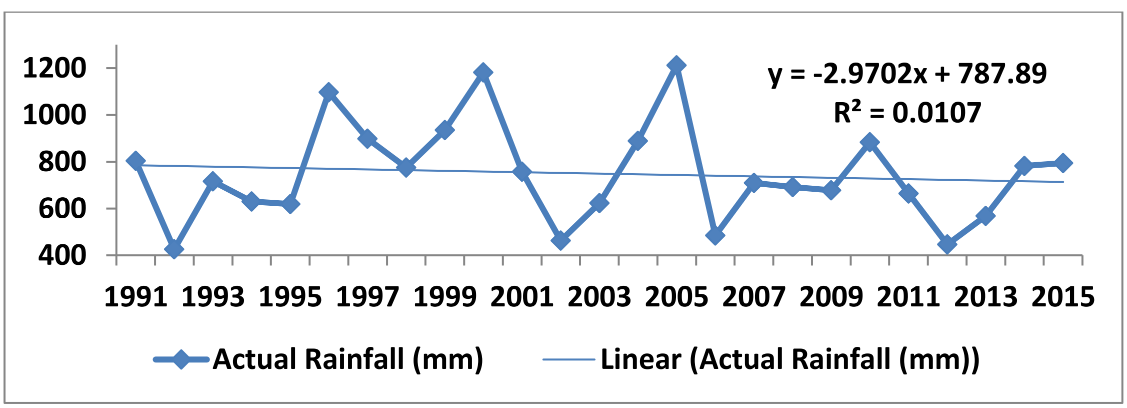


Fig 2.4.6.1 **Annual rainfall of V. C. Farm of Mandya**

II. Log Frame / Theory of change /Program Theory

3.1 Establishment of Jaggery Park at V.C. Farm, Mandya.

Inputs	Outputs	Outcome	Impact
A. Crop Production			
i. Varietal development	Co 86032, VCF 0517, Co 92005	VCF 0517 in > 5000 ha.	high sugarcane yield (15-20%) and jaggery recovery(10-15%)
ii. Agronomic Practices	Drip irrigation, wide row , intercropping	Wide row adoption -reduced pest & disease & sustained yields drip irrigation – saving in water and nutrients	Water use efficiency (35-50%)increased, increased fertilizer use efficiency(20%)
iii. Capacity Building	Training programmes and demonstrations	Farmers trained in chemical free jaggery preparation	Awareness created among consumers and producers on chemical free jaggery and ill effect of chemicals used in jaggery preparation, improved health.
B. Processing Unit			
i Crushing mills,	Improved mill	Increased extraction of juice	Saving of sugars by reduced sugars in bagasse, higher income.
ii. Boiling units	Stainless steel fabricated equipments	Steel avoids metal contamination	Hygiene and quality maintained
iii. Modified Furnace	Improved furnace	Increased fuel efficiency	Saving of fuel (20 -35%)and avoids investment on additional fuel
iv. Moulding units	Wooden and tin moulds	Moulds of wood absorbs moisture very quickly	Improved quality of jaggery with less moisture and hygiene.
v. Storage Structure	Well aerated storage units	Reduces the deterioration of jaggery quality	Improved quality and shelf life
vi. Construction of baggase drying unit	Drying unit	To make ready the bagasse with minimum moisture	For increased fuel efficiency for better quality jaggery
Vii. Capacity building of processors	Trainied human resources	Improvement in efficiency of processing, quality &hygiene.	Enhance productivity and quality higher returns.
viii. Establishment of jaggery Testing Laboratory	Laboratory equipments for analysis of jaggery samples	Quality standards determined	Jaggery quality and grading possible

C. establishment of steam Boiling plant	Steam unit with boiler,evaporators and vapour separators	Indirect method of jaggery processing	Results in high quality jaggery without caramalisation. Fuel and labour efficiency.
D. Value addition			
i. Types of jaggery			
a. Solid	Solid jaggery protocol	Jaggery with ease of transportation and handling	Better shelf life
b. Liquid	Liquid jaggery protocol	Jaggery with ease of use with all confectionaries	Comared with all receipes, health benefits, higher returns Ready to use jaggery with all receipes
c. Powder	Powder jaggery protocol	Jaggery with minimum moisture	Improved Keeping quality and extended shelf life
ii. Storaballity	Jaggery with minimum moisture	Stored for longer period	Can improve the quality and revenue of farmers
iii. Packing	Good packaging material with aluminium foil, carton	Sustains the quality for a longer period and hygiene	Improved shelf life and keeping the quality
iv. Branding and Marketing	University brand for chemical free jaggery	Brand with people for an assured marketing	Impact of the reliability with consumers, export potential
v. Implementation of PPP Model	Model for increased jaggery production involving private entrepreneurs	Large scale production of jaggery and upscaling of technologies. Quicker output	Environment friendly, efficiency in all spear of processing, high nutricical value, prevention of migration.

IV. Progressive Review

Jaggery processing is one of the largest agro based cottage industry of unorganized sector in the study area. As on today the Mandya district is the second largest processor of jaggery in the state of Karnataka. The industry is facing many constrain on the field and off the field with respect to stagnated production and productivity. The processing of sugarcane into value added product jaggery needs scientific approach namely in the field of sugarcane crushing, sugarcane juice boiling, moulding and packaging, besides use of clarificicants for getting bright colour, hardness and keeping quality. In line with the above information a thorough review of literature has been presented in order to draw scientific conclusions in the field of chemical free jaggery preparation.

4.0 Review of Literature

The research and development work carried out at various institutions in India and abroad on various aspects in sugarcane varietal development, cultivation and processing of sugarcane to Jaggery are reviewed critically under the following headlines in this chapter.

4.1 Sugarcane varieties

Karnataka stands fourth place in jaggery production in the country. The sugarcane varieties identified and found good for jaggery production in Karnataka are Co 7704, Co 62175, Co 8014, Co 8011 and Co C 671 (Asokan, 1983).

Field studies on screening of sugarcane varieties suitable for jaggery making were conducted (Shivaramu et al, 2002). It was observed that variety Co 62175 found to be that best in terms of jaggery recovery and quality parameters viz. high Net Returns value, higher hardness, light to golden yellow colour and crystalline structure followed by Co 7804 and Co 8201 varieties for southern Karnataka region.

Sugarcane genotypes tolerant to salinity were tested for jaggery quality that seems to differ under salinity. Tolerant types were rated based on better biomass production, cane yield and other physiological parameters viz., photosynthetic rate, leaf area index etc., under higher soil salinity. Among the tolerant genotypes difference in jaggery quality was recorded with respect to net returns value (%), colour and taste under salinity, grading tolerant genotypes as good, poor and unsuitable for jaggery preparations, when grown in saline soil. (Vasantha et al, 2009)

4.2. Sugarcane Agronomy:

Singh et al, (2007a) reported highest ratoon cane yield (78.16 t/ha) with addition of pressmud at the rate of 10 tonnes per hectare. Further, they added that in both plant and ratoon crops, organics produced yields statistically similar to those with recommended NPK. Dineshkumar et al,. (1996) reported that application of pressmud (equivalent to 25%N) along with 75% of the recommended inorganic fertilizers remained at par with 100 % recommended fertilizers in terms of cane and sugar yields thus a saving of 25% of the inorganic fertilizers without any sacrifice in cane and sugar yield. Bokhtiar et al,. (2001) from Bangladesh reported that application of pressmud @ 20 t/ha accompanying 200 kg N/ha significantly increased cane yield by 20-30 per cent compared to plot receiving no pressmud.

Application of pressmud at the rate of 4 tonnes per hectare with Azotobacter in conjunction with 100 per cent N fertilizer registered significant increase in sugarcane yield by 11 per cent (Nagaraju et al, 2000). Application of 250 kg nitrogen through urea and 50 kg N through pressmud showed positive response with respect to cane yield (101.54 t/ha) and trash yield (Sonawane and Sabale, 2000). Bhalerao et al,. (2005) reported a saving of 40 per cent chemical fertilizers by substituting 9 tonnes of pressmud with spent wash, neem cake and bio fertilizers with a cane yield of 127 tonnes per hectare. Srivastava et al,. (2008) reported the highest cane yield with sulphitation pressmud (10 t/ha) + FYM (10 t/ha) in autumn (79.4 t/ha) and spring (68.8 t/ha) planted sugarcane.

Application of 250 kg nitrogen through urea and 50 kg N through pressmud showed positive response with respect to brix, pol, CCS per cent and sugar yield (Sonawane and Sabale, 2000). Venkatakrishnan and Ravichandran (2007) reported higher value of brix (20.32%) and pol (19%) per centage when pressmud at the rate of 25 tonnes per hectare was applied. Saini et al,. (2006a) reported that PMC at 10 t/ha coupled with biofertilizers (PSB) at 2.5 kg/ha improved the quality of sugarcane compared to recommended NPK alone.

Results of the experiment conducted in sandy loam soils during 2006-07 and 2007-08 revealed that quality parameters of cane juice and jaggery were positively and significantly influenced by the application of sulphur irrespective of sources of sulphur. Application of sulphur at 100kg/ha had significantly influenced the quality of juice but it was comparable with the application of sulphur at 80kg/ha which was reflected in quality of jaggery. There is an increase of 1.27 units in juice sucrose was observed with the application of sulphur at 80kg/ha. But sucrose did not differ markedly on juice quality parameters. As Gypsum is cheapest source compared to Elemental sulphur, it can be concluded that maximum returns can be obtained at 80kg/ha through Gypsum application,

4.3. Jaggery Industry

Sugarcane occupies a prominent place as a cash crop in India. It is cultivated in an area of about 4.83 M hectares, with an annual production of over 355 M tons. Over 45 M farmers and a large mass of agricultural labourers in India are engaged in sugarcane cultivation (Jain, 1999). In the last three decades 62 to 65 per cent of the sugarcane produced in India is crushed in jaggery industries producing on averages of 10 million tons of jaggery annually (Teggi *et al,* 1999). In Karnataka, 60 percent of the sugarcane produced is crushed jaggery making (Shivaramu *et al*, 2002c).

Karnataka state is one amongst the major sugarcane and sugar-producing states in the country. Karnataka has conductive agro-climatic conditions for sugarcane cultivation resulting in increased sugarcane production year after year, giving scope for establishment of more sugarcane industries in the state. An account of this large number of sugar factories have come up as on date 49 established sugar mills with a combined. Crushing capacity of 2, 15,450 tons of cane per day. Out of which 26 in private sector, 20 in cooperative sector, 2 in public sector and one in joint sector with a crushing capacity of 65.0, 30.0, 4.0 and 1.0 per cent respectively. In addition there are 14 sugar mills are in different stages of construction in the state. These new sugar mills are expected to add about 25 per cent to the current crushing capacity. The annually crushing capacity is over 250 lakh tones with an average recovery of 10.79 per cent [Anon.2009]

There are about 566 sugar factories in India of which 56 per cent in the co-operative sector, 34 per cent in the private sector and the remaining 10 per cent in the public sector. The crushing capacity of sugar factories rages from 1250 to 10,000 TCD and the period of crushing vary from 160 to 180 days with an average recovery of 9.95 to 10.00 per cent (Anon. 2008).

It is estimated that two third of the sweetness required in the food habits of rural population in India is met by jaggery. Hence, the demand for the jaggery is steadily increasing because of the facts that it is not only a chief sources if sweetening in the food habits of rural mass but has considerable linkage in the rural economy.

In the last three decades 60 to 65 per cent of the sugarcane produced in India is crushed in jaggery industries producing on averages of 10 million tons of jaggery annually (Teggi et al, (1999). In Karnataka, 60 per cent of the sugarcane produced is crushed for jaggery making (Shivaramu et al, 2002c).

Jaggery industry does not require any sophisticated machinery and equipment mostly indigenously developed equipment are use (Jaswant Singh and HarinarainShahi, 2002). Jaggery has high export potential. Efficiency of the existing practices of jaggery processing is low and yields less leading to considerable loss to the cane producers as well as to the nation. Therefore, there is a strong need to rehabilitate the jaggery industries in the country by introducing modern equipment and technology.

It is a rural based agro-industry located at the conventional place of the farmers and helping them to avoid the harassment that the farmers has to undergo in transporting cane to the sugar industries, cost of transportation involved and delay in payments made by the sugar mills (Kanchanavasdev 2003).

Converting sugarcane into jaggery fetches three times more profitable than supplying to sugar industry (Anon. 2004). Jaggery making industries are becoming more attractive and spreading across the country, because of the increase in consumption rate, availability of man power locally, improvement in rural economy and available advances technical knowhow as compared to converting sugarcane into sugar. This industry requires very less capital investment for establishment and operation hence, production of jaggery is within the reach of sugarcane farmers and entrepreneurs (Anon 2005, Anon. 2006b).

According to Singh and Shashi [2002] by 2020 the population of India would be 1360 million. Considering on average of 40 kg per head pre year sweetness consumption, the India would need 54 million tons of sweeteners of which about 40 per cent will be met by jaggery. Thus, jaggery would continue to play significance role not only in processing of sugarcane at rural level but also create employment and improve the economies conditions of the rural population. Jaggery industry does not require any imported and sophisticated equipment and machinery as mostly indigenous equipment are used. Jaggery has a high export potential. The efficiency of jaggery process being low and yield less, which not only in loss to the cultivators but to the nation as a whole on account of the poor recovery of the sugar from sugarcane. Therefore, there is a strong need to rehabilitate the jaggery industries in the country to help the cultivators in the vicinity, where vacuum pan factories are not available.

More than 50 per cent of the sugarcane produced in Karnataka is processed into sugar but, in recent years the sugar industry is facing complex problems such as high stocks, financial crunch etc. This has resulted in delayed and low payments to the farmers. In such a situation, diversion of sugarcane to jaggery making is an alternative option. Against this background, the study was undertaken in Belgaum district of Karnataka, with an objective of analyzing strengths, weaknesses, opportunities and challenges in jaggery processing. Data collected from 40 sugarcane producers cum processors in Gokak Taluk. The major strengths in jaggery production are large employment potential, utilization of family labour and quicker payments whereas, requirement of high capital, irregular electricity supply and labour scarcity are the major weaknesses. Increasing demand for jaggery, improvements in production technologies, increasing area under sugarcane are the major opportunities whereas, loss of man power to other industries, competition from sugar industry and lack of marketing facilities are the major challenges Sachinkumar, and Arunkumar, (2012).

Gur (Jaggery) is a traditional unrefined sugar, which is consumed in Asia, Africa, Latin American and also the Caribbean. The Gur industry has been considered as one of the small scale and cottage industry in India. The production of Gur ranges between five million tons to seven million tons. Maharashtra is one of the leading producers of Gur apart from sugar. Large numbers of Gur production units are located in state. Kolhapur is the main market for Gur in the country as it ranks first in qualitative terms and second in terms of quantity. Sugarcane seeds preserved by the Farmers' community by age old practice form the prime factors for good quality of Gur. Kolhapur Gur contains no chemicals, it tastes sweet and has longer shelf life as compared to the Gur produced in other areas of the country. Gur making plants are generally small units fabricated by local artisans and run by villagers in different parts of India. These plants are designed and fabricated on the basis of age old expertise without any technical support further it offers employment opportunity to millions of people of the total world production. More than 70% of the Gur is produced in India but most of the Gur business suffers from losses. The development of different value added products from Gur and their commercial availability becomes needs of the hour to sustain future profitability in the Gur trade Yogesh Shankar Kumbhar (2016).

Jaggery is unprocessed natural sugar, produced through evaporating water from sugarcane juice in steel pans situated over pit furnaces. It is a vital sweetener for rural and urban people and more than 70% of total world's jaggery is produced in India. Jaggery is popularly known as 'medicinal sugar' and nutritionally it is comparable with honey. It exhibited supremacy over sugar, since it contains 80-85% sucrose and 5-15% reducing sugars and provides essential nutrients viz. proteins, fats, vitamins, minerals and energy. Jaggery is utilized for production of several Ayurvedic medicines. The medicinal and nutritive value, quality and taste of jaggery can effectively be improved by adding dried amla shreds, dried ginger (sunti), turmeric (haldi), black pepper (kali-march) etc. It is used in various baked products like-chocolates, biscuits, breads, cakes, gaga, chikki, pastries, rolls etc. Jaggery can scientifically be formed through various steps viz. harvesting, pre-cleaning and crushing of cane, filtration, clarification, heating, boiling and concentration of cane juice, cooling of concentrated cane juice (i.e. slurry), mouldling of slurry, packaging, storage and marketing of jaggery. The jaggery should be prepared in very clean, tidy and hygienic conditions. The utensils and equipments used in jaggery making should be clean and sterilized. The floor of jaggery unit should be cemented and free from insects, flies, ants, bacteria, fungi etc. The use of injurious chemical(s) should be avoided and herbal clarificants should be used for clarification of cane juice. Sugarcane is the most important sugar crop of India and around 14.20% of the sugarcane produced in the country is being utilized for making jaggery and khandsari. Thus jaggery production will be greatly imperative and beneficial to sugarcane growers. Sugarcane varieties CoS-767, Co-1148, Co-66-17, and Co-00421 found suitable for jaggery making in Rajasthan, Kumar (2015).

4.4. Post-Harvest Sugarcane

Puttasubaiah (1976) reported that when harvested cane kept in open air, trash covered and water sprinkled on cane for a period of 7 days results in loss of cane weight and low sucrose recovery. Mugdum et al, (1987) reported that staling of sugarcane for 14 days results in loss of cane weight (3.4 to 13.7 %) and reduction in sucrose recovery. Srivastava et al,. (1988) stated that if the time gap between milling and harvesting of sugarcane increased beyond 24 hours, spraying of water or covered with moist trash helps good protection to cane and to ensure higher sugar recovery to the extent of 0.5 units besides obviating losses in weight of cane. Freshly harvested cane crushed in jaggery industries recorded higher recovery (8.51%) as compared to the factory delivered cane (6.05 % to 7.75 %). Thangavelu (2007) stated that post harvest deterioration and stalling of cane effects the quality of juice results in low recovery and loss in loss in sucrose content when cane left in the field over 5 days. According to him post-harvest deterioration of sugarcane loses estimated to be of about 20-25 kg of sucrose per ton of cane. Jaswant Singh (1999) reported 12 per cent loss of purity in case of canes kept indoor for 5 days and 20 per cent when left in field for same period before indoor storage.

4.5. Crusher:

The extraction of juice should be done as far as possible from fresh and in my case not later than 24 hours after harvest of the cane to avoid juice quality deterioration. Crushers used for extraction of juice should be of good design so as to get not less than 65 per cent extraction. Extracted juice should boil as quickly as possible to avoid inversion and bio-deterioration losses. The research and development work carried out on sugarcane crushers in India and abroad is reviewed critically in this section.

The last hundred years have seen stone and wooden crushers being supplemented by iron crusher; bullock powered vertically mounted roller crushers and gradually replacing motor driven horizontally mounted roller crushers in the process of extracting juice from sugarcane for making better quality jaggery [Gerry, 1989].

Sugarcane crushers mounted with three types of cylinders viz. zigzag grooved cylinders, v-grooved cylinders and hook – grooved cylinders were evaluated by Hegenbarth [1938]. He has stated that the zig-zag grooved roller crushers having ridges extended laterally over the entire length on both top and bottom rollers coffer a typical example of a crushers, where at least partial re-absorption must be expected due to depression in the bottom roller surface this system of grooving is found effective in juice drainage and often produced a considerable amount of trash under the crushers. Where as in case of hook – grooved crushers a considerable area of voids is created leading too many pockets for the deposit of loosely packed cane particle upon which no effective pressure can be applied.

Sugarcane crushers are used for juice extraction by farmers and jaggery and khandsari industries. It is observed that most of the traditional sugarcane crushers used by the farmers have less juice extraction capacity. Indian Institute of Sugarcane Research (IISR), Lucknow has developed improved designs (KVIC and ATDA design) of animal/ power operated sugarcane crushers (Singh, 1998). The IISR designed horizontal cylinder type power cane-crusher gave maximum of 64 per cent juice extraction at 3.7 mm roller-gap at 3.3 m/min. roller speed. At this roller setting, power requirement for crushing one ton of sugarcane was 7.9 kwh (Anon. 2006).

GurarajHunsasgi (2001) stated that jaggery made by farmers on small scale using 3 rollers crushers extract only 50-60 per cent of juice from cane and the rest is burnt with bagasse which is used as a source of fuel in the jaggery industries.

Yadav (2003) reported that the efficiency of power operated three rollers horizontal crusher is 2-4 per cent higher than the efficiency of power operated three rollers vertical crusher. Further, he has stated that the efficiency of power operated four rollers crushers is 3-4 per cent lower than the efficiency of three rollers horizontal crusher due to higher operating speed of rollers.

Juice drainage through bagasse in the crusher is critical and important. Inadequate juice drainage in the crusher necessitates the application of higher pressure/load to get the desired compression ratio. This higher pressure increases the re-absorption factor affecting the increased power in the crusher and reduction in juice extraction per cent. Hugot (1986) developed equation for a 3 roller conventional crusher establishing the relation between pressure on the bagasse and bagasse density under pressure, through which it is possible to set appropriate operative parameters of the crusher.

Joshi and Pandit (1959) discussed various types of cane crushers used in India to extract juice from sugarcane for jaggery making.

Asokan and Rao (1988) stated that the crushers used should be good quality so as to get not less than 65 per cent extraction.

Naiduet al, (1992) stated that the rollers used in crushers should be in good conditions, in such a way that its efficiency should not be less than 65-70 per cent. Further he stated that crusher and surrounding should be clean and hygienic to avoids due to microorganisms by sprinkling chemicals like formalin.

Baboo and Solomon (2000) reported that 52 to 55 per cent of juice is extracted using three roller crushers by the jaggery units loosing 22 to 25 per cent of juice in cane due to poor extraction and burnt with bagasse at fuel. Further, they have suggested that this loose can be minimized by developing improved methods of crushing which can extract up to 80 per cent of juice from cane.

4.6. Juice quality

Dakshindas and Kale (1961) reported that the presence if high concentration of soluble juice plays an important role in darkening of gur colour during pressing. The gur with golden yellow colour, hard, granular and sweet in taste with good flovor is of superior quality and falls on grade No. 1 on physical criteria basis (Gupta and Balyan, 1973).

During stalling of sugarcane enzymatic hydrolysis (caused by bacteria) of starch causes formation of dextrin and reducing sucrose as a result, the brix content increases and recovery decreases (Gupta, 1981). Rekhi and gil (1987) reported significant positive interrelationship between sucrose content and purity of cane juice.

Gravois et al, (1991) stated that the purity if juice and brix is the main factors in increasing sucrose content. The juice quality of cane crushed at different ages (10^{th} and 12^{th} month was compared (Anon. 2006. Per cent of brix, sucrose and purity present in the juice extracted from 12^{th} month old sugarcane has comparatively higher.

Good quality jaggery should have cream light golden colour, granular texture and prepared exclusively from clarified juice in the form of shaped solid lumps, free from extraneous matter, sweet in taste, good flavour and moisture content less than 6% (AGMARK 2002). Jaggery is prepared in three forms like lumps, powder and semi liquid (Roy, 1951).

A cluster study conducted by Gangal (2002) to locate and pinpoint the reasons for poor quality jaggery. Poor quality raw material with mud and dirt, operational negligence, non use of filters to juice collecting tank, delay in use of fresh juice (which leads to oxidation), improper machine handling, loose ‘V’ belts, selecting immature raw material, very poor housekeeping. low juice extraction efficiency, delay in drying the biomass due to more moisture, poor equipments design, unchecked addition of impurities, lack of preventive measures etc. were the major contributors for inferior quality jaggery production.

4.7 Jaggery Processing :

Production of jaggery is cheap and simple as compared to production of sugar. Production of sugar is very expensive and complicated as it depends on heavily centralized, giant sugar plant and skilled workers. On the other hand, jaggery can be produced at farm level with semiskilled workers without any complicated machineries and equipment. Traditionally, jaggery is made by extracting juice from sugarcane and boiling in an open pan evaporator. Different types of furnaces viz, single, double; triple and four pan evaporators are used for jaggery production in Karnataka. The fuel required for juice boiling, man power required for unit vary from type of evaporators used. Four pan evaporators system of jaggery making is an advanced technology for efficiency utilization of heat energy generated by burning fuel wood, quickness in juice boiling and quality production of jaggery. Though the four pan evaporator system is popular in the states like Uttar Pradesh, Bihar and Maharashtra, the adoption of this technology is yet to pick up in Karnataka in spite of its proven merits.

GururajHunasigi (2001) stated that juice boiling in open shallow iron pan (210-270) cm dia. and 45 cm depth) has very poor fuel efficiency. Further, he stated that a steady but slow boiling would permit the scum to appear on the surface.

Quickness in juice boiling has direct impact on production rate of jaggery and the efficiency indicates the amount of heat generated in the furnace for juice boiling per unit of fuel consumption. The main criteria for choosing the type of furnace by the farmers of Cauvery command area in Karnataka was based on the quickness in boiling vis-à-vis per day jaggery production rate (Shivaramu et al, 2002b).

Baboo and Solomon (2002) stated that all the chemicals used for clarification of juice except partial liming produce a bright coloured jaggery, but this leads to fast deterioration during storage and rendering the product unstorable and inedible in some cases. Use of bhendi mucilage (45-50g per quintal of juice) is the safest and effective organic clarification than the less safer inorganic clarificants like sodium bicarbonate and indiscriminate use of bleaching agent like sodium hydro sulphite (GururajHunasigi, 2001: Shivaramu et al, 2002b).

Optimum clarification of juice with deola seed powder was achieved at 0.1 to 0.5 per cent concentrations. Apart being good in physical appearance, jaggery obtained was hard crystalline and light – yellowish in color because of the intrinsic properties of the seed powder for enhancing efficiency of juice clarification (Anon. 2006).

4.8. Juice clarification

The freshly extracted juice is acidic in nature with a pH of around 5.2. Boiling of juice under acidic condition will invert the sucrose leading to problems in solidification and development of dark colour of jaggery. Hence before boiling the juice pH is to be adjusted to 6.8 with the addition of a clear solution of lime (CaOH). On vigorous boiling, non-sugars float on the surface of the boiling juice in the form of scum which is removed as and when formed periodically when the clear juice starts boiling any one of the available organic clarificants such as Deola, Bhendi, Castor, Groundnut, Soybean, Phalsa may be added to further clarify the syrup and improve the jaggery colour, storability and marketability Jayamala et al, (2009).

Naidu et al, (1992) suggested some of the important points to be taken into account while using additives/ clarificants to achieve better quality of jaggery. They are filter the juice through fine cloth for removing fiber particles and suspended impurities, use vegetable clarificants instead of chemicals and freshly prepared milk of lime without residue for adjusting pH of 6.6 – 6.8, avoid excess lime additions to prevent formation of black coloured jaggery, add chemical clarificants like sodium carbonate, sodium bicarbonate, super phosphate etc., in place of lime and avoid use of hydrous as its presence in the jaggery is injurious to health. Improvement in colour of jaggery is only temporary and it will affect the keeping quality.

Among the different inorganic additives used in jaggery production, sodium hydrosulphite (hydrous) is one which contributes to increased amount of SO_2 in jaggery. At lower concentration, SO_2 is a recommended preservative. As per the PFA specifications, SO_2 content in jaggery should not exceeds 70 ppm in food stuffs it possesses toxicological effects (Aruna et al, 1997).

Mungare et al, [1999] reported that jaggery stored better when clarificants like bhendi, phalsa and groundnut seed meal and gur seed were used in the preparation of jaggery.

Patil et al, (1999) reported that bhendi at 2kg/1000 lit of juice found effective in improving NRS, colour, jaggery recovery and maximum removal of scum showing better effect on quality of jaggery and also helped in maintaining higher NRS and better colour jaggery during storage. None of other clarificants were found beneficial in keeping jaggery in good condition during storage.

Vegetative clarificants are generally added at the juice boiling. Some chemicals such as hydrous, lime, sodium bicarbonate, sodium carbonate, super phosphate and alum have been used in combination with vegetative clarificants. Most of the chemicals are polyacrylamide based compounds, while some are ion exchange resins. These chemical clarificants adversely affect the health of human beings since traces of chemicals remain in the final product (Anjaj and Tagare, 2006). All these chemicals (except lime) brighten jaggery initially, but colour of the jaggery becomes dull during storage.

Soharb [2001] defined ‘’hazard’’ as a biological, chemical or physical agent in or condition of food with potential to cause an adverse health effect. ‘’physical hazard’’ include variety of materials or foreign object, whereas ‘’chemical hazard’’ is any chemical introduced in to the food system, which may cause illness or injury. Chemical hazard includes added chemicals, contaminants and naturally occurring toxins. ‘’Biological hazard’’ is the microbiological hazard, which may cause the food borne disease or illness. WHO [1995] defined ‘CCP’’ as a step at which control is essential to prevent or eliminate a food hazard or reduce it to an acceptable level or it can also be defined as the sets at which control is essential to guarantee that potential hazard do not become actual hazard.

Experiments conducted at the Regional Sugarcane and Jaggery Research station, Kolhapur during 1999 2000-2001 and 2001-2002 to study the clarification efficiency of some synthetic an herbal clarificant suitable for the quality jaggery. The synthetic clarificant like Bhendi power or SNI @ 2 ppm with herbal clarificantbhendi plant @ 2kg/1000 lit we found effective in improving NRS, Colour, Jaggery recovery and maximum removal of scum, showing better effect on quality of jaggery and also helped in maintaining higher NRS and before colour jaggery during storage than the control treatment. None of the other clarified was found beneficial in keeping jaggery in good condition during storage Patil et al, (2005).

4.9. Concentration of Juice

The juice extracted from sugarcane is heated to the temperature of 118 ^{0}C to 120 ^{0}C, the concentrated juice in the form of syrup is then puddle and allowed to cool (Jabber, 1983). Singh (1998) reported that time required to reach striking point (118^{0}C to 120^{0}C) for making different kinds of jaggery depends on the variety of sugarcane crushed, capacity of the pan used and designs of furnaces working on natural draft using dried bagasse as fuel.

Baboo and Solomon (2002) reported that after the scum is removed the juice is boiled briskly for an hour or little more for evaporation of water. During this period the temperature of boiling juice rises from 100^{0}C to 105^{0}C. When the temperature reaches 105^{0}C the juice starts frothing. At this time onwards the fire is to be regulated to prevent charring and spilling over the sides of the pan. At this stage vegetative oil is added to prevent frothing to certain extent. The striking point corresponds to temperature range from 118^{0}C to 120^{0}C. Double pan furnace takes three times more time to produce reach cycle of jaggery as compared to triple pan furnace. Hence, the quality of jaggery produced per unit time in double pan furnace is less than that produced using triple pan furnace (UshaRavindra et al, 2004a).

4.10. Furnace

Way back in 1933, Morris [1933] stated that availability of heat for boiling juice is very important. The assumption is often made that a deduction should be allowed for heat passing up the chimney. Taking 60 per cent as average furnace efficiency and 10 per cent as radiation loss, it would appear that about 30 per cent of the heat in the fuel burnt at present passes up the chimney. By promoting more efficient combustion furnaces will tend to increase both pan output and furnace efficiency.

Naidu (1992) listed out some of the important points to be considered while constructing the furnace to achieve higher output with quality jaggery production. They have to adopt proper furnaces to achieve maximum heat efficiency, provide chimney to escape burnt gases with good draft, provide a baffle wall in the furnace to prevent escape of heat through the chimney passage, use galvanized iron pans to prevent reaction of iron with the juice constituents forming dark coloured substances, heat the syrup properly so that no charring takes place particularly at later stages of boiling, keep the heat spread uniformly throughout the bottom of the pan and remove ash in the furnace periodically to provide proper air flow with better combustion.

To achieve maximum heat efficiency, the important points to be considered while constructing furnace in the jaggery unit has been suggested (Mohan Naidu, 1992). They are, (i) provide chimney with good draft to escape burnt gases, (ii) provide a baffle wall in the furnace to prevent escape of heat through the chimney passage, (iii) use galvanized iron pans to prevent reaction of iron with the juice constituents forming dark coloured substances, (iv) construct I such a way that the heat should spread uniformly throughout the bottom of the pan and (v) provision to remove ash in the furnace periodically to provide air flow with better combustion.

Lande (1997) stated that continuous boiling of juice in the pans is the most important process where fuel can be saved considerably provided the furnace and the pans are properly designed. According to Goel (1999) design of furnace is strongly governed by the characteristics of fuel. This include, fuel moisture content, fuel size, volatility and ash content of the fuel. These characteristics of the fuel affect the combustion system, combustion air temperature, combustion air delivery system, furnace construction and size.

Baboo (1990) designed a setting tank for juice clarification in the jaggery units and introduced the prevailing method of juice clarification with vegetable clarificants. The performance evaluation report indicates that introduction of settling tank in the prevailing clarification method removed 0.362 per cent more impurities and the production of jaggery was found to be superior in colour, texture and storability.

The Indian Institute of Petroleum (IIP) developed a new plant design for production of jaggery. This furnace cut down the consumption of bagasse significantly with increase in production. The reports indicated that this new design saves up to 11 per cent of fuel energy and if it runs continuously for 14 hours, the production of jaggery will go up to eight quintals compared to 6.5 quintals in the conventional plant (Anon 1999). During last two decades considerable research work has been carried out on improvement of thermal efficiency of juice boiling furnaces. In spite of the development of improved furnaces the whole bagasse is consumed to concentrate the juice. The overall heat utilization efficiency of these furnaces is nearly 20 per cent which is too low (Baboo and Solomon, 2000).

Single pan furnaces for jaggery making were familiar in 1940's and later in 1960's double pan furnaces which are superior over single pan furnaces in consuming less fuel energy and higher production were introduced Later in the year 2000 the triple pan furnaces which are an improved version of double pan furnaces in consuming less fuel higher production and quality product were introduced [shivaramu et al, 2002b].

Jaswant Singh [2003] conducted survey to study the working conditions of existing furnaces in Uttar Pradesh His study reveals that three pan furnaces were commonly used for jaggery making in Uttar Pradesh and found satisfactory in waste heat utilization and saving of bagasse as fuel Jagadish [2004] reported that use of single pan furnace for jaggery making is most inefficient as it consumes more fuel required, more time to complete the process and yield low quality product Further the reports indicate that the units using single pan furnaces find always shortage of fuel as they depend mostly on dried bagasse as fuel.

IISR, Lucknow has designed improved version of double pan furnace. This furnace has several in the design which include step grate for burning of fuel gutter pan treating of juice chimney with sufficient draft etc. Further they have stated that jaggery making with improved double pan furnace is cheaper. The improved three pan furnace designed by IISR consist of combustion chamber with improved grate design and middle chamber for trapping heat from flue gases coming out of the combustion chamber. The specially designed and fabricated juice boiling pans are placed on respective chambers. The first two pans are circular with convex bottom having 1 1/4 inch and 1.0 inch bottom thickness respectively while the third on known as gutter pan was rectangular in shape with convex bottom of 0.5 inch thickness. The chimney height was kept at about 12 feet from the base chamber [Anon.2006c].

The reports indicate that placement of specially designed open pans at there different elevations drastically reduced fuel consumption human labour, drudgery and inconvenience otherwise involved in the other designs during loading and unloading of cane juice at different stages of heating, boiling and concentration process [Jaswant Singh,2003].

Conventionally, jaggery is made by heating sugarcane juice in the underground furnaces constructed using locally available materials. The furnace and chimney design of these traditional plants have been modified. Heat resistance bricks have been used in the furnace instead of ordinary bricks. A chimney of suitable height and circular cross section has been constructed instead of square cross section. Fuel feeding system has been improved and air entry ports have been optimized. This modification resulted in the better combustion of fuel [bagasse] yielding about 20 per cent of increase in gur production and 10 per cent reduction in bagasse consumption with reduced chimney smoke [Anon.2006b].

Sugarcane is one of the main crops of Cauvery Command Area of Mandya district and 60% of which is used for jaggery production. The jaggery making units use different types of furnaces varying from single pan to multi pan furnace systems mainly, depending upon quantity of cane to be crushed and capacity of initial investment by the farmers. The quantity of fuel consumption, use of skilled manpower and rate of jaggery production vary with the type of furnaces used. Among the furnaces, multipan furnace proved better in conserving fuel energy, quickness in boiling and quality end product. Fabrication of boiling pan with a proper gauge material and design plays an important role in minimizing fuel consumption, quickness in boiling of juice and to obtain quality product Shankar et al, (2009).

4.11 Bagasse in furnace

Scarcity of fire wood and escalated cost, use of bagasse available at the jaggery units is encouraged as furnace fuel for boiling juice. Bagasse or ‘megass” as the English call it, is the dry refuse of sugarcane after the juice has been extracted. The quality of bagasse available at jaggery units very between 29 at 34 per cent of the sugarcane crushed. This bagasse contains about 45 per cent of fiber and pith, 4.5 per cent soluble solids and 50 per cent moisture. The design of boiler of firing bagasse depends on the same principle that is adopted for other fossil fuels and he design considerations are invariably depending on fuel characteristics such moisture content, size, volatility and ash contents of the fuel (Goel, 1999).

Shivaramu et al, (2002b) reported that consumption of bagasse is comparatively more in triple pan furnace as compared to that consumed in double pan furnace, because the feeding rate of bagasse as fuel is more in triple pan furnace since all the three pans has to be kept under continuous warming / boiling conditions hence, consume comparatively more bagasse as fuel.

Singh et al, (2008) evaluated the performance of two pan furnace system with forced draft combustion over natural draft combustion. The study revealed that the rise in temperature inside the combustion chamber was higher at forced at forced draft system in the early phase as compared to natural draft system. Whereas in boiling pans the rise in temperature was similar in both the system of combustion up to 110 minutes and there after it was higher in case of forced draft system and striking point for jaggery making was attained 10 minutes earlier as compared to natural draft combustion. There was saving of 8 per cent of the bagasse used under forced draft systems and combustion efficiency was increased by 2.6 per cent as compared to natural draft combustion system.

Bagasse is normally used as fuel in jaggery making furnaces for sugarcane juice concentration. Proper burning and release of maximum amount of heat for use is important and it largely depends upon the physical condition and calorific values of bagasse. Calorific value is due to bagasse constituents like fibre, sucrose and moisture, which again depends upon the cane parameters like fibre content, brix of sugarcane juice etc. sugarcane crushing and bagasse drying also affect bagasse composition and thus its calorific value. Certain empirical equations for calculation of net calorific value (NCV) of mill bagasse have been developed but not such relations have been developed for bagasseobtained from jaggery plants. There equations have been used to see the effect of operating parameters like juice extraction and the juice brix on net calorific value. It was found that operating factors also affect calorific value of bagasse and the total amount of heat is more in case of dried bagasse. Therefore, a provision for bagasse drying, using furnace waste heat, may be incorporated in the systems Anwar (2010)

4.12. Quality parameters

Freshly extracted juice is acidic with pH of around 5.2. Heating and boiling under these acidic conditions will invert the sucrose leading to problems in solidification and development of dark colour jaggery. Hence before boiling the juice pH is adjusted to 6.8 with the addition of clear solution of time (CaOH). On different stages of boiling, the non-sugar floats on the surface of the boiling juice as such which is removed as and when formed periodically. When the clear juice starts boiling, any one of the available organic clarificants such as Deola, Bhendi, PhalsamSemal, Sukhlai, Soybean and Groundnut may be added to further clarify the syrup and improve the jaggery colour and storability with less harmful residues in the final product (Asokan, 1983).

Jaggery is prepared in three forms like lumps, powder and semi liquid form. Good quality jaggery should have cream light golden colour, granular structure, free from extraneous matter, sweet in taste and good flavor (Roy, 1951). Jaggery is nothing but the concentrated cane juice by removing impurities. The use of bhendi mucilage and super phosphate as clarificants, found to be effective in improving jaggery quality (Venkarapathi and Mohan Rao, 1960; Hunsugi, 2001). Use of lime juice or saturated lime water was found to give a hard and reddish colour of jaggery (Dakshindas and Kale, 1961). Moulding of jaggery in the form of buckets of ¼ kg to 10 kg, cubes, pallets, balls and cakes of different sizes (varying from 50 gm to 500 gm) is common practice in Karnataka. Naidu, et al, (1992) suggested the use of coconut oil at 25 to 28 ml per 100 liter of juice during later stages of boiling to prevent charring. When the juice reaches striking point the pan is removed from furnace and thick syrup is poured on the platform where it will allow cooling and moulded. Baboo and Solomon (2000) stated that use of chemicals clarificants produces a brighter colour jaggery but deteriorates very past during storage and becomes inedible. Shivaramu et al, (2002) suggested the use of bhendi mucilage is safest and effective organic clarificant.

An investigation was carried out to assess the status of jaggery storage at house hold and jaggery making units and grading. Commercial samples of jaggery produced in Mandya district were used for the study. About two kg samples of six forms of jaggery (n=8) were stored in air tight plastic containers and LDPE covered for a period of five months. Moisture content ganged between 3.6 to 8.3%. Porosity ranged between 4.50 to 16.78 cc/100 ml and hardness of jaggery different according to the form of jaggery. The sucrose content was least in pellet form jaggery while other forms were at par with each other. Reducing sugar content in bar jaggery was significantly higher compared with cube jaggery. The reducing sugar content ranged between 4.70 to 8.84% in fresh jaggery. Cube form and ball form jaggery were well accepted by the panelists (n=100) due to their size, colour and texture followed by bucket form and other types. All the respondents used deferent containers for storage of jaggery on small scale. Majority (48%) of respondents stored jaggery in aluminium and steel boxes followed by plastic boxes (33%). Sugarcane trash (10%), earthen pots (5%) and polythene bags (4%) and the period of storage ranged from one week to six months. There was reduction in NR values of all forms of jaggery samples. Pellets jaggery deteriorated most in its quality after storage. It may be concluded that storage methods was in line with the scientific knowledge base. The end users were following correct practices of storage. There was significant change in the quality of jaggery after storage. Therefore, jaggery with good shelf life is the need of day. The problem of grading is indeed difficult because of the wide variations in its quality and also its complex chemical composition Ravindra, Usha et al, (2009).

The jaggery quality is the most challenging aspect for the jaggery making process. Jaggery provides an alternative market to sugarcane growers. About 26 per cent of the sugarcane produced is diverted for jaggery production. Jaggery production with the use of chemical clarificants is very common and is widely adopted by almost all jaggery manufactures in view of cheapness and ready availability of chemicals in the market. The presence of sulphur as sulphur dioxide in the jaggery beyond 70 ppm is injurious to the health. The technology developed at Sugarcane Research Station, TNAU, Melalathur has established that the use of slaked lime solution along with the mucilaginous extract of wild bhendi / bhendi as clarificant (40 - 45 g / 100 l). The results of the experiments conducted at various research centres also revealed that among the herbal clarificants used for the jaggery making the bhendi mucilage significantly contributed in removing higher amount of scum and highest non reducing sugars (83.56%) and significant decrease in the reducing sugars (4.44%) due to beneficial in reducing the inversion process. Use of bhendi mucilage, soybean seed meal improved the colour of jaggery Ragavan et al, (2011).

4.13. Storage

Jaggery as a sweetener is an important item of the Indian diet and is either consumed directly or used as a sweetening agent for sweet preparation it is preferred by consumers over white sugar for preparation of sweet dishes due to its unique taste and characteristics.

Production of jaggery is a seasonal and usually stored over a fairly long period of 6-8 month. During storage jaggery suffers physical, chemical, biological and micro-biological damages, depending upon the type of storage and package of jaggery for local consumption and trade purpose are practiced in different parts of Karnataka depending upon consumer demands, facilities available for storage and weather conditions.

For storage purpose jaggery should have high sugar content [above80%] low in reducing sugars [below 10%] as well as in salts [below 0.3% Ca and 0.1% mg] and should not have more than 5% moisture content [Anon, 1964].

Different storage period were attempted at low temperature (7-9^{0}C)for knowing the long and better shelf life of jaggery. With increase in storage time, there was decrease in quality of jaggery but there was complete check of microbial growth till storage period of 2 years 8 months with some changes in physiochemical characteristics and visual observations along with smell like old jaggery. But storage of jaggery up to 1 year 8 months was very safe with no changes in quality Uppal (2002).

Jaggery industry is a cottage industry in India. In today's world liquid jaggery has been gaining a much importance due to its nutritional value. Studies were conducted to investigate the parameters affecting shelf life such pH, colour, brix, moisture content and range of temperatures on the concentration of reducing sugars. The variety Co86032 was selected to observe the effect of storage period on quality characteristics of liquid jaggery. Samples were stored at three different conditions i.e. room temperature(27°C), refrigeration (7°C) and high temperature (37°C) in pre-sterilized PET bottles for 90 days .In order to optimize the changes in properties physio-chemical tests were evaluated during storage. Refrigerated sample was found more acceptable among other two samples after storage period of three months in terms of its chemical properties Supriya, D. Patil and Anekar (2014).

Storage behaviour of jaggery samples, stored in different containers (open pan, polythene bag and jaggery drying cum storage bin) was studied for a period of 6 months. The change in quality characteristics such as moisture content, colour, sucrose and reducing sugar were determined at an interval of 1 month. The study was conducted on commercial jaggery to observe the effect of storage period on quality characteristics of jaggery. The experimental data revealed that the jaggery moisture content was increased from an initial value of 12.07 to 22.36% (db) in open storage, while it was decreased to 9.23% (db) in case of polythene bags. Similarly the per centage change in sucrose, reducing sugar and colour was lesser in bin and polythene bags than in open storage. Good keeping quality of jaggery could be maintained in storage bin. Jaggery, should in bin, showed less reduction in quality parameters Khan Chand et al, (2011).

Investigations were carried out for storagebehaviour of jaggery samples, stored in polythene bags, IISR bins and hanging basket under hilly climatic conditions of Uttarakhand. Samples were stored for a period of five months during which changes in product parameter such as moisture content, sucrose, reducing sugar and colour were determined at an interval of 30 days. The study revealed that the quality of jaggery was affected significantly by both containers as well as ambient conditions. The moisture content jaggery samples increased form an initial value of 11.02-24.32% in open storage, while it only increased to 14.89% in bins and 15.84% in case of polythene bags. Similarly the change in per centage of sucrose, reducing sugar and colour was observed less for the samples kept in storage bins and polythene bags than for the samples kept in open storage. Overall, IISR bin preserved the quality better than the open and polythene bag storage Khan Chand et al, (2012).

4.14. Keeping quality

Baboo (1985) developed and fabricated a solar aspirator of 20 cm diameter and 1.5 m height which can produce a flow of about 200 cm^3 of hot air per hour. Taking into consideration the resistance offered by the stored jaggery blocks to the air flow one can expect about 100 cm^3 of air flow per hour to pass through the stored jaggery from this unit. Father, Baboo and Solomon (1995) suggested to store jaggery in gunney bags and placed at elevated position.

The effect of cold storage on keeping quality of jaggery from immature (10 months), mature (12 months) and averaged cane (14 months) of variety Co 7706, under different staking strength of lumps (13-14 kg) kept in piles of 5,6,7 and 8 was studied (Rao et al,2003). The results of four months storage revealed that good keeping quality of jaggery was maintained with little changes in sucrose content, total non-sugar content, colour, weight and hardness in all the three types of jaggery under cold storage. As far as stacking strength is concerned there was no effect on change of shape and other characteristics when lumps of jaggery from mature cane are kept in breaking when kept in piles of 8? The post cold storage study revealed that jaggery lumps from immature, mature and overaged cane showed reduction in quality and deterioration was faster.

Uppal et al, (2002) reported that jaggery dried under ambient temperature till it reaches 3.5 per cent moisture content and stored in tightly closed glass container and kept at low temperature proved better to retain its keeping quality, colour and complete check in microbial growth for over a year.

Uppal*et al*, (2004) reported that qualities of stored jaggery at controlled low temperature (7-9 ^{0}C) than ambient temperature found much better. Further, they have reported that there was no significant difference in quality of stored jaggery in tightly closed glass container and sealed polythene bag at controlled temperature. However,, storing jaggery at ambient room temperature condition in tightly closed glass container found better than storing in sealed polythene bags.

4.15. Moulding and Packing

Research work done on various aspects of moulding, packaging, transportation and marketing of jaggery in India and abroad by different organization and scientists has been reviewed critically.

MaharajNarain and Singh (1985) reported that cooling and moulding process after removal from the evaporation pan influence the mechanical strength of jaggery.

Moulding frame to make jaggery into bricks of 12.7 x 6.3 x 4.5 cm size weighing 500 g each was designed and fabricated. Jaggery made into brick shaped lumps was compared with two other shapes viz. laddu and balei. Brick shaped lumps exhibited higher bulk dengher compressive strength and lower porosity as compared to laddu and balti. Characteristics are useful for jaggery storage. Moulding and packing process are also easy with brick shaped lumps and requiring no skilled labour [Baboo et al, 1988]. As regards to different jaggery moulding frames the smaller size bucket shaped jaggery samples of 1 kg and 2 kg were superior in respect of keeping quality and the brick shaped jaggery samples were also found superior in respect of keeping quality [patel et al, 1997].

Baboo and Solomon (1995) stated that bucket shaped jaggery of 1 kg and 2 kg weight are found better in keeping quality. Further they have observed that brick shaped jaggery moulds 125kg, 150kg 500g, 1kg and 2 kg are better storability than round shaped jaggery (round ball/goli)

Rao and Lakshminarayana (1999) reported that hygienically packed powdered jaggery in polythene pouches can be stored up to 2 years with negligible physic chemical changes.

Anon. (2004) investigated the storage of jaggery cubes and liquid jaggery. It was reported that jaggery cubes packed in LDPE and liquid jaggery in LDPF pouches and glass bottles stored at low temperature (7-10 ^{0}C) maintained better quality as compared to that stored in ambient region.

In experiments conducted in the Research Laboratory of PalliSiksha Bhavana (Institute of Agriculture), Visva-Bharati during 2002 and 2003, it was revealed that the best packing material for storing *gur* during monsoon season was heat-sealed LDPE (Low Density Polyethylene) packet of 150 gauge followed by glass jars. LDPE packets prevented moisture ingress, fall in pH and inversion of sucrose in the stored *gur* to the maximum extent. However,, colourof*gur* in LDPE packets was darker as compared to *gur* stored in glass jars. PET (Poly Ethylene Terephthalate) jars were as good as glass jars but the stored *gur* darkened more in PET jars. Mandal et al, (2006).

4.16. Value addition

Jaggery is prepared in three forms like lumps, powder and semi liquid. Goo quality jaggery should have cream light golden colour, granular structure and prepared exclusively from clarified juice in the form of shaped solid lumps, free from extraneous matter, sweet in taste and good flavor (Roy, 1951). In Karnataka jaggery is moulded in ¼ kg to 30 kg buckets and also in the form of pellets (50kg) and cubes, bricks, balls and cakes (varying between 125-500g) of different sizes (Jabbar, 1983; Shivaramu et al, 2000b)

Sugarcane is the main source of sugar, jaggery and khandsari and holds prominent position as a cash crop. It occupies 1.8% of the total cropped area in the country. Sugarcane plays an important role in agricultural and industrial economy of the country. At present, nearly 40% of the sugarcane produced in the country is used for jaggery/khandsari production. The varieties suitable for this purpose should possess high sucrose content, low reducing sugar, low ash content, less phenolics, less polysaccharides and chlorophyll content in juice. Value addition in other products of sugarcane juice live jaggery chocolate, vinegar, gazak, reori, chikki and ramdana can also be prepared. As value addition in these forms fetch higher prices in the market and has great export potential in global market, the sugarcane growers can increased their incomes Singh et al, (2009).

Jaggery is sugarcane based natural sweetener made by the concentration of sugarcane juice without any use of chemicals. It is available in the form of solid blocks and in semi-liquid form. Besides this, the sap collected from some palm trees such as palmyra-palm (*Borassusflabellifer*L.), coconut-palm (*Cocosnucifera*L.), wild date-palm (*Phoenix sylvestris*Roxb.) and sagopalm (*Caryotaurens*L.) is used for preparation of jaggery. It contains the natural sources of minerals and vitamins inherently present in sugarcane juice and it is one of the most wholesome and healthy sugars in the world. The micro nutrients present in the jaggery possess antitoxic and anti-carcinogenic properties. In India, of the 300 Mt of sugarcane produced, 53% is processed into white sugar, 36% into jaggery and khandsari, 3% for chewing as cane juice and 8% as seed cane. The methods of converting sugarcane and manufacturing sugar, gur and khandsari are different but a great value is added in the manufacturing of these consumable final products. Further, it offers employment opportunity to millions of people. Of the total world production, more than 70% of the jaggery is produced in India but most of the jaggery business suffers from losses. The development of different value added products from jaggery and their commercial availability becomes needs of the hour to sustain future profitability in the jaggery trade Nath et al, (2015).

4.17. Jaggery Quality Standards

Patill and Adsule [1998] have proposed a simplified version of grading which is similar to AGMARK. They recommended that for fixing norms for jaggery grading, quality parameters in terms of colour, taste, texture, flavor, reducing sugars, sucrose and extraneous matters etc., are important. They have categorized jaggery as mentioned below.

Grade	Special	A	B
Physical parameters;			
Colour	Light brownish yellow	Medium brownish	brown
Texture	Granular	Semi granular	Very small granular
Hardness	Hard	Soft	Very soft
Taste	Sweet	Sweet	sweet
Chemical parameters;			
Non-reducing sugars [%]	80	75.1-80.0	70.1-75.0
Reducing sugars [%]	10	10.1-15.0	15.1-20.0
Moisture [%]	Up to 6	6.1-8.0	8.1-10.0
Extraneous matter [%]	Up to 1	1.1-2.0	1.1-2.0

4.18. Marketing

To keep producing any agricultural product including sugarcane, there must be demand for the product, there must be well developed marketing systems and farmers in turn must have confidence in the marketing system. There is a great demand to improve export competitiveness of jaggery in the International market. Hence, selection of suitable variety of seed improving processing efficiency, reducing cost of cultivation/ jaggery production, encouraging farmer level of grading and storage facilities, improving transportation and marketing information net work etc. needs more attention (Rao and Ravi Kumar, 2002).

The quality of gur is decided mainly by colour, taste consistency, texture and keeping quality. The study conducted at Anakapalle sugarcane research station reveals that jaggery packed in hessian cloth and exposed outside in transporting become soft and runs into molasses during onset off monsoon. Such losses in storage and transportation are estimated to be over 15 per cent. The study further reveals that the jaggery moulds wrapped in alkathene film and hessian cloth kept their consistency and colour during storage and transit as compared to other methods (Venkatapathi and Mohan Rao, 1960).

Baboo and Anwar (1995) reported that uniform sized bricks of jaggery packed in double layered butter and glazed paper with cellophane wrapping kept away the files, dust and also attracted the consumers and fetched good price. Further, they have suggested that for uniformity in shape and size and for better consumers acceptability / marketing, the concentrated semi solid mass after puddling in cooling pan should be poured into molds and leveled. After an hour the solid jaggery sets into the form off brick or cube shape depending upon the type of mould used and will be removed from the mould followed storage and marketing.

The presence of sucrose plays in important role in marketing. The jaggery with higher percentages of sucrose keeps better in storage, while low in sucrose is poor in storage and thereby fetches low market values (Patil and Adsule, 1998).

Thakur (1999) suggested that for better marketing and to fetch higher price it is important to maintain uniform colour, shape and size of jaggery. Hygienically manufactured cubes packed in butter paper and glazed papers with cellophane wrapping attracts consumer and fetch good price.

India has great potential for production and export of sugar and sugar product. The sugar industry being second largest agro-based industry in India, plays a major role in the economic development of rural areas by generating large-scale direct employment and also helps in giving indirect employment to the rural population in various ways jaggery has enormous export potential in the present day world where, uses of natural products are increasing on the ground of health and environmental security. As jaggery is indigenous unbranded product, it needs to be promoted by latest market techniques. In recent years, there has been a quantum jump in the export of jaggery from India. During the period from 1992-93 to 2006-07, the annual compound growth rates of quantity exported and per Kg price realized were 21.51 and 2.33%, respectively. India was non-competitive in export of jaggery to Singapore, Malaysia and Bangladesh as the nominal protection coefficient [NPC] values for these countries were more than one. India was moderately competitive in export of jaggery to UK, Yemen, USA and Srilanka as the NPC values were lower than one during the year 2006-07. Proper steps should be taken to popularize the jaggery and jaggery based products in the international market by branding the product and increasing the awareness of various uses of jaggery and its benefits to the potential consumers Deokate et al, (2009)

There has been a study increase in the demand for jaggery because it is the chief source of sweetening for rural masses and has considerable forward linkages in the economy. The trends in arrivals and prices of jaggery in all the three selected markets have been found identical in the initial years, the jaggery arrivals were decreasing and in the mid-period, it started increasing significantly while in the later period, the arrivals again decreased significantly. The seasonal indices of arrivals of jaggery in the Gokak market were highest in the month of January [179.59] and lowest in June [43.72]. The seasonal indices of market prices of jaggery in the Gokak market were highest in the month of October [113.33] and lowest in the month of April [90.44]. The seasonality in the arrivals and prices of jaggery was more conspicuous in the study area. The study has observed that development of storage facilities could help in reducing such seasonal fluctuations in the markets Awaradi et al, (2014).

The study was undertaken in Mandya district of Karnataka during the year 2010-2011. Based on the primary data obtained from 30 processors and 64 consumers each of organic and inorganic jaggery was elicited through survey method. The result revealed that average investment of Rs.933255 and Rs.988081 were required to set up organic jaggery processing unit with a capacity of nine quintals per day. The average per quintal cost of inorganic jaggery preparation was more [Rs.2392.24] when compared to organic jaggery units Rs.2187.00] per quintal income from organic jaggery was found to be higher [Rs.3450.84] than of inorganic jaggery [Rs. 2990.47]. Net return in organic jaggery was higher than inorganic jaggery at Rs.1411.40 and Rs. 725.50 per quintal, with B: C ratio of 1.11, respectively Swamy et al, (2015) The present study was conducted during 2008–2009 in Andhra Pradesh state of India, is an attempt to work-out various facets of economics involved in Jaggery manufacturing and marketing, constraints faced by jaggery manufacturers. Multistage sampling technique was adopted in selecting the sampling units. Averages, benefit–cost ratio (BCR), net present worth (NPW), internal rate of return (IRR), break even output (BEO), payback period (PBP), Garrets ranking technique and Kendall's coefficient of concordance (W) test were employed as analytical tools. Cost of cultivation of sugarcane (68.22%) is the prime factor in jaggery manufacturing. Lack of infrastructural facilities in jaggery production and insufficient price dissemination in jaggery marketing were major constraints. Market concentration in whole sellers was moderately high (Gini coefficient = 0.59) and in commission agents was medium (Gini coefficient = 0.45). For profitable and sustained way of jaggery manufacturing and marketing these constraints should be addressed at war foot basis Rama Rao (2011).

Karnataka is one of the major sugarcane growing states, with an area of 3.06 lakh hectares and production of 262.40 lakh tonnes. More than 50% of the sugarcane produced is processed into sugar. In recent years, the sugar industry is facing problems of high stocks and financial crunch. The jaggery industry is also expanding in the sugarcane growing areas both for export and domestic markets. Hence, the study was undertaken in Mandya and Bagalkot districts of Karnataka to assess the export competitiveness of jaggery. The data were collected from 30 jaggery producers each from Mandya and Mahalingapur market hinterlands which represent highest jaggery producing districts in the state. The Nominal Protection Coefficient (NPC) was found to be less than unity (0.57), which implies that jaggery is a good exportable product; hence there is competitive advantage for export of jaggery from India. Similarly Domestic resource cost (DRC) was found to be less than unity. All these ratios indicated comparative advantage in production and export of jaggery. Therefore, its export should be encouraged to earn foreign exchange Basavaraj Bankar et al, (2012).

Sugarcane in India is processed into sugar, jaggery and khandasari and undergoes considerable weight reduction during processing. Jaggery is prepared in almost all parts of the country where sugarcane is grown extensively. Multistage random sampling procedure was followed. The returns from organic jaggery processing per unit worked out to ` 30, 69,232 with net returns of ` 6, 33,536. The benefit-cost ratio was estimated at 1.26. The cost and returns in inorganic jaggery preparation per unit per annum in which the total variable cost worked out to ` 26, 47,512 in which the cost of raw material (sugarcane) was accounted a lion's share in the total variable cost (79.46 %) and the total cost (78.01 %). The major cost items in the fixed cost was apportioned cost (` 43,887) accounting for 89.29 per cent of the total fixed cost and interest on fixed capital which had small share (` 5266) accounting for 10.71 per cent to the total fixed cost. The returns from inorganic jaggery processing per unit worked out to ` 32, 84,661 with net returns of 5, 87,992 per unit. The benefit-cost ratio was estimated at 1.22 Shivanaikar et al, (2014).

In India, sugarcane in an important cash crop for sugar and allied industries related to its by-products and agro based industries like power, ethanol, fertilizer fungicides, etc. out of many by-products, jaggery occupies an important place. Jaggery making and marketing in India continues to be the larger agriculture- based occupation in spite, of the phenomenal increase in the production and consumption of white sugar. About 40 per cent of the sugarcane produced in India, is utilized for the production of jaggery. Jaggery is made mostly by small and marginal farmers who employ semi-skilled persons. In India, jaggery manufacturing is considered as a big cottage industry under unorganized sector. As far as jaggery marketing is concerned direct sale of jaggery to the ultimate consumer by the product is not possible. The reason behind this is the places of production and consumption are widely scattered. Therefore, the role of middlemen becomes significant. Also, Agricultural Market Committee plays a vital role in marketing of agricultural goods. It becomes necessary to identify and understand the role of producers, middlemen and agricultural market committee in the developed of jaggery industry in Kolhapur Puja Pawar (1972).

Sugarcane is the main source of sugar, jaggery and khandsari and holds prominent position as cash crop. It occupies 1.8% of the total cropped area in the country. Sugarcane plays an important role in Agricultural and industrial company economy of the country. At present, nearly 40% of the sugarcane produced in the country is used for jaggery/khandsari production. The varieties suitable for this purpose should possess high sucrose content, low reducing sugar, low ash content, less phenolics, less polysaccharides and chlorophyll content in juice. Apart from traditional jaggery, solid jaggery can be prepared in attractive shape and sizes such as bricks and cubes. Jaggery in other forms like granular jaggery and liquid jaggery can also be prepared. Value addition in other products of prepared. As value addition in these forms fetch higher prices in the market and has great export potential in global market, the sugarcane growers can increased their incomes Singh et al, (2009).

The study on economics of processing and marketing of gur in Indore district of Madhya Pradesh by Ananth Ram (1989) revealed that a sum of Rs. 6.80 per quintal of gur was the processing cost of sugarcane under power of kolha units. The level of capital investment, type of crusher used and the quantity of sugarcane crushed were the factors influencing the processing cost.

Raju and Ramesh (1989) worked out cost of production in jaggery on per hectare basis of sugarcane cultivated. The cost of production of jaggery worked out to be Rs. 28,417 per hectare of sugarcane area. About 70 per cent of the total cost accounted for the production of sugarcane. The other major items of cost were wages paid to human labour, rent paid for the use of crushers and chemical ingredients. The jaggery production from one hectare of sugarcane worked out to be 93.28 quintals. The net returns of jaggery production per hectare from sugarcane were estimated to be Rs. 5,127 with a total return of Rs. 33,724.

In a study by Rohal *et al,* (1990) the average cost of processing of sugarcane in to khandasari worked out to Rs. 8,54 per kg. The economic analysis of capital structure in khandasar unit showed a better capital turn over (Rs. 1.83 per rupee investment). This indicated further scope of capital investment in the industry.

Suryawanshi *et al*, (1994) reported that the cost of jaggery production was Rs. 565 per quintal. They further noticed that 98 quintals of jaggery was prepared from the sugarcane grown on one hectare. They reported that the per hectare total cost of sugarcane cultivation was Rs. 41,484 and the out-put per hectare was 89.93 tons. The cost of production per ton of jaggery was Rs. 446.

Anonymous, (1998) stated that in the conventional method of jaggery manufacture juice extraction is only 55-60%, compared with 80-82% in a typical cane sugar factory. It is recommended that jaggery be manufactured from juice extracted in a factory: the process by which is done at Jaknur factory, India, is described. Since less cane would be required to make a given quantity of jaggery, more would remain for sugar manufacture.

Malik and Singh (1999) analyzed the cost and returns of sugar cane production in Haridwar district of western Uttar Pradesh. In case of reserve area (<10 kms from sugar mills) cost A1, A2, B1, B2, C1, C2, gross income from main product and by product were Rs. 21605, Rs. 21605, Rs. 24724, Rs. 3390.8, Rs. 28231, Rs. 37415, Rs. 45002 and Rs. 4419 respectively. In far area (> 10 kms from sugar mills) the above costs in the same order were Rs. 21366, Rs. 21366, Rs. 24498, Rs. 33293, Rs. 28009, Rs. 42758 and Rs. 4416 respectively.

Ramaswamy *et al,* (1999) stated that jaggery making is a traditional making is a traditional enterprise in Tamilnadu and is more profitable of cane producers than supply to the factory. But, higher profitability is counter veiled by price risk in jaggery. Traditionally, jaggery making is under taken by cane growers in their own farm. The trend changed with the entry of new enterprisers who venture jaggery manufacturing as a pure enterprise by procuring cane from the cane growers. On the other hand absence of price risk, labour shortage in the case of own jaggery making, financial and technical assistance extended by the factory are the major factors attracting supply of cane to factory. The experience in jaggery making has negative influence on the cane supply to factory. Lobour shortage had significant influence in encouraging farmers to supply the cane to the sugar mills. Distance of factory appears less significant in the decision process as the modern transport system viz., tractor had made transport of cane a non issue. Therefore the dummy variable, ownership of tractor had no influence on cane supply decision to factory.

Lohar *et al,* (2000) estimated per tonne cost of production of sugarcane, per quintal production of jaggery, per quintal manufacturing of sugar and profitability of production of jaggery and sugar. The study was conducted with samples of 30 jaggery producers from six villages in Karveeer, Tahsil, Kolhapur district, Maharashtra, India and it revealed that profitability in more in jaggery production.

Power (2001) studied the jaggery processing in India, and the study revealed that; India produces 10.3 million tons of jaggery (gur) annually. Tremendous scope exists for improving the manufacturing process. This paper reports on data collected from 23 processing units in the Satara and Kolhapur districts of Maharashtra, and makes recommendations for the production of quality jaggery.

Shivaramu *et al,* (2002), undertaken a detailed survey of jaggery-making units in Cauvery Command Area (Karnataka, India) to evaluate the performance of a triple pan jaggery making furnace compared to local types. It was noted that the local types, i.e., single pan and double pan furnaces, took more time in boiling and also affected the quality of jaggery produced. Local furnaces also contained less safer inorganic clarificants and bleaching agents (sodium bicarbonate and sodium hydrosulphates) as compared to the triple pan jaggery, which contained bhendi mucilage. Because of the shorter boiling period, the daily production rate of jaggery in a triple pan furnace was 11.5 q, as compared to 7-8 q in local types. Using the triple pan furnace, the net returns were almost 2-2.5 times more (Rs. 122000/year) than with local types (Rs. 51000-65000/year). In conclusion, the triple pan furnace is more efficient than the local types of furnaces.

Usha *et al,* (2004), conducted a study to investigate the prevailing processing practices being followed by jaggery manufacturers in the Cauvery command area of Karnataka, and Study revealed that High income manufacturers used a triple pan furnace, while the majority used a double pan furnace due to lower investment and skill required. It was found that sodium bicarbonate, sodium hydrosulfitesand sodium formaldehyde sulfoxylate were the inorganic additives commonly used by all. Besides this, some used trisodium phosphate, while the majority used Magnafloc, of which the chemical composition was not known. Some chemicals were found to be unlabelled and the safety limits not set by quality control institutions. Organic additives include bhendi mucilage and coconut or castor oil to get the light golden yellow colour and crystalline texture of jaggery. Pan cleaning with dilute HCI was regular and daily among triple pan furnace users, but a majority of double pan furnace users cleaned their pans one in every 3 days. None of the manufacturers used disinfectants. A majority of manufacturers stored jaggery in jute bags or in open storage with an average storage time of less than one week. 40% of the manufactures felt a need for an improvement in color and hardness and were concerned with discoloration during storage. It is concluded that jaggery manufacturers in are not satisfied with the jaggery they produce. This may prompt them to use chemicals indiscriminately to achieve good colour and texture. The manufacturing units are also unhygienic.

4.19. Organoleptic Evaluation:

With respect to sensory parameters, very few studies have been reported. Flavour is one of the important quality parameters. Compounds responsible for flavor in jaggery are reactions involved in caramelization and Maillard reactions. High temperature during jaggery production leads to loss of volatile flavor compounds. High moisture content leads to inversion and multiplication of microbes, resulting in other chemical changes which give unacceptable flavor. Sometimes use of mustard oil in final stage of juice concentration gives off flavor affect keeping quality of jaggery. [Shukla et al, 1990].

The investigations were carried out to study the effect of different particle size and packaging materials on storability of jaggery powder on the basis of changes in chemical composition and organoleptic characteristics. Jaggery powder of three different grades viz., coarse (0.500 -0.708 mm), medium (0.351 - 0.420 mm) and fine (0.211 - 0.296 mm) were prepared and packed in 100 gauge polyethylene bag. The samples were stored at room temperature for the period of 6 months. In order to optimize the particle size of jaggery powder, the changes in chemical composition and organoleptic properties were evaluated during storage. The results revealed that change in chemical composition was lower in case of coarse jaggery powder. The coarse jaggery powder having particle size in the range 0.500-0.078 mm) was found more acceptable among all other powder sizes after storage period of six months in terms of its chemical properties and organoleptic characteristics.

4.20. Uses of Jaggery

Effect of jaggery supplementation on lead induced biochemical changes in blood and urine and on lead [Pb] absorption into blood and tissues were investigated in rats. Study revealed that a daily single dose of 200 mg jaggery/kg with 10 mg Pb /kg for 6weeks restored the inhibitory activities in rats [Flora and Singh, 1988]. Jaggery has been attributed with cooling, diuretic and refreshing properties, besides improving throat condition, increasing sperm count having lactogenic and serving as a cardiac tonic Singh and Shahi [2002].

Jaswant Singh (2001) reported that jaggery has cooling, diuretic and refreshing properties, besides it improves throat condition, increases sperm count and serve as a lactogenic and cardiac tonic. Further, he has reported that jaggery is also prescribed as medicine for various diseases like anemia, jaundice, breathlessness and kidney problems. Hence, consumption of jaggery as an eco-friendly sweetener in the rural food habits of India is bound to increase in the coming years due to its tremendous nutritional and medicinal potential.

Jaggery has higher nutrition value as compared to sugar. It preserves all minerals and vitamins found in cane juice, viz; Calcium and Phosphorus etc. The Ayurvedic medicine advocates that the jaggery consumption purifies blood, improves digestion and strengthens lungs, bones and nerves system. The low glycemic index and chain of sucrose make jaggery a low glucose releasing sweetener as compared to refined sugar hence awareness should be created among people for the benefits of jaggery consumption through mass media publicity, campaigns and advertisements. Inspite of, good source of natural minerals and vitamins jaggery products have lost the race to sugar sector during rapid industrialization era. Gangwar et al, (2015).

V. Execution of jaggery Park, V.C. Farm, Mandya

Jaggery Park was established by the University of Agricultural Sciences, Bangalore at Zonal Agricultural Research Station, V.C. Farm, and Mandya with the financial assistance from the Rastriya Krishi Vikasa Yojana (RKVY) of the Government of India through the Karnataka State Department of Agriculture (KSDA) through the release of funds from its state level screening committee. The funds were released during February 2009 and the project implementation was initiated during 2009-10. Before the initiation of the project a Scientific Advisory Committee was constituted by the University of Agricultural Sciences, Bangalore with the drafting of members from across different Development Departments relating to Jaggery industry. Further, during the course of the implementation of the project, need based committees were formed from time to time for the smooth implementation of the project. Jaggery Park did seek the assistance of experts in sugarcane and jaggery industry from various institutes across the country for preparation of a blue print of the project. The committee members visited the Jaggery units in the Cauvery and Bhadra command area of Southern Karnataka, Sugarcane Breeding Institute, Coimbatore, Regional Sugarcane and Jaggery Research Station, Kolhapur, Indian Institute of Sugarcane Research, Lucknow and Central Food Technological Research Institute, Mysore. The members also held parleys with experts from different Institutes and Departments to chalk out the mode of implementation of the project. The details of the visit are as under:

A visit was made to Regional Sugarcane and Jaggery Research Station, Kolhapur to observe the jaggery demonstration units and held discussions with scientists at Kolhapur. Also visited local jaggery processing units nearby Kolhapur to have first hand information for the establishment of jaggery demonstration unit at Jaggery Park, Mandya.

The team visited SBI, Coimbatore, where research on Jaggery has been taken up since long and Jaggery production is taken up on a small scale in the laboratory, to acquaint with the jaggery processing and have discussions with the jaggery Scientists. CFTRI, which is a pioneering institute in food processing, was also visited by the members to have interaction with the Scientists and food engineers for fabrication of suitable equipment for jaggery preparation.

S.N.Swamy Gowda, Project Leader, Jaggery Park and Dr.K.V.Keshavaiah, Associate Professor (Jaggery) visited Indian Institute of Sugarcane Research, Lucknow during 26-28

February 2013 to acquaint with the method of jaggery processing and other research activities related to sugarcane and jaggery and had interactions with the jaggery and sugarcane scientists.

The team collaborated with the Scientists of IISc., Bangalore for the design and fabrication of improved furnace for jaggery preparation. The furnaces designed have been found to be fuel efficient as evidenced by the evaluation later.

Different committeeswere constituted at various stages for smooth implementation of the project. Among them the important committees are:

1. Jaggery Park Scientific Advisory committee
2. Purchase cum Implementation committee
3. Executive committee
4. Committee for Commercialization of Jaggery Processing unit
5. Committee for Establishment of steam based Jaggery boiling demonstration unit.

The following protocol has been developed by the Scientists of Jaggery Park, ZARS, V.C. Farm, and Mandya after conduct of series of experiments in the laboratory on jaggery processing variables

5.1. Jaggery processing protocol

Jaggery processing as such involves a few important steps viz, Juice extraction, heating and clarification, evaporation /concentration, open pan boiling and cooling and packing.

5.2. Juice extraction

This is usually accomplished by crushing the clean ripe cane in a three roller power operated crusher. A maximum of sixty per cent extraction of juice is obtained. Thus, considerable quantity of juice is lost in the bagasse by crushing in a small crusher by the farmers. Improved crusher with proper maintenance so as to get maximum possible extraction of juice will improve the jaggery yield.

5.3. Heating and clarification

The aim of clarification is to remove, as far as possible, all objectionable material present in the juice as well as to prevent formation of new non-sugars during boiling. For achieving the above objectives, a number of clarifiers, both organic and inorganic origin, are used. The quality of jaggery largely depends on clarification of cane juice. The sugarcane juice is highly acidic in reaction. Before boiling the juice, juice acidity is neutralized with addition of required quantity of lime extract. This helps in prevention of inversion of sucrose into glucose and fructose as well as proper precipitation and removal of colloidal and other impurities during the boiling of juice. On an average 300 grams of lime (calcium hydroxide) per 1000 litres of cane juice is the lime requirement for neutralizing juice pH to 6.4-6.6.

Jaggery quality and storability often depend on effectiveness of juice clarification. Several vegetative and chemical clarificants are being used. Chemicals are now frequently used for juice clarification and brightening jaggery colour. An ideal juice clarification process for jaggery making should meet the following requirements.

- Removal of all constituents of juice other than sucrose, reducing sugars, inorganic (phosphates, iron and calcium) and organics (higher proteins and fats).
- Control of undesirable colour development and inversion of sucrose during boiling and concentration.
- Better crystallization.
- Prevention of overheating and charring.
- No adverse effect on jaggerytaste and human health.
- Longer storage life of the product.
- Easy availability of clarifying agent.

5.4. Evaporation / Concentration

After clarification is over, the juice is boiled vigorously to evaporate most of the water. The temperature of the thick mass of the syrup steadily increases up to 110 - 115ºC and becomes a semi-solid material. At this stage, small quantity of coconut oil (20 ml for 100 litres of juice) is added to the syrup and stirred periodically. Addition of coconut oil helps in contained boiling, prevents charring of the syrup and helps in proper development of crystal size and shape. Evaporation and concentration of cane juice in the intermediate stage is done in closed evaporators.

5.5. Open pan boiling

When the cane juice reaches the 65 brix stage where most of the moisture would have evaporated, taken to the open boiling pan where kneading and pedaling would be done to lose further moisture and reach a stage of 95 brix. This also happens to be the end point (striking point) of jaggery which goes for moulding.

5.6 Cooling and packing

When the syrup reaches the strike temperature (i.e. when syrup neither goes into solution nor becomes glass like hard mass in water), the pan is removed from the furnace and cooled by stirring with the help of wooden ladles. When it is almost cooled, the syrup is transferred to wooden or earthen moulds of required shape and size. After solidification and cooling, the jaggery is collected and stored.


A novel method of jaggery preparation by utilizing steam generated from the boiler for boiling of juice using evaporators has been established with the main aim of production and demonstration of hygienic quality chemical free jaggery.

5.7. Establishment of Steam Based Jaggery preparation Demonstration Unit

The conventional system of Jaggery preparation is open boiling. Jaggery Park has ventured into an innovative novel system of Jaggery preparation using steam boilers and evaporators. The principle involved is that steam is generated with the help of a suitable boiler. The juice extracted is heated at 2-3 stages in the pans facilitated with steam jacket. In this system, the heat is totally under control which facilitates easy and efficient removal of scum. Caramalization and discoloration of juice and jaggery are totally avoided and heat, fuel and labour efficiency are enhanced. Overall, there is an improvement in the quality of jaggery.

Following are some of the advantages that could be achieved in steam boiling.

1. Effective Scum removal: In the production of organically processed jaggery removal of scum is important and for clarification only organic clarificants and flocculants are used. Gradual heating of juice will allow ample time to remove the scum and other suspended materials in the juice.
2. Evaporator in the system under closed boiling enhances fuel efficiency and steam from evaporators is recycled for preheating and heating of juice. This also improves the fuel efficiency.
3. The down time of the plant, auxiliary power consumption of the equipment etc., are greatly reduced.
4. The hygiene and safety of the workmen are ensured.

5.8. Evaporators:

Sugarcane juice after initial clarification is let in to the evaporators for further evaporation of moisture in the juice till it is taken to the final pan before moulding.

Time Span: Rate of evaporation of water is more in evaporators with steam compared to open pan boiling. This is because of the fact that the surface area exposed is more when juice is passed through the tubes containing steam. This results in faster evaporation of water from the juice. The surface area exposed in open pans is lesser which results in more time for evaporation of same quantity of water. In the evaporators the vapour can be collected and recycled where as in open pan it is not possible.

Fuel Efficiency: The package boilers have the fuel efficiency up to 72 per cent whereas in the open pan boiling it is merely 35 per cent. In addition, the steam boiling has got other advantages like hygienic conditions, good working environment, thermal efficiency and recovery of vapour which can be condensed for refeeding into the boiler. The comparison and contrast of important parameters of steam boiling and open pan boiling are as follows

Advantages of Evaporator:

1. Heat transfer isquick because of condensation of steam

2. Since surface area provided is more, rate of heat transfer is higher, as a consequence the efficiency is also high

3. Since the juice is divided into thin vertical columns, the surface contact for heat transfer naturally increases

4. Heat transfer by convection is very fast

5. Time required in evaporator to attain required temperature, brix, viscosity etc is very less.

The Jaggery prepared from the steam boiling would result in higher quality Jaggery under most hygienic conditions. The plant set up at Jaggery Park has installed capacity of producing one quintal of Jaggery per boiling.

5.9. Costs and Returns form Sugarcane Varieties and Technology

Sugarcane varieties identified as suitable for jaggery making or Co 86032, VCF 0517 and cost & Returns are as follows

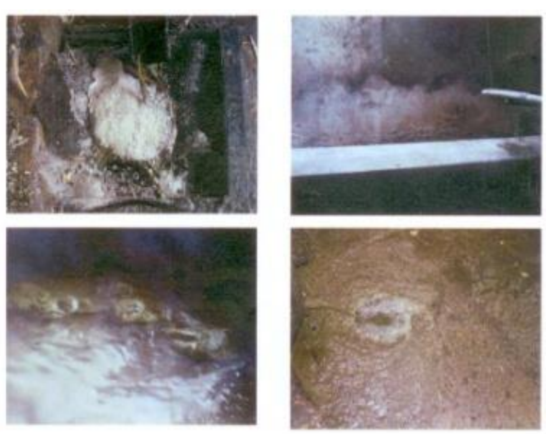
Table: 5.9.1 Costs and Returns form Sugarcane Varieties and Technology

Particulars	**Varieties**		**Technologies**		
Varieties	**Co 86032**	**VCF 0517**	**INM**	**Drip**	**Chemical free jaggery**
Years for development	6	7	3	3	3
Total costs (Rs. In lakh)	79.0	81.0	42.0	42.0	30.0
Area under varieties (ha.)	30,000	35,000	1,00,000	30,000	15,000
Yield advantage (t/ha.)	-	20	-	25	-
Sugar advantage over check (% pol)	2	1.5	0.5	-	-
Price advantage (Rs./ kg)	-	-	-	-	25
Total estimated sugarcane production (tons)	-	-	-	-	54,000
Total returns in Cauvery command area (Rs. In crore)	180	315	100	172.5	135

5.10. Justification for Establishment of Jaggery Park

- Sugarcane is one of the most important crops in command areas. More than 50 per cent of sugarcane is available for jaggery making in the state in the years of excess cane production. Hence, Jaggery sector has vast potential to improve the socio economic status of the farmers.

- Non-availability of technology and existing research gap, low price for jaggery due to poor quality are causing the closure of many Jaggery units.
- Cauvery command is the only area in India where jaggery is manufactured in the off-season (June-Sep.), apart from the regular crushing season (Oct.-March). But, the farmers in this area do not get appreciable price for jaggery because of poor quality. Hence, there is a need to utilize the off-season crushing in a profitable manner through advanced research.
- Usually in command areas, farmers grow excess sugarcane without knowing the demand from the sugar industries. Under such circumstances, it will be extra burden on the sugar factory for crushing and they will refuse to purchase excess cane thereby farmers incur loss both in terms of cane yield and quality. Under this situation, the best way to rescue the farmers and build confidence for their crop is by diverting cane to jaggery units.
- Many farmers are preparing jaggery by age-old method under most Unhygienic conditions and it is considered that the process is scientifically inefficient to produce quality jaggery. Hence, they are incurring loss in quality and quantity of jaggery production.

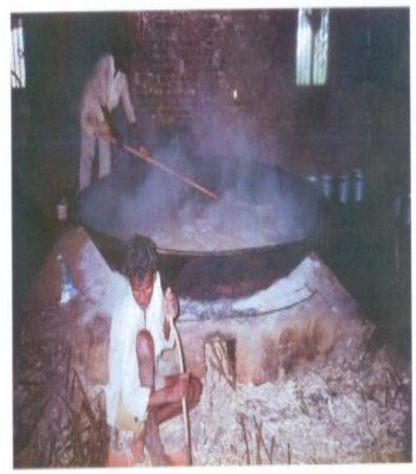


- There is no specific research centre working exclusively on jaggery production in Karnataka except some research being carried out at ZARS, V.C. Farm, Mandya and ARS, Sankeshwar to solve the problems faced by the farmers in Karnataka.
- Jaggery making is a cottage industry operated at decentralized level in unorganized rural sectors and needs institutional support for quality jaggery production, handling, storage, management and cost effective Jaggery processing.
- This cottage industry has vast scope for employment generation in rural areas and has got high export potential owing to its immense nutritional and medicinal values.
- Farmers in Karnataka are preparing jaggery by using several chemicals (clarificants) like hydros (Sodium hydrosulphite), Sodium formaldehyde sulphoxylate (chakke), and Sodium bicarbonate (Baking soda), Sodium carbonate (washing soda), Super phosphate, Phosphoric acid, alum and lime at higher concentrations and dose. Hydros (Sodium hydrosulphite) and Sodium carbonate (washing soda) are liberally used to get attractive colour of the jaggery without knowing the deleterious effects on human health. Jaggery which is prepared by using higher quantities of hydros and Sodium formaldehyde sulphoxylate (Chakke) contains more than 500 ppm of sulphur di-oxide which is well above the permissible norms of 50 ppm by Indian standards (IS 12923):1990. This amount of sulphur di-oxide is detrimental to the beneficial intestinal micro flora leading to digestive disorders and gastrointestinal problems etc. and also can cause breathing problems in asthmatic patients. It can also cause colon/rectal cancer and can destroy the formation of vitamin A and vitamin B1. Hence, extensive research has to be carried out on use of clarificants of plant origin and safe chemical clarificants.


- The crushers that are being presently used are old, unsafe and highly inefficient to crush more quantity of cane, have less extraction efficiency (50-60%). Hence, there is a need for modification of existing crushers for effective juice extraction (65-70% efficiency) and by adopting improved crushers a 10 % increase in crushing efficiency will yield more than 15 kg extra jaggery to the farmers.



- The furnaces and boiling pans that are presently used have many disadvantages to get maximum jaggery yield and good quality. The type of furnace for jaggery making plays an important role in deciding the efficiency and quickness of juice boiling besides other factors. The overall heat utilization efficiency of these furnaces is merely 20 per cent which is too low. Hence, it is very much essential to improve combustion and heat utilization efficiency of existing furnaces. Development of furnaces working on forced draft system in order to reduce the boiling time is the need of the hour.



- Fuel use efficiency in traditional methods is very poor. In some cases farmers are using old vehicle tyres and tubes as fuel source which emit toxic gases which are directly absorbed in the process of jaggery making and ultimately affect the quality of jaggery. Development of bagasse gasifier to generate producer gas for concentrating juice over burners appears to be promising.

- ☞ The present Jaggery units manufacturing harbour many harmful micro organisms due to unhygienic conditions where all jaggery making process is carried out in open shed. There is a need to design scientific jaggery manufacturing units at low cost to produce quality jaggery.




5.11. Rationale for Establishment of Jaggery Park:

a) Sugarcane production passes through a cycle of higher cane production and subsequent glut of cane followed by lower cane production. Further in the Cauvery command area jaggery is produced in the off season and utilizing this cane as well as excess cane produced during certain years is only possible through concerted research efforts.

b) Indiscriminate use of poisonous chemicals such as sodium hydrosulphite, safolite, washing and baking soda etc. as clarificants in jaggery making warranted immediate action for production of chemical free / organically processed jaggery safe for human consumption.

c) The age old method of jaggery preparation under unhygienic conditions results in poor quality of jaggery. There is a need to revamp the jaggery processing.

d) The research needs to be strengthened in the processing, value addition, storage and marketing of Jaggery.

e) Identification of safe chemicals as well as screening efficient herbal clarificants in jaggery preparation needs to be given top most priority.

f) Evaluation of crushers & furnaces need to be done to get maximum crushing rate, crushing efficiency and fuel efficiency.

To address some of the problems of the Jaggery farmers afore said, the Rashtriya Krishi Vikasa Yojana (RKVY) of the Union Ministry of India sponsored a project with an outlay of ₹8.0 Crores for Establishment of Jaggery Park at ZARS, V.C. Farm, Mandya to cater to the needs of the Sugarcane farmers of Southern Karnataka. Jaggery Park was commissioned at ZARS, VC Farm, Mandya during April 2011 with the following objectives.

Objectives of the project

1. Identification of sugarcane genotypes suitable for jaggery production and to develop viable agro-techniques for improving juice quality and jaggery yield.
2. Identification and modification of different types of crushers suitable for efficient juice extraction and safety.
3. Improvement of furnaces for heating the juice for higher fuel economy and reduced drudgery.
4. Mechanization in jaggery processing to reduce manpower at different stages of jaggery production.
5. Identification of different herbal and safe chemical clarificants for obtaining better texture, colour, fragrance and quality of jaggery.
6. To develop value added products of quality jaggery suitable for local consumption and export.
7. To develop packing and storage techniques for longer shelf life of jaggery.
8. To impart training and conduct demonstrations on quality cane and jaggery production.
9. To establish marketing network cell to cater the needs of jaggery farmers.

5.12. Research Activities

The following research activities were carried out in the thrust areas of disciplines viz., Breeding, Agronomy, Processing including engineering, storage and value addition etc.

5.12.1. Breeding:

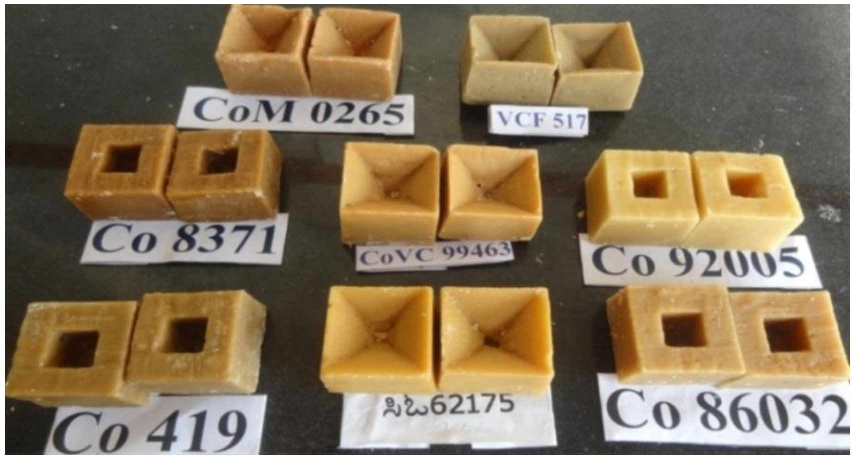
1. In the final yield trial Among 12 test entries evaluated along with local and zonal checks viz., Co 62175, CoVC 99463 and Co 86032, variety VCF 0517 was found to be significantly superior over all the three checks for cane yield (210.7 t/ha), sugar yield (30.15 t/ha) and jaggery yield (20.6 t/ha). With regards to sucrose % in juice and jaggery recovery % the zonal check Co 86032 recorded higher sucrose (19.74 %) and jaggery recovery (10.24 %).
2. Evaluation of Isolated Elite Clones of Sugarcane for Jaggery yield - Among four AVT test entries, Co 09009 recorded highest jaggery recovery followed by CoSnk 07103.

3. Evaluation of Station Elite Genotypes of 2009 Fluff for Performance in Plant Cane Totally 12 entries of station crosses were evaluated along with local check Co 86032 and CoVC 99463. The entries VCF 0977, VCF 0963 and VCF 0986 were found to be significantly superior over local checks CoVC 99463 and Co 86032 for cane yield by recording 202 t/ha, 214 t/ha and 203.8 t/ha respectively. With regard to sugar and jaggery yield, the entries VCF 0977 (28.17 t/ha, 20.0 t/ha) and VCF 0963 (26.12 t/ha, 19.80 t/ha) excelled the local checks CoVC 99463 (23.76 t/ha, 14.83 t/ha) and Co 86032 (23.46 t/ha, 17.23 t/ha) respectively.

4. Evaluation of Elite Genotypes for Jaggery Quality - Totally 10 entries were evaluated for their performance of jaggery quality along with local checks Co 62175 and Co 86032. The entry CoVC 99463, recorded numerically superior over local checks Co 62175 and Co 86032for cane, sugar and jaggery yield by recording 159.7 t/ha, 20.5 t/ha and 14.8 t/ha respectively. The other entry Co 92005 was significantly superior over Co 62175 for sugar yield (21 t/ha) and jaggery yield (13.5 t/ha) due to its high sucrose percentage (20.8%).

5. Estimation of Quantity of Scum in Different Sugarcane Varieties during Jaggery Preparation - Seven released varieties was used for estimation of scum in different sugarcane varieties during jaggery preparation. Jaggery was prepared with and without addition of bhendi mucilage to find out the quantity of scum removed in the process. The scum percentage ranged from 0.694% (Co 86032) to 1.36% (Co 92005) with addition of bhendi and 0.65% (Co VC 99463) to 1.3% (Co 92005) without bhendi. Addition of bhendi was effective in the removal of scum, as the percentage of removal of scum was higher.

Jaggery Samples of Sugarcane Varieties



5.12.2 Agronomy:

1. Studies on Organic Sugarcane Production and its Influence on Jaggery Quality - In the study on organic sugarcane production trial higher sugarcane yield was recorded with integrated nutrient management with organic and inorganic sources of nutrients (119.75 t/ha with Co 62175 & 140 t/ha with COVC 99463 variety) when compared to supply of nutrients through either chemical fertilizers alone or organic sources. Integrated nutrient management with CoVc99463 has recorded higher Jaggery yield (13.17 t/ha) compared to Co62175 (11.36 t/ha) Organic nutrients with 62175 has recorded lower Jaggery yield (7.9 t/ha)

2. Standardization of Bhendi Mucilage as Clarificant for Jaggery Preparation - In the laboratory experiment on study of the efficacy of bhendi mucilage on the clarification of sugarcane juice in jaggery preparation, bhendi stem and fruit mucilage were used to find out the part of bhendi ideal for clarification with different dosages of 1.25, 1.0, 0.75 and 0.5 kg of mucilage per ton of cane crushed. The results indicate that scum yield was more with the addition of bhendi. Bhendi stem at a dosage of 1.25 kg/ton of cane is ideal as clarificant. Though the scum weight is more with fruits, it was observed during jaggery preparation that the fruit mucilage goes along with juice and which results in softness of jaggery.

3. Drip irrigation in Sugarcane – In the drip irrigation experiment when nutrients were supplied through drip fertigation up to 8 months of crop growth period, the sugarcane yield data indicated a 50 per cent increase in cane yield (227.86 tons/ha) compared to surface irrigated

crop (150 t/ha). Saving of water and nutrients and increase in the up take efficiency of the nutrients were also observed.

5.12.3. Processing:

1. **Standardization of Process Variables for Jaggery Preparation -** Under laboratory condition, the jaggery preparation took 1.30 to 1.55 hrs to reach the striking point. The brix of the boiling juice increased progressively with time and pH values shown declining trend up on heating / concentration. The temperature at the striking point was recorded to be 118^{o}C.
2. **Studies on Clarification of Sugarcane Juice for Jaggery Preparation -** The materials viz., Starch, Potash alum, Activated charcoal were tested with fresh juice and warm juice and the centrifugation technique was employed for their clarification abilities and none of the materials / technique was effective in separating the suspended colloidal particles. However, centrifugation helped to separate the physical impurities.
3. **Studies on Use of Herbal Clarificants for Sugarcane Juice Clarification in Jaggery Preparation -** Clarification of sugarcane juice is an important step during jaggery preparation which decides the ultimate colour of jaggery. Efficient clarification results in attractive golden yellow colour of jaggery which fetches remunerative prices in the market. For clarification of juice chemical as well as herbal clarificants are used. The chemical clarificants used by the farmers at higher doses result in white collared bleached jaggery. Most of these chemicals used are industrial chemicals and not food grade. By virtue of these facts, they are posing health hazards in human beings. In the light of these different herbal clarificants were used to study their efficacy in clarification of sugarcane juice and imparting favourable colour during jaggery preparation. Among the clarificants used, the jaggery obtained was of A1 grade irrespective of clarificants. However, colour was golden yellow when bhendi, castor and soybean extract was used. Jaggery with groundnut and hibiscus as clarificants recorded very sweet taste compared to other clarificants.

4. **Studies on Preheating of Sugarcane Juice and its Effect on Clarification -** Pre heating of sugarcane juice in clarification of juice was studied by heating sugarcane juice up to 60°, 65° and 70°C. One litre of juice was taken for the study and observations were made on floating and settled particles in the juice in preheated as well as cold juice. It is clear that heating of juice up to 70° yields more of scum (5.26 g of fresh wt) with higher floating particle (20ml)

and settled particles (10ml) there by extraction of scum is made easier. When cold juice (raw) was observed for its floating and settled particles, only floating particles were observed (5ml) which was the lowest among all.

5. **Evaluation of Jaggery Furnace -** The bagasse consumption per kg of jaggery on two consecutive days ranged from 1.92 to 2.03 kg. It was observed that, the bagasse consumption on the second day was higher because of higher bagasse moisture content due to rain on the previous day.
6. **Evaluation of Sugarcane Crusher -** The crushing capacity of the crusher with MS roller on two consecutive days ranged from 1.5 to 1.7 tons/hour. The juice extraction efficiency ranged between 53.05 to 56.44 per cent with a jaggery recovery range of 8.8 to 10%.

7. **Standardization of pH for Jaggery Preparation -** Sugarcane varieties viz., Co 62175, Co 86032, VCF 0517, Co 8371, CoVC 99463, Co 419, Co 92005 and Co 7804 were used for this study. The jaggery samples were prepared under laboratory conditions by adjusting the pH of the juice at varied levels from 6 to7 pH at an interval of 0.2 pH. It was found that 6.4 to 6.6 pH were found to be ideal for different varieties in getting the correct consistency and colour of jaggery.

The lime requirement is represented graphically. As it is seen from the graph the variety with lower initial pH requires higher quantity of lime to neutralize it.

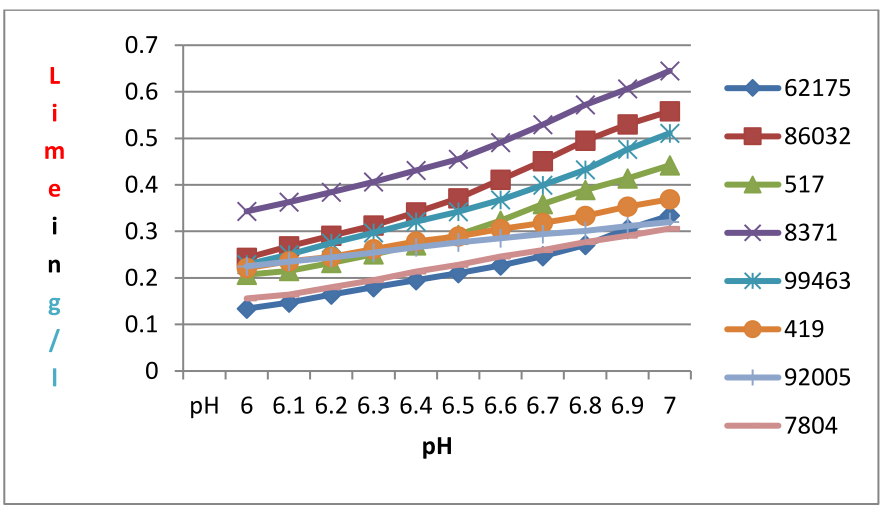


Fig. 5. 1 Jaggery Samples of Co 62175 at Different Juice pH

8. **Studies on Sources of Liming Material for Adjustment of pH in Jaggery Preparation -** Different sources of liming materials were used for adjusting pH viz., calcium oxide, calcium carbonate and calcium hydroxide. The efficiency of different sources of liming is not known. Hence, to study the neutralizing efficiency, ease of use and the cost to find out the best sources of liming material during jaggery preparation, different sources of liming materials were used. Different varieties of sugarcane viz., Co 92005, Co 62175, Co 86032 were used in the experiment. The jaggery so prepared was analysed for its physical and chemical parameters and grading was done. With respect of quality of jaggery from different sources of liming material, A1 and A2 grades were obtained with calcium oxide and calcium hydroxide. Calcium hydroxide is available in powder form and easy to use for neutralizing the pH of juice as its dissolution is faster. As per the results among the major chemicals tested calcium oxide and calcium hydroxide are found to be more efficient. However, with respect to price of liming material, calcium oxide is cheaper as given in table.

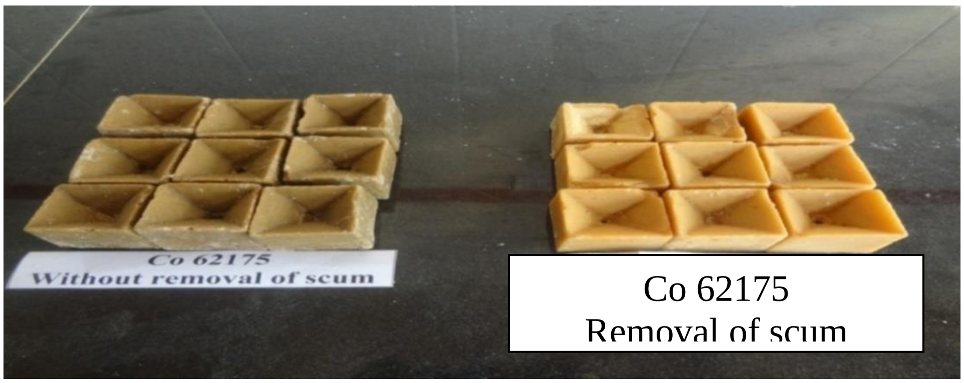
9. **Standardization of Lime Requirement for Adjustment of pH in Jaggery Preparation Across Sugarcane Varieties -**In an experiment on standardization of lime requirement for adjustment of pH of sugarcane juice, on an average, 290 g of lime is required to neutralize 1000 litres of juice among different sugarcane varieties. Calcium hydroxide is the ideal source of liming material for its faster dissolution, ease of use by virtue of its powdery nature. The initial pH of the juice decides the quantity of lime requirement and initial pH varies across sugarcane varieties.

10. **Studies on use of Herbal Agents to Maintain pH of Sugarcane Juice for jaggery Preparation -** Soybean extract, Ragi extract, Lemon juice and Soybean powder were used for neutralizing pH of cane juice. However, none of the above agents were effective in

neutralizing the pH of sugarcane juice. Addition of lemon juice resulted in decrease in pH of the juice.

11. **Quantification of Scum in Different Varieties of Sugarcane during Jaggery Preparation -** Different jaggery varieties were used for quantification of scum with and without addition of bhendi stem mucilage. Addition of bhendi was useful in removal of scum. Among the varieties, CoVC 99463 variety was found to be having higher scum content.

Jaggery Samples With and Without Removal of Scum



5.12.4 Storage:

To develop packing and storage techniques for increasing shelf life of jaggery

1. **Studies on Post Harvest Deterioration in Sugarcane and Yielding Quality of Jaggery:** A study on staling of cane on sugarcane juice and jaggery quality with different treatment combinations of open sun, shade, use of trash, spraying of biocide and water was undertaken. Jaggery samples were prepared from day 1 to day 12 and assessed for various physic-chemical parameters. The results revealed that when jaggery prepared from cane covered with sugarcane trash and preserved under shade resulted in reduction of loss of sucrose content, sucrose content. Among the treatments decline in physio-chemical properties of jaggery was observed with the jaggery samples prepared from cane staked in open sun and improvement in quality was observed when cane was covered with moist sugarcane trash and preserved under shade.

2. **Studies on Different Types of Packaging Materials on Storability of Jaggery -** The experiment on "Effect of storage period and different packaging materials on the quality parameters of Jaggery" was conducted in the Jaggery Park, V.C.Farm, ZARS, Mandya during 2012-2013 and 2014-2015. Jaggery produced from pilot jaggery plant of Jaggery Park, V.C.Farm, ZARS, Mandya was used for the purpose. Jaggery was stored for a period of six months with nine treatments *viz.*, control, sugarcane trash, gunny cloth, hessian cloth, aluminium foil, butter paper, polyolefin film, polythene pouch and paper box. During storage changes in quality characteristics such as moisture content, brix content, sucrose content, reducing sugars, ash content, hardness, porosity, taste and colour were determined at monthly interval.

3. **Moisture Content:**The experimental data revealed that the jaggery moisture content was decreased from an initial value of 6.67% to 5.17% with lapse of storage time to a significant level. Among the packaging materials polyolefin film, butter paper and hessian cloth recorded in this order over other and control recorded lowest per cent of moisture. Aluminium foil and paper box prevented moisture ingress into jaggery samples.

4. **Hardness:** Hardness of jaggery differed accordingly to the type of packaging material. Control jaggery had harder texture followed by polythene pouch. Hardness of jaggery was significantly higher in control jaggery than other and moisture was the least.

5. **Reducing Sugars:** Reducing sugars increased significantly in jaggery with lapse of time and lower reducing sugars recorded with aluminium foil, paper box and sugarcane thrash.

6. **Ash:** No changes were observed with respect to ash content with lapse of time or with different packaging material.

7. **Sucrose:** Decrease in sucrose content was observed during storage. The sucrose content was decreased from 75.08% to 63.28% with lapse of time. Higher sucrose content was found in aluminium foil, paper box and sugarcane thrash.

8. **NR Values:** There was reduction in NR values of all packages of jaggery samples. Jaggery in different packaging materials were graded 'A2' with good quality when they were fresh. After storage for 180 days jaggery with different packaging material fall into 'B' grade with medium quality except jaggery stored in aluminium foil graded 'A2' up to 90 days after storage.

   Overall grading of jaggery with different packaging material indicated that aluminium foil and paper box can retain the good quality of jaggery with higher sucrose and lower reducing sugars recorded 'B' grade, compared to other packaging materials.

9. **Training/Awareness Programme to Jaggery and Sugarcane Farmers:** Sugarcane Farmers and Jaggery unit owners of Mandya district were imparted training on Sugarcane cultivation for quality Jaggery production and chemical free Jaggery preparation by conducting training and demonstrations at Jaggery Park. The details are as under

Table 5.9.2: Training Programmes Conducted at Jaggery Park

Sl. No	Date	No of Trainees
1	15.03.2013	40
2	06.12.2013	61
3	11.03.2014	40
	Total	**141**

Some of the Jaggery unit farmers so trained have started Jaggery units of their own for preparation of chemical free Jaggery.

In addition, the Farmers, Delegates, Students and other visitors who had visited the Jaggery Park on various occasions (which run up to 1500 numbers) were provided information on chemical free Jaggery preparation.

Extension folders on Improved Sugarcane varieties, Improved Sugarcane cultivation practices and chemical free Jaggery preparation have been prepared and distributed to farmers, department officers, students and other visitors.

5.13. Field Demonstrations in Farmers Fields to Popularize Sugarcane Production Technologies and Varieties Suitable for Jaggery Preparation:

A total of 54 farmers (Annexure 3) in an area of 53 acres were selected for demonstration of Sugarcane production technologies and varieties in different villages of Mandya District. Improved Sugarcane varieties suitable for Jaggery preparation, Nutrient management particularly Nitrogen management, Harvest management for quality Jaggery preparation were demonstrated in the farmers fields. Sugarcane yields recorded were 20-25 per cent higher compared to farmers practice in addition to 15-20 per cent increased Jaggery yield and better quality as a result of these demonstrations.

5.13.1 Commercial Jaggery Production:

The Jaggery Park is engaged in preparation of Jaggery on commercial scale. In the initial years, Jaggery preparation was on a pilot basis and now it has reached commercial scale. Mandya organic Agricultural co-operative Society, a farmers group, has been entrusted with the responsibility of preparation and marketing of chemical free/Organic Jaggery by utilizing the facilities for Jaggery preparation at Jaggery Park on lease basis with the monitoring by the University Scientists.

5.13.2 Value Addition:

Jaggery Park is also engaged in production of value added Jaggery products like powder Jaggery, liquid Jaggery and Jaggery in different size and shape though in a small scale in addition to regular production of lump Jaggery. The shelf life of powder Jaggery is substantially higher than other forms of Jaggery.

5.14 Outcome/Output (Results)

5.14.1 Jaggery Preparation Pilot Plant

The pilot jaggery preparation plant has been utilized for demonstration of chemical free jaggery preparation to farmers and farm women, trainee farmers, trainees of water users associations of Bhadra and Cauvery CADA, officials and trainee farmers of the Department of

Agriculture, School children during krishimela of ZARS, V.C. Farm, Mandya and other occasions of visit of the above. In addition, delegates from within and outside the country visiting Jaggery Park on various occasions, students from different universities and colleges have been exposed to the chemical free Jaggery making.

In addition, the pilot jaggery preparation plant has also been utilized for large scale jaggery preparation. The jaggery so prepared was sold locally and outside. As a result of the awareness created on the chemical free jaggery in and around the villages of Jaggery Park, most of the jaggery produced was sold out locally. Further, some jaggery unit farmers have been influenced by the process of chemical free jaggery preparation at Jaggery Park to venture into chemical free jaggery preparation in their own jaggery units. Since inception of Jaggery Park a total of 510 tons of Sugarcane has been crushed to produce 45 tons of Jaggery (Table 5).To involve the stakeholders particularly the farmers of Jaggery industry, the university has outsourced the facilities of Jaggery preparation at Jaggery park (since 2015-16) to Mandya Organic Agricultural Co-operative Society, Mandya which is vested with Sugarcane procurement, preparation, Storage, Packing and marketing of Jaggery so prepared. They are utilizing the sugarcane produced at the Agriculture University farm in addition to procurement of cane from the farmers' fields for Jaggery preparation.

5.14.2 Sugarcane Juice and Jaggery Quality Analysis Laboratory

The laboratory equipments have been put to use by the sugarcane and jaggery scientists working at Jaggery Park for analysis of sugarcane juice, physical, chemical, biological properties and grading of jaggery. The laboratory is also attracting jaggery samples for analysis and grading from jaggery unit farmers. The UG and PG students from the Agriculture College, Mandya have also been utilizing the laboratory facilities at Jaggery Park. The laboratory is also very useful for analysis of soil samples from different experimental blocks of sugarcane and jaggery.

5.14.3 Storage Structures

The storage structures are used for storage of jaggery produced from large scale plant and the samples from different sugarcane and jaggery experiments till their analysis, characterization and grading

5.14.4 Training Hall

A total of 141 jaggery unit farmers have been trained on production of quality sugarcane for chemical free jaggery preparation. In addition, the jaggery unit farmers and sugarcane farmers visiting Jaggery Park on other occasions including Krishimela were also trained on chemical free jaggery preparation. The number of farmers so trained with witnessing of chemical free jaggery preparation demonstrations was to the tune of 1500. The training facilities have also been utilized for conducting training programmes and seminars from other development departments.

5.14.5 Bagasse Drying Yard and Bagasse Storage Shed

Bagasse drying yard and bagasse storage shed are being used for drying and storage of bagasse obtained after crushing sugarcane for better fuel efficiency.

India Coordinated Research project on Post-Harvest Engineering Technology,
Regional Sugarcane and Jaggery Research Station, Kolhapur

5.15. JAGGERY PRODUCTION TECHNOLOGY

5.15.1. Pre Harvest Technology

1) Soil: Well drained soils, medium to deep. Avoid the salty, alkaline and calcareous soil,

2) Recommended varieties:

   i) Early maturing- CoC671, Co8014, Co 7219 and Co 92005 (released)

3) Fertilizer application: For better jaggery quality 20% reduction in nitrogen fertilizer is recommended while phosphorus and potash fertilizers should be applied as per recommendations for sugarcane crop.

4) Irrigation: Excess irrigation as well as moister stress affects the quality of jaggery. Irrigation to sugarcane crop should be applied considering the season and type of soil. Sugarcane crop should not be irrigated minimum 15 days before harvesting.

5) Sugarcane harvesting: Sugarcane crop should be harvested for jaggery when juice brix is more than 21^0. The cane crop should be harvested close to the ground level and top of 2-3 immature internodes should not be used for jaggery production. Detrashed clean sugarcane should used for crushing.

5.15.2. Post-Harvest Technology

1) **Cane crushing:** After harvesting the sugarcane should be crushed as early as possible. The sugarcane staling period should not be more than 12 hours in any case. For crushing, horizontal three roller crusher having juice extraction efficiency about 65 % may be selected. The extracted juice should be cleaned by using two stage filtration systems. The juice from collection tank is pumped into overhead tank for natural settling. After juice from storage tank to the boiling pan it should passed through nylon cloth for filtration.

2) **Juice boiling:** Fro boiling of juice, improved Kolhapur type chimney chulhan (Furnace) is used. Generally 1000 litres of juice is taken in boiling pan for jaggery processing. Dried cane bagasse used as fuel for boiling. The pH of fresh juice ranges between 5.2 to 5.4 needs to be raised up to 6.5-7.0. The alkaline pH juice facilitate the coagulation of suspended impurities of gummy colloidal substances. It also helps to avoid inversion of sugar. For this purpose lime solution (prepared by dissolving lime @ 150-200 g in 5 litres of water for 1000 litres of juice) is added in cane juice.

3) **Juice clarification** for clarification of juice, the vegetative clarificants, okra plant (wild species) stalk extract is used. This extract is prepared by crushing 2 kg of okra plant stalk and soaking in 15 liters of water. The filtered extract is added in juice for clarification. At 85^0 C temp., the nitrogenous impurities in juice stats coagulate and float on surface as black scum which is removed by strainer.

To avoid effect of excess nitrogen and lime on jaggery colour, the arsenic free phosphoric acid is applied @ 150-200 ml/ 1000 litres of cane juice. The phosphoric acid should apply accurately otherwise excess quantity will make the jaggery softer. Removal of second golden scum should be carried out during boiling as and when it appears on top of juice.

4) Juice concentration: After clarification of juice, when temperature rises to about 99^0 to 100^0 C the juice begins to froth. To control excess frothing and to avoid loss of juice due to overflowing, continuous stirring is applied by churner. After defrothing, juice gets concentrated and at 103^0 – $105^{0\ C}$ temperature the liquid jaggery stage is attained. The liquid is further concentrated and edible oil @ 200ml / 1000 litres of juice is mixed. Application of edible oil helps to increase temperature of liquid without caramelization. The electronic thermometer with 1 m long sensor attached to the boiling pan is used for accurate recording of juice temperatures at different stages.

5) Jaggery cooling and Moulding: At $118^0 \pm 0.5^0$ C temperature of liquid the jaggery stage is observed. This stage could be ascertained by jaggery ball test. Immediately at this stage, the boiling pan is removed from furnace and hot jaggery is poured in cooling pit. Generally cooling pit size. 91/2′ x 91/2′ x 1/2′ are constructed in ground and lined on all sides with kadappa tiles. During cooling, two stirrings are applied to hot jaggery with wooden ladles. This stirring application helps to improve colour and granularity of jaggery. Before the temperature of jaggery drops down to 76^0C, the hot jaggery mass is filled in different size moulds as per market demand. After complete cooling, jaggery is removed from moulds and allowed to dry for 48 hrs.

5.16. Pilot Plant for Production of Quality Jaggery

Year of establishment of the pilot plant: 2003-2004.

Cost of establishment of the pilot plant: Rs. 7.50 lakhs

Grants sanctioned by AICRP on Post Harvest Technology, Ludhiana

(Indian Council of Agriculture Research, New Delhi)

5.16.1. Salient features:

- As per the directives from the ICAR, all the equipments, machineries, accessories required for jaggery processing have been fabricated from stainless steel (304 grade) and wherever required from the food grade plastic material.
- Jaggery production in clean and hygienic conditions
- Consistency in quality of jaggery production
- Labour and time saving operations
- Fuel saving due to energy efficient furnaces and two pan system
- Utilization of waste heat of flue gases by routing beneath second pan
- Minimization of risk and hazards during jaggery production
- Ideal plant layout – sequential arrangement and installation of equipments with best utilization of minimum space.

5.17. Technical Information:

A) General Information		
Production process	:	Batch type process Duration ~ 2 hrs
Capacity	:	500 litres juice processing per batch
Production per batch	:	Solid jaggery – 105 kg or Liquid jaggery -120 kg
B) Information on equipment		
Sugarcane crusher	:	Horizontal, three roller (SS 319) Crushing capacity – 600 kg/hr Juice extraction % - 65 % Operated by 5 HP electric motor ′V′ belt and pully arrangement Cane requirement/batch – 770 kg Crushing time – 90 minutes
Filtration system	:	Two stage filtration a) Primary filter – SS, 4mm dia b) Mechanical rotary – SS sieve 0.5 mm Covered over inclined rotary drum.
Boiling pan tipping	:	Two stainless steel pans, Cap. 500 litres. a) Pre heating or gutter pan, shape-rectangular heating surface area, Fabrication SS 304, 14 gauge, size 2000 x 600 x 660 mm b) Concentrating main pan, shape – regular circular, two valves at bottom for jaggery discharge, fabrication – SS 304, 14 gauge, size 2000 x 6600 x 400 mm
Boiling pan tipping	:	Frame – wheel – track arrangement for carrying the pan up to cooling pit. Lifting of pan and tilting of pan is carried out simultaneously.
Furnace	:	Modified Kolhapur type chimney chulhan, constructed from ‘B’ class fire bricks, provided with ash grate ash pit for better combustion efficiency. Damper and gates provision for control over natural draught, provision for forced draught system. Dia. – 1500 mm, Ht. 900 mm. Flue passage – 400x400 mm, carries hot exhaust air to pre heating pan, take turn at an angle of 45^0 before get connected to chimney. Provision of bypass gate and damper. Chimney – Bottom – 1650 x 1650 mm Top – 900 x 900 mm, Ht. – 6100 mm. Door provision for removal of ash.
Juice collection tank	:	SS 304, 18 gauge, circular, capacity – 500 lit. Dia –

		1100mm, Ht. 900 mm, conical bottom, provided with ball valve at bottom for cleaning lid provision
Juice settling tank	:	SS 304, 18 gauge, circular, capacity – 600 lit. with lid, Dia – 900mm, Ht. 1000 mm, Taper bottom for collection of sediment/impurities at one side with minimum juice loss, two separate ball valves for discharging clean juice and impurities
Liquid jaggery settling tank	:	SS 304, 18 gauge, circular, capacity – 300 lit. with lid, Dia – 700mm, Ht. 900 mm, taper bottom, two ball valves at bottom
Liquid jaggery storage tank	:	SS 304, 18 gauge, circular, capacity – 600 lit. with lid, Dia – 900mm, Ht. 1000 mm, taper bottom, two ball valves at bottom
Cooling pan	:	SS 304, 16 gauge, rectangular tray type shape length – 200 mm, width – 1500mm, Ht. – 150 mm, 6 rings placed at top.

C) Jaggery Processing Accessories

a) Jaggery moulds	:	SS 304, 22 gauge, bucket shape, 10 kg, 5 kg, 2 kg and 1 kg capacities
b) Strainer	:	SS 304, 22 gauges, Soccer shaped for main boiling pan and square tray descending bottom for pre heating pan.
c) Scrapper	:	SS 304, 12 gauge, scraper plate i) Long handled – 25 mm OD, 1500mm long, SS pipe for stirring purpose. ii) Short handled – 25 mm OD, 1200 mm long for filling 5 and 10 kg moulds iii) Short handled - 25 mm OD, 450 mm long for filling 1 and 2 kg moulds.
d) Scum strainer	:	SS 304, 18 gauges, circular Dia. – 431 mm, ht – 500 mm with 100 mm dia., SS screen and tap at bottom.

5.18. Flow Chart of Jaggery Processing and Material Balance

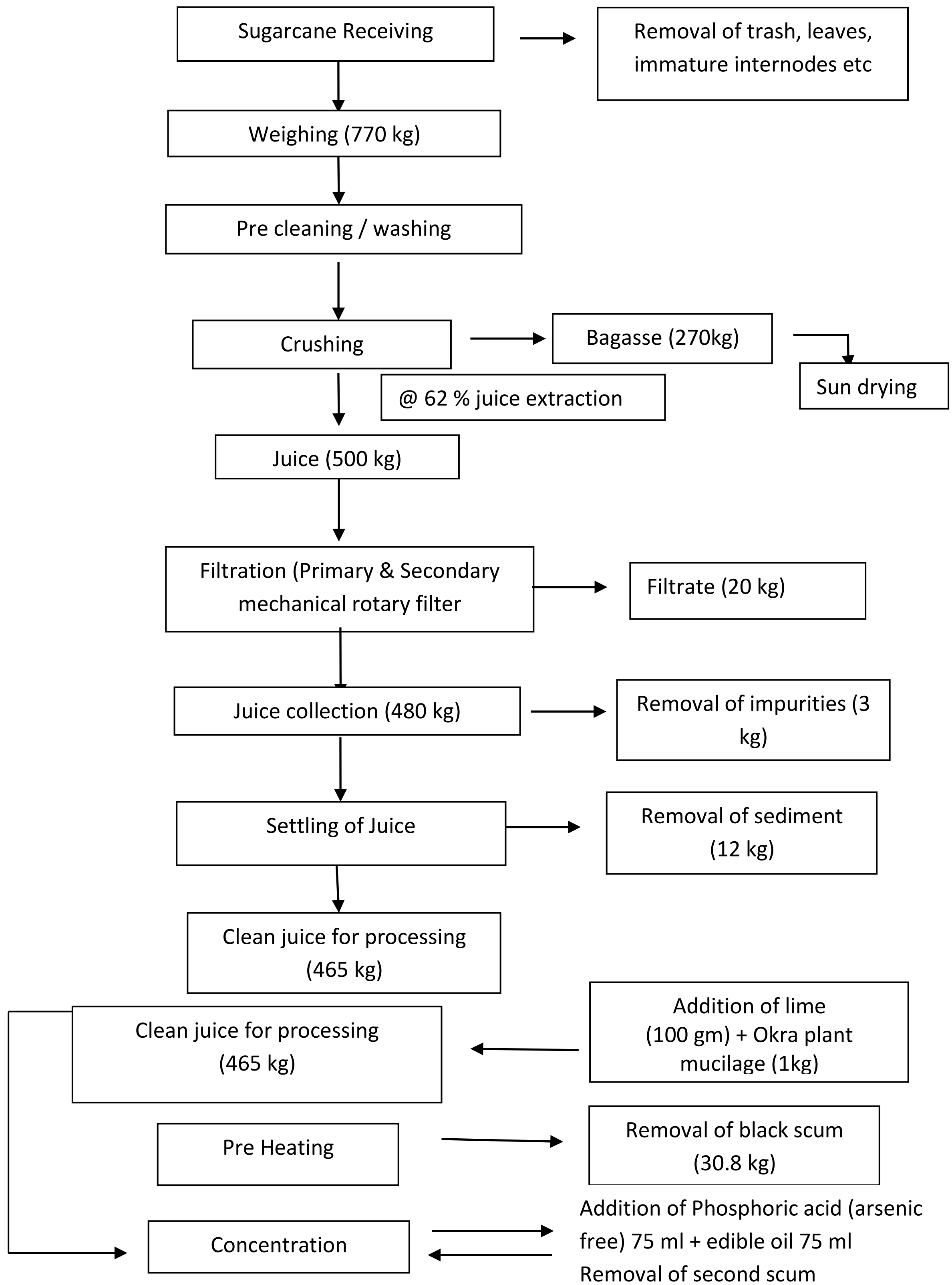
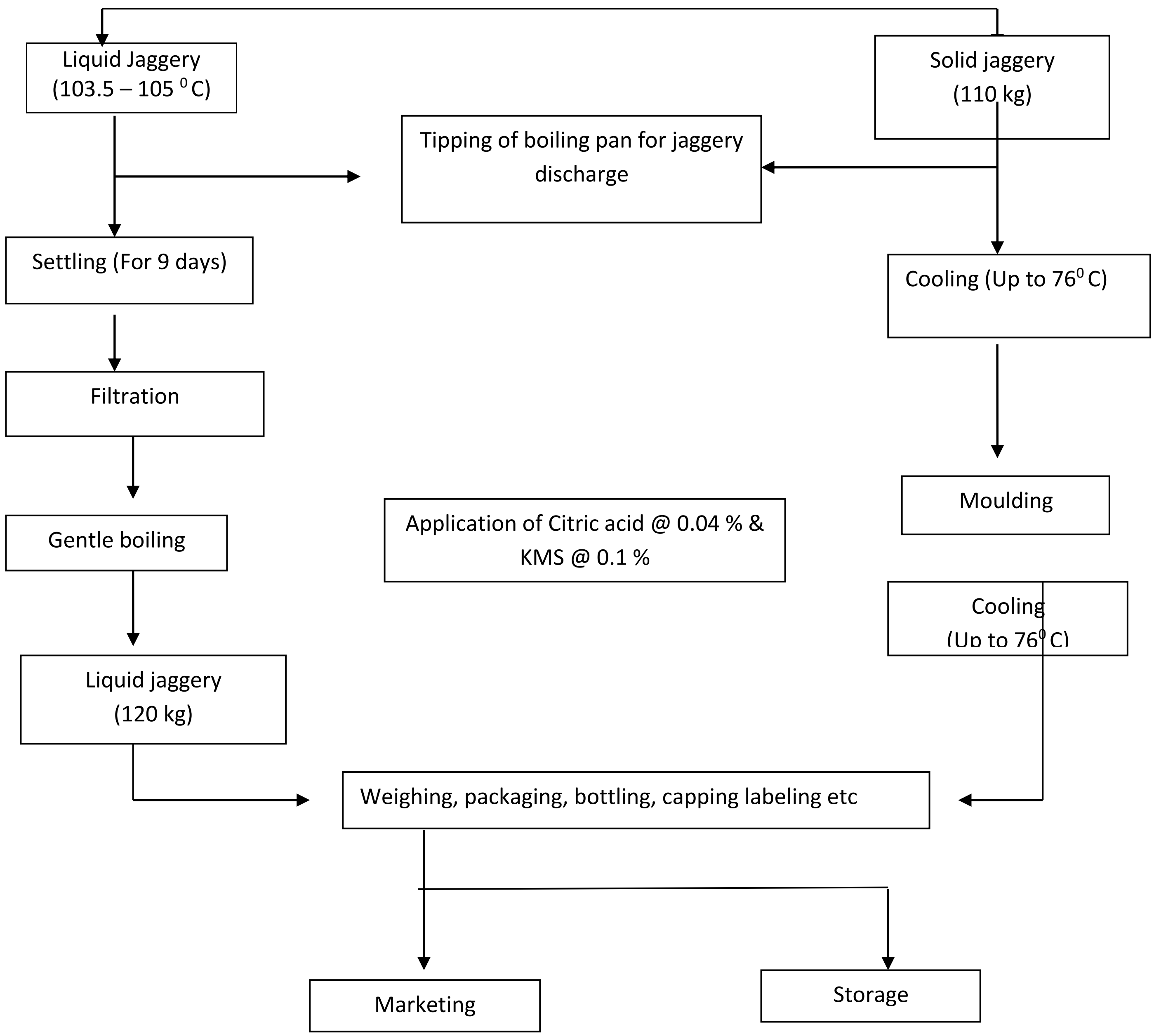


Fig – 5.18.1 Flow Chart of Jaggery Processing and Material Balance

Fig –5.18.1 Flow Chart of Jaggery Processing and Material Balance **Continued ….**



5.19. Powder Jaggery

Compared to lump jaggery of different shape and size powder jaggery is easy to use like centrifugal sugar for table purpose. In the preparation of lump jaggery the end point is 115-118^{0} C. For preparation of powder jaggery a temperature of 121^{0} C is maintained and syrup is taken out from the pan to the cooling pit and further kneading and cycling is done to remove the moisture from the syrup. Powder jaggery should have less than 2 per cent moisture to increase the shelf life and quality. Following is the flow chart for preparation of liquid jaggery.

5.19.1. Flow Chart

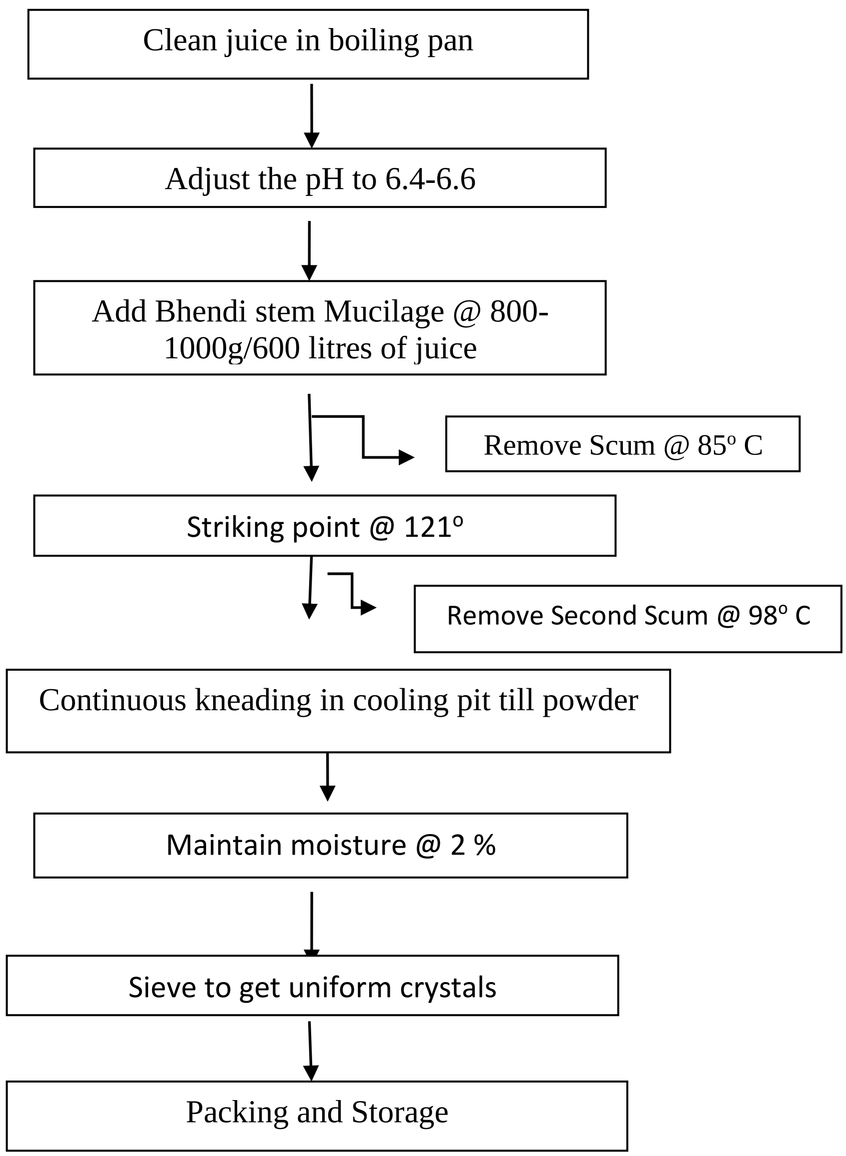


Fig: 5.19.1 Powder Jaggery

5.19.2 Sugarcane Scenario in Karnataka

Year	Area (lakhha)	Production (lakh tons)	Productivity (tons/ha)
2004-05	1.78	142.76	80.20
2005-06	2.19	182.67	83.41
2006-07	3.26	286.70	87.94
2007-08	3.06	262.40	85.75
2008-09	2.81	233.28	83.01
2009-10	3.37	304.43	90.33
2010-11	4.23	396.57	93.75
2011-12	4.30	388.08	90.25
2012-13	4.04	322.3	79.8
2013-14	4.20	359.10	85.50
2014-15	4.25	357.32	84.07

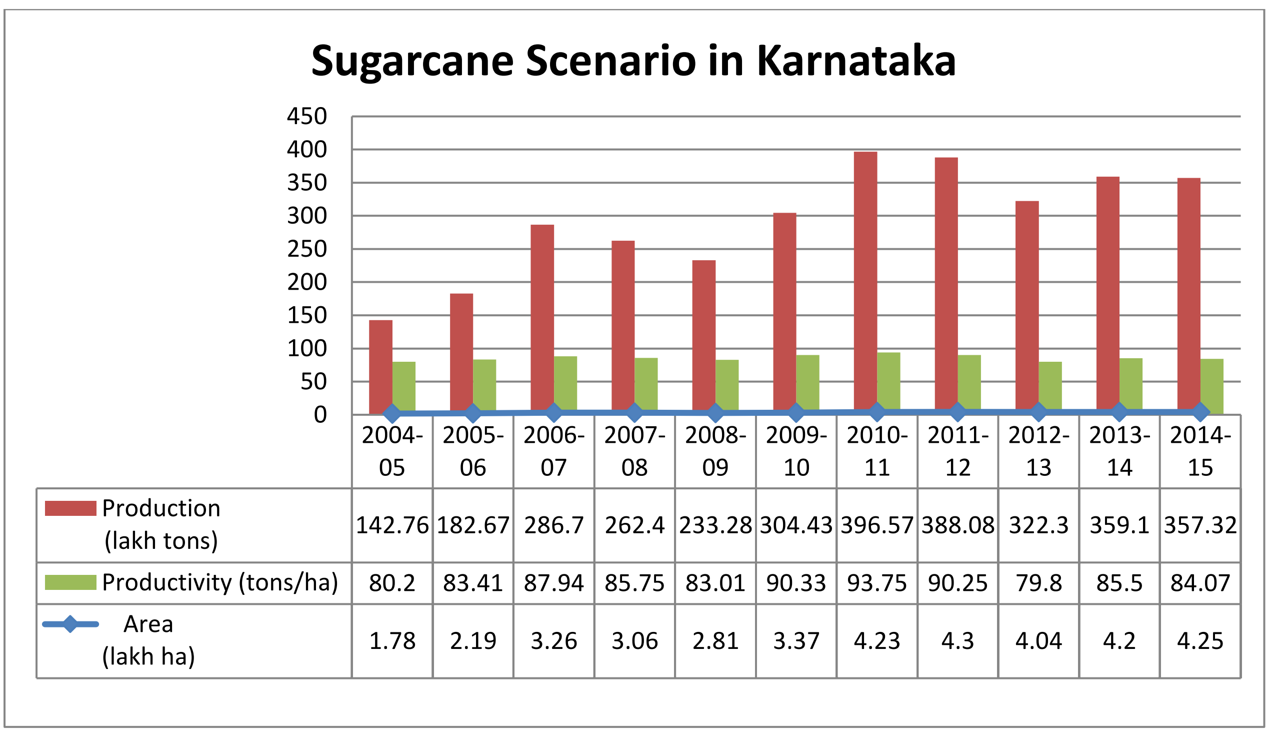


Fig 5.19.2 Sugarcane Scenario in Karnataka

VI. Problem Statement

6.1 Major problems of Jaggery industry

1. Cyclic cane production and recurrent drought.
2. Low profit realized from units which operate at low processing capacity.
3. Stalling of cane and High transportation cost (Cane as well as jaggery)
4. Disproportionate expansion of cane area beyond their installed capacity by sugar mills
5. Highly unorganized sector.
6. Lack of unity among jaggery processors
7. Very poor R and D support for jaggery
8. Competition from sugar mills
9. Outdated methods and machinery for jaggery processing
10. Use of Injurious industrial chemicals for bleaching jaggery.
11. Lack of hygiene and sanitation within the premises jaggery processing
12. Storage, grading and packaging technology are totally absent
13. Insufficient value addition
14. Very poor market infrastructure monopoly by traders.

6.2. Limitations in Evaluation Study

1. The entrepreneurship and managements capability is very low among rural youth.
2. Group approach is also a sound lacuna in rural area.
3. One of the major bottle necks is that the farm produce is a seasonal activity and requires suitable processing machinery for different farm produces during different periods of the year.
4. Paucity of funds to start and running the units.

VII. Specific Objectives of Evaluation:

1. To assess the relevance of crop production, processing and value addition technologies in attaining the objectives of the jaggery project for getting chemical free jaggery.

2. To know the impact of knowledge of chemical free jaggery technology dissemination to the farmers, consumers and traders.

3. To assess the potentiality of chemical free jaggery solid and liquid form for its export potentials.

4. To assess the strength and weakness of technologies involved in chemical free jaggery production and its refinements.

5. To document the overall progress of the objectives of the jaggery park envisaged in the final report.

6. To study feasibility of e-market initiatives and PPP models under taken by the implementation agencies.

7. To assess the economic viability of the project.

Note: After a detailed study of the final project report submitted by the Scientist of Jaggery Park and the survey conducted by the evaluation team, it was decided to restrict the study up to the sixth objective only. Further, based on the recommendation of the Karnataka Evaluation Authority (KEA) it was suggested to include one more objective that is comparative performance of similar jaggery units in Northern parts of Karnataka and Neighbouring state Maharashtra viz, Kolhapur (Comparative performance of both Public sector units and Private sector units i.e. farmer units).

VIII. Evaluation Methodology

8.1 Th**e** objective of this evaluation is to arrive at valid data in order to know the relevance of the jaggey park to the region and to know the basic reasons why the projects has failed to reach out of the beneficial farmers and what are all the steps needs to be initiated to reach the farming community. In order to harness the benefit of jaggery park. For this the research methodology adopted is of basically three module i.e. I. Desk research, II. Factual Data Collection, III Perceptual Survey, IV. Lastly analysis of data and final report

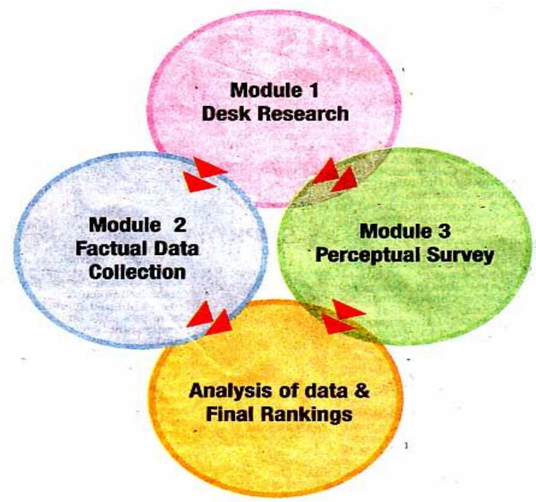


Fig 8.1.1 The flow chart of methodology for data collection

IX. Data collection and Analysis

A thorough inspection of Jaggery Park at Mandya was carried out for documentation of primary, secondary/ tertiary data regarding the instalment of Jaggery Park at V.C Farm, Mandya

Relevant questionnaires were developed based on the objectives of the study in order to get the information for its assessment and they are

i. Questionnaire for the processor at jaggery park
ii. Questionnaire for the processor at farmers jaggery units
iii. Questionnaire for the jaggery consumers
iv. Questionnaire for the Scientists of Jaggery Park
v. Questionnaire for the jaggery traders
vi. Questionnaire for sensory evaluation

A thorough inspection of (20 twenty) jaggery manufactures was under taken in around jaggery park of Mandya.

The principal Investigator visited about 20 jaggery processing units which were randomly selected in the area of the study (Mandya) in order to study and assess various aspects of jaggery processing activities starting from procurement of sugarcane till the end product jaggery, packing and marketing that existed on the farmer's jaggery processors field (i.e., chemical jaggery processing and chemical free jaggery processing units) respectively.

The primary data (Survey)collection through visiting(60 farmer's) sugarcane field. A total of 60 farmers who are cultivating sugarcane and processing jaggery were selected for collecting the validated data with respect to sugarcane cultivation, their knowledge, jaggery processing, value addition etc. were selected randomly in the entire belt of Cauvery command area representing each of the taluks where the jaggery is been processed. The data collected have been systematically pooled and analysed by adopting appropriate statistical tool wherever applicable.

A focused group discussion of progressive sugarcane farmers, jaggery processor traders, consumers was organized to collect the primary information on sugarcane cultivation and jaggery processing at various places of farmer's jaggery units and APMC yard Mandya. The relevant information was systematically collected pooled and analysed by adopting appropriate statistical toolwherever applicable.

9.1. sensory Evaluation : Jaggery samples such as chemical free sample (A) and Chemically processed samples (B) which is procured from the local Mandya market were subjected to sensory evaluation by regular consumers of jaggery, who are well versed with the jaggery taste and usage (n=50). The panel members for sensory evaluation consisted of staff of ZARS, V.C. Farm, Mandya as well as consumers of Mandya urban and rural places. Panellists were provided with coded samples along with glass of water and instructed to rinse and swallow water between samples. Panellists were given written as well as oral instructions regarding evaluation procedure and asked to evaluate the products for acceptability based on its appearance, colour, taste, texture and overall acceptability on nine point hedonic scale, where in 9= like extremely, 8= like very much, 7= like moderately, 6= like slightly, 5= neither like nor dislike, 4= dislike slightly, 3= dislike moderately, 2= dislike very much, 1= dislike extremely.

Visit to jaggery parks at Mudhol, Sankeshwar and Kolhapur. The principal investigator of the project visited the public and private jaggery processing units i.e., Mudhol and Sankeshwar coming under jurisdiction of UAS Dharwar, as well as farmer's field in around Mudhol and Sankeshwar. In addition, the PI visited the Regional sugarcane and Jaggery Research station, Kolhapur and the farmer's jaggery processing units in and around Kolhapur, in order to evaluate the comparative performance of the jaggery processing units of Mandya and to that of Northern Parts of Karnataka and Maharastra. In order to identify the gaps in production and processing technologies that exists in the jaggery industry as a whole.

9.2 Statistical Analysis:

The relevant primary datawas collected by using different questionnaire for assessment of the project work. Where systematically pooled and analysed accordingly.Since the study was restricted to one unit there were no much variable to compare. Hence, the data collected was averaged and simple khysquretest were applied wherever necessary to draw inference.

9.3. Evaluation of Frame work

a. What is the purpose of the evaluation? Why it is done now?

i) To know the relevance and the potentiality of established jaggery park in meeting the objectives of the project proposal funded through RKVY.

ii) Sugarcane is one of the most important crops in command areas. More than 50 per cent of sugarcane is available for jaggery making in the state in the years of excess cane production. Hence, jaggery sector has vast potential to improve the socio – economic status of the farmers.

- ☞ Non-availability of technology and existing research gap, low price for jaggery due to poor quality are causing the closure of many Jaggery units.
- ☞ Cauvery command is the only area in India where jaggery is manufactured in the off-season (June-Sep.), apart from the regular crushing season (Oct.-March). But, the farmers in this area do not get appreciable price for jaggery because of poor quality. Hence, there is a need to utilize the off-season crushing in a profitable manner through advanced research.

iii) The evaluation process of the project has been envisaged in order to assess the strength and weaknesses of the ongoing Jaggery Park and to up scaling and replicating in other parts of the state.

9.4 SWOC*Analysis of Jaggery Processing Units at Mandya*

It is a well-known fact that sugarcane is processed into sugar, Jaggery and Khandsari; jaggery has more nutritional and medicinal value when compared to sugar.

The jaggery industry has been considered as one of the small scale and cottage industries in India. As much as 35-40 per cent of sugarcane has been processed annually into jaggery or Khandasari (Kachru 2001). The production of jaggery ranges between 5 to 8 million tonnes. Further, it is estimated that two thirds of the sweetener requirement in rural areas is met by jaggery. The jaggery industry in the country has thus, been continued to be a cottage industry of great importance and relevance.

Off late, in recent years the sugar industry is facing complex problems such as high stocks, increased cost of processing, labour issues and closer of some of the factories, imbalances in export import leading to financial crunch etc. This has resulted in delayed and low payments to the farmers. In such a situation, diversion of sugarcane to jaggery making is an alternative option.

In support of above fact to strengthen the scientific jaggery production in the state of Karnataka, the department of agriculture (GOK) has financed for establishment of two jaggery parks to the state Agricultural Universities, i.e., UAS (B) and UAS (D), i.e., one at Mandya, under UAS Bangalore and under UAS Dharwad, main unit at Mudhol and sub unit at Sankeshwar, through RKVY funding.

A look into the present position of jaggery processing in Mandya (UAS (B)) and Dharwad (UAS (D)) region, for farmers losing their interest on jaggery processing it is apt to assess its strength and weaknesses of the jaggery park through model parks, would help the policy makers to take appropriate policy decisions regarding better and economical utilization of their facility created by government of Karnataka. Hence, the current study was under taken with specific objective of analyzing strength, weakness, opportunities and challenges in jaggery processing.

The Study Area: Mandya district ranks 3rd in Cultivation of sugarcane. As many as 2000 to 2500 jaggery processing units are located in the District. A total of 60 cane cultivators-cum processors in Mandya Dist were randomly interviewed for eliciting the required information on SWOC analysis of jaggery processing units that are located in the District.

The SWOC analysis is a valuable step in situational analysis. Assessing the jaggery processing units strengths, weakness, market opportunities and challenges through a SWOC analysis is a simple process that can offer powerful insight into the potential and critical issues like internal issues strengths and weakness and external opportunity and challenges issues influencing the jaggery processing. The role of SWOC analysis is to take the information from the environmental analysis and separate it into internal issues (Strength and Weaknesses) and external issues (opportunities and Challenges). The analysis will indicate the strength, weaknesses opportunities and Challenges of a system in order to overcome or minimize the ill effects of weakness and challenges to achieve desired results by taking appropriate measures.

Strengths.

Table 9.4.1: Strengths in jaggery processing:

Sl. No.	Parameters	Respondent No.	Respondent (% total)
1.	Availability of sufficient cane	60	100
2.	Low investment oriental industry	55	91
3.	Effective utilization of family labour	60	100
4.	Man power availability (8-12 men/unit)	52	87
5.	Quicker payment than sugar factories	60	100
6.	Small Scale Industry	10	17
7.	traditional knowledge and less technical labour	25	42
8.	Research facilities available	35	58
9.	High profit	35	58
10.	Availability suitable cane varieties	20	33
11.	Storability	35	58

Strength : the major strengths in the jaggery processing in the study area reveals that, there is sufficiency of raw material which is an important strength of jaggery production and up to 50 per cent of sugarcane produced is available for jaggery processing. The processing industry as such requires low investment because of majority of equipment used in jaggery processing are of indigenous nature. Family labour can be effectively utilized in the production of jaggery.

Indeed, each processing unit will generate 8-12 employment opportunities. It was interesting to note that the processers are capable of providing labour requirement through their family for various works of jaggery processing. About 87 per cent of jaggery processers had a larger family size of 8 to 9 members, from among themselves when joined can manage the units by themselves.

These units have been considered as small scale cottage industry. These units have ample opportunities to generate employment in the rural area. The average crushing period noted in the study area was 200 days in a year. Each processing unit provides 8-12 man days of employment per day. Thus each jaggery processing unit generates about 1600-2400 man days of employment in the rural area at very low cost. Therefore, jaggery processing sector has vast potential to improve the socio-economic status of farmers and strengthen the rural economy. In addition, jaggery is rated for it is highly medicinal and nutritional value.

In addition, the quicker repayment of cane prices to sugarcane farmers than sugar factories is also acting as greater strength of jaggery industry. Consequent to delay in payment by factories the farmers are starved of financial problems till payments are received, hence, they find it an easy way to supply the sugarcane to the jaggery units.

The study also revealed that the availability of good sugar rich quality cane varieties needed for jaggery production are inadequate. Except VCF 0517 and Co86032 while others are low jaggery yielders and low recovery varieties. There is a need for more focused research on development of more number of short duration high yielding sugar rich quality canes varieties to suit the soil and climatic conditions of Mandya, in order to facilitate all round the year planting and crushing.

Another advantage of jaggery industry is that the net return on rupee investment by farmers is higher than the cane supplying to factories because of higher price to jaggery manufacturing than sugar if they manufacture chemical free jaggery which is having both medicinal and nutritional value. Besides, other strength as expressed by the jaggery processers are availability of traditional knowledge of jaggery processing with the local people and requirement of less technical and labour input. That apart, the jaggery can be stored for longer duration without any quality deteriorations with proper care.

Weakness

Table 9.4.2: Weaknesses in Jaggery Processing

Sl. No.	Parameters	Respondents No.	Respondents (% total)
1.	Lack of good manufacturing practices	36	60
2.	Lack of modern technology: it needs to be up sealed to industrial level.	35	58
3.	Lack of awareness about export procedures and requirement of export countries	49	81
4.	High working capital	56	93
5.	Irregular electricity supply	55	91
6.	Labour cost and scarcity	51	85
7.	Excessive use of chemicals	45	75
8.	Lack of storage facilities	55	91
9.	Lack of information	30	50
10.	Non availability of authentic data on production	45	75
11.	Unhygienic conditions	55	91

Weakness: the major weakness is the jaggery processing are presented in table 9.4.2

The major weaknesses in jaggery processing are high working capital for cane procurement, irregular electricity supply, lack of storage facility and unhygienic processing in the area of study in Mandya.

As observed among the respondents almost all the jaggery processers are small farmers and do not have sufficient working capital to invest on modernizing crushers, pans, furnaces and chimney etc. and working capital like raw material purchases, labour and other variable cost. Besides more serious problems faced by farmers is electricity. That is most of the jaggery processing units are electrically operated. The power supply in the study area was not only inadequate but also erratic. As a result, the processing unit did not work continuously resulting in poor quality jaggery in terms of yield and recovery leading to rise in cost of production.

Non-availability of the hired labour and lack of awareness about export procedure to exporting countries, excess production and accumulation of jaggery due to inadequate market facility leading to price crash and loss to the processers. Besides, there is excessive use of chemicals to bleach the jaggery to get shining and white colour is in vogue, in spite of knowing the ill effects of such chemicals on human's health.

The crushers that are being presently used are old, unsafe and highly inefficient to crush more quantity of cane and have poor juice extraction efficiency. Hence, there is a need for modernization of existing crushers for improving extraction efficiency.

The furnaces and boiling pans that are presently used have many disadvantages like poor fuel efficiency, loss of heat and caramalization of jaggery and high occupational hazards. The type of furnace and number of pans have a role to play in jaggery quality recovery hence, it is very much essential to improve combustion efficiency and heat utilization efficiency of existing furnace, besides boiling pans which are made of Iron/MS, should be replaced with food grade steel materials. More than 50 per cent of jaggery quality depends on the above factors. Fuel use efficiency in traditional method is very poor, in some cases farmers are using old vehicle tyres and tubes as a fuel source which emit toxic gases which are directly absorbed in the processes of jaggery. Similar results have been reported by Shivaram et al, 2002, in their study on jaggery unit in the Cauvery command area in Mandya.

Farmers in the study area are preparing jaggery by using several chemicals like sodium hydrosulphite, sulphoxylate, sodium bi carbonate, super phosphate. Phosphoric acid and lime at higher levels of concentrations than the dose recommended. Sodium Hydro sulphite and sodium carbonate (washing soda) are liberally used to get attractive colour without knowing the deleterious effect on human health and need of the hour is to bring the policy changes to ban such jaggery. In line with the above findings, similar opinions have been expressed by Usha et al, 2004.

Majority of the farmers are preparing jaggery by adopting good old methods of processing under unhygienic conditions, and it is considered that the whole process is scientifically inefficient to produce quality jaggery. Hence, they are incurring loss in quality and quantity of jaggery production. Apart from their lack of information on these aspects, acceptability and adoptability of new technology need encouragement in order to modernize the jaggery industry.

Opportunities

Table 9.4.3: opportunities in jaggery processing

Sl. No.	parameters	Respondents No.	respondents (% total)
1.	Increasing demand for chemical free jaggery	55	91
2.	Promotion in international market (export) as a substitute for sugar	42	70
3.	Scope for modernization of existing units	60	100
4.	Increasing area under sugarcane	10	17
5.	Breeding new sugar rich sugarcane verities	52	86
6.	Development of value added products and by products	42	70
7.	Improvement in production technologies	38	63
8.	Alternate uses of beggasse and molasses	40	66
9.	Seasonal employment generation	50	83
10.	Mobile jaggery processing units	45	75

Opportunities in jaggery processing in the study area are presented in Table 3. The results reveal that increasing demand for chemical free jaggery in the national and international markets is going much faster than expected because of its medicinal value and nutritional value. Hence, improvements in the hygienic production technologies are the major opportunities for jaggery processing.

Breeding for sugar rich quality cane is another opportunity to meet the area expansion based on soil and climatic conditions. Nevertheless, the sugar cane variety VCF 0517 needs more propaganda to harness the beneficial effects of high cane yield and high sugared variety to rural poor which is highly suitable for jaggery processing. Similar results have been reported by Pawar and Dongre (2001) in their study on jaggery processing in India.

There is a great potential to explore the benefit of round the year jaggery production in Mandya which is unique in the entire state of Karnataka and also in the country. Establishment of mobile jaggery processing units may add much more benefits to the farming community through natural recycling of organic wastes on their farm itself, resulting in low cost of production and economic stability, besides preventing migration of rural mass.

In the era of organic products the demand for organically produced jaggery is increasing. Being a healthy sweetener quality jaggery and its value added products such as lump jaggery, liquid jaggery, chocolates and confectionaries of various combinations of cereals and pulses are the need of the hour.

Further, it's also possible to significantly increase the export of jaggery in solid, powder and liquid forms. As on to date, India contributes about 65-70 per cent jaggery production in the world. Its being exported to many countries like Bangladesh, Great Britain, Canada, Chile, Egypt, Fiji, Iran, Iraq, Kuwait, Malaysia, Nepal, and USA. This needs to be exploited by the farmers and has large potential if organized through cooperative organizations similar to that of milk union which is a success story in an Indian context.

Challenges

Table 9.4.4: Challenges in Jaggery Processing.

Sl. No.	Parameters	Respondents No's.	Respondents (% total)
1.	Price fluctuation	58	96
2.	Trade contracted mainly by traders/ exporter	52	86
3.	Seasonal production	55	91
4.	Usage of jaggery presently limited to ethnic population	54	90
5.	Competition from sugar industry	55	91
6.	Inadequate marketing facilities near site of production	58	96
7.	Usage of hazardous chemicals for processing	55	91
8.	Pre harvest contracts	40	66
9.	Lack of credit facilities	25	42
10.	High commission charges	55	91
11.	Inadequate institutional supports	39	65
12.	Loss of manpower to other industries.	52	86
13.	Inadequate efforts on research	20	33
14.	Occupational hazards	45	75

The major Challenge in jaggery processing is the fluctuation in the jaggery price and competition from sugar factories which are hindering the growth of jaggery processing. It could be recalled here that five sugar mills are operating in the study area which have significant influence on the farmer's choice of jaggery production. The other challenges in jaggery processing are in adequate marketing facility near the sight of production, use of hazardous chemicals for processing of jaggery and high commission charges by middle men traders need to be re looked in order to make jaggery a viable agro-based industry.

The pre -harvest contract and exploitation of the farmers by jaggery traders, jaggery processing as a cottage industry being operated at decentralized level in an unorganized state in rural sectors needs institutional support to quality jaggery production, handling storage, management and higher returns and lower cost.

Jaggery marketing is an important activity in its production process that has bearings on economic profitability of rural cottage processing units. The marketing involves various operations and services such as grading, packaging, storing and transportation etc. The most prominent marketing channels followed for sale of jaggery are

Channel –I: Producer –Commission Agent – Wholesaler – Retailer-Consumer.

Channel –II: Producer –Co-operative Sangh – Wholesaler – Retailer-Consumer.

The review studies reveal that the highest producer share in consumer rupee and channel wise marketing efficiency was recorded in channel I, followed by channel II. The effort should be made to minimize marketing cost and middlemen margins. The jaggery product market was dominated by wholesalers which entail administrative reforms such as product ceiling limit, commission charges and product quantity transaction etc. The other constraints such as lack of infrastructural facilities and incentives for jaggery processing and price dissemination should be addressed on priority.

Similar to the above observations, the commission agents were found to charge

2-3% commission when the jaggery was disposed through channel -I (producer → commission agent → wholesaler → retailer → consumer). The charges were still more when the jaggery was sold by the processers in the neighboring state of Maharastra. Perhaps this was the reason why channel II (producer → wholesaler → retailer → consumer) was more familiar and acceptable in Mandya market. The above phenomenon was reported by Sachin Kumar and Arun Kumar 2012.

The basic reason for this type of marketing was lack of storage facility, the processors were forced to dispose of their jaggery soon after its processing. Due to its seasonality (crushing only for 200 days) in production and occupational hazards that exists in the jaggery processing industry, there is a loss / diversion of trained man power to other industry and other professions is of great concern and a major threat to the jaggery industry.

Though the Govt. of Karnataka has set up two jaggery parks, one in southern Karnataka and another two in Northern Karnataka, the benefits of these parks in meeting the demand of jaggery research requirements in tune with the farmer demand is not fully materialized by both the institutes due to inadequately qualified technical man power availability in the area of jaggery processing, furnace technology, mechanization, value addition, storage and packing technology in the area of study and these are the inputs which are very much needed in order to modernize the jaggery processing to meet international standards and demand.

Nevertheless, both the institutes have contributed towards development of sugar rich varieties suitable for jaggery making and standardize protocols for chemical free jaggery processing, besides cane cultivation practices for which they are strong.Hence, there is need of in-depth research in all the spears of jaggery processing, looking into its greater depth of contribution to human medicinal values and nutrition, and export potential in addition to employment generation in the rural sector.

9.5 What is the scope of Evaluation? What reference time period it covers?

i) To study the impact of Jaggery Park and training provided in making chemical free Jaggery on Jaggery units, AMPC's merchants and consumers.

ii) To assess the consumer perception on use of chemical free Jaggery.

iii) To study the impact of partial mechanization of Jaggery units including Juice extraction, processing, moulding, Storing and packaging in relation to chemical free jaggery

iv) To examine the potential of up scaling chemical free jaggery.

v) To study the awareness level among the farmers, consumers, traders on use of chemical free jaggery.

vi) To assess the potentiality of chemical free solid and liquid jaggery for its export potential.

The Evaluation Period covers from inception time that is 2008-09 to 2012-13.

9.6. Who are the stakeholders? Who are the key audience for the study?

i) The stakeholders are:

1. The scientists of university of agricultural sciences
2. Officials of the state Agricultural University, Agriculture and Allied Department.
3. Farmers in and around command area growing sugarcane.
4. Jaggery Manufacturers.
5. Jaggery traders.

Key Audience:

1. Farmers and Farming Family
2. Research Scholars.
3. Traders.
4. Consumers.

9.7 What will the study evaluate basically? Program effectiveness, efficiency, economy? Administrative Processes?Program / scheme out puts? Outcomes and from whose prospective?

i) The study envisages the relevance of implementation of the jaggery Park for its technical services rendered in processing chemical free jaggery in terms of its efficiency, economical feasibility, sustainability and health prospective of Consumers, Farmers and traders.

In addition, the study also encompasses administrative hurdles/bottle necks for corrective measures needed in achieving the scheme output/outcomes in relation to Jaggery Park rendering the services to the farming community, scientist and consumers.

9.8 What are the specific objectives for this evaluation study? Are any refinements to the objectives listed in the ToR necessary?

Objectives of the Evaluation Study:

1. To assess the relevance of crop production, processing and value addition technologies in attaining the objectives of the jaggery project for getting chemical free jaggery.
2. To know the impact of knowledge of chemical free jaggery technology dissemination to the farmers, consumers and traders.
3. To assess the potentiality of chemical free jaggery solid and liquid form for its export potentials.
4. To assess the strength and weakness of technologies involved in chemical free jaggery production and its refinements.
5. To document the overall progress of the objectives of the jaggery park envisaged in the final report.
6. To study feasibility of e-market initiatives and PPP models under taken by the implementation agencies.

7 To assess the economic viability of the project.

The refinements to the objectives listed in ToR will be looked into after making a detailed analysis of the study

(Furnished in Introduction Chapter also)

9.9 What is the baseline or benchmark against which evaluation will be done? Does it involve control group or a counterfactual? How will the attribution issue be addressed?

The newly established Jaggery Park at VC farm, Mandya will be compared with other existing similar Jaggery units located in northern parts of Karnataka and Maharashtra in order to assess the feasibility and efficacy.Detailed comparative information on crop production, processing, value addition technologies will be collected and compared for to know the strength and weaknesses.

9.10. What is the precision required in the study? What is the confidence limit and statistical power?

The chemical free Jaggery prepared by the Jaggery park as well as its ancillary units of Jaggery Manufacturers will be assessed for its quality in tune with the food grades and hygiene as suggested by FASSI / CFTRI for consumer. (Tested in accredited laboratory of Government of India/State)

The data generated based on the evaluation questions will be statistically analyzed and interpreted accordingly.

9.11 What are the risks and limitations that may undermine the reliability and validity evaluation results?

1. The entrepreneurship and managements capability is very low among rural youth.
2. Group approach is also a sound lacuna in rural area.
3. One of the major bottle necks is that the farm produce is a seasonal activity and requires suitable processing machinery for different farm produces during different periods of the year.
4. Paucity of funds to start and running the units.

X. Evaluation Findings

10.1 SGS: A SURVEY ON SUGARCANE GROWERS IN THE STUDY AREA (MANDYA)

Table 10.1.1: Land holding information of the respondents

	Dry Land	
Landholdings	F	Per cent
No Dry Land	57	95.0
< 2 acres	2	3.3
2- 5 acres	1	1.7
Total	60	100.0
Irrigated Land		
< 2 acres	6	10.0
2 - 5 acres	27	45.0
5- 10 acres	17	28.3
> 10 acres	10	16.7
Total	60	100.0
Garden Land		
No Garden Land	60	100.0
Total Landholdings		
< 2 acres	5	8.3
2 - 5 acres	28	46.7
5- 10 acres	16	26.7
> 10 acres	11	18.3
Total	60	100.0

Note: SG: Sugarcane Growers

About 60 cane growers were surveyed to know the sugarcane growing scenario, extent of adoption of scientific knowledge in growing of sugarcane and Jaggery production status in Mandya district. Among the 60 respondents, most of the farmers are having irrigated area as compared to dry land (Table 10.1.1) and none of them is having garden land. This encourages the farmers to grow sugarcane since; it requires irrigation water throughout the year. The farmers of Mandya district are having small and marginal landholdings as indicated in the survey, only 18.3per cent of the respondents are having >10 acres of land, while 26.7Per cent are having 5-10 acres, 46.7Per cent are having 2-5 acres and 8.3 Per cent are holding <2.0 acres.

Table SG 10.2: Extent of sugarcane area, production & consumers among the respondents/sugarcane growers before inception of training.

Table SG 10.2.1: Area under sugar cane earlier to training/in the programme

Landholdings	F	Per cent
< 2 acres	6	10.0
2 - 5 acres	32	53.3
5- 10 acres	16	26.7
> 10 acres	6	10.0
Total	60	100.0

Table SG 10.2.2: Production (in tons) earlier to training/in the programme

Tons	F	Per cent
< 50	7	11.7
50 - 100	6	10.0
100 – 200	20	33.3
200 – 300	15	25.0
> 300	12	20.0
Total	60	100.0

Table SG 10.2.3: Cane used for jaggery (in tons) earlier to training/in the programme

Tons	F	Per cent
< 50	7	11.7
50 - 100	6	10.0
100 – 200	20	33.3
200 – 300	15	25.0
> 300	12	20.0
Total	60	100.0

Table SG 10.2.4: Cane sold for the factory (in tons) earlier to training/in the programme

Tons	F	Per cent
Total	60	100.0

In Mandya district sugarcane is a major cash crop and is grown by majority of the farmers. Among the respondents, 53.3 Per cent are growing sugarcane in 2-5 acres, 26.7 Per cent in 5-10 acres and 10Per cent in less than 2.0 acres. While, only 10Per cent of the respondents are growing sugarcane in more than 10 acres of land (Table SG 10.2.1).

The sugarcane production also varied greatly among the respondents depending upon the land holdings. Majority of the farmers (33.3Per cent) are producing 100-200 tonnes of cane per year. While, only 20 Per cent of the farmers are producing > 300 tonnes of cane per year. Only 11.7 Per cent of the farmers are producing less than 50 tonnes of cane per year (Table SG 10.2.2).

Most of the farmers in the study area sell their cane to jaggery making units because of non-running of the My-sugar factory at Mandya and also getting higher cane price due to prevalence of higher price for jaggery in the market (Table SG 10.2.3 and SG 10.2.4).

10.3: Extent of sugarcane area, production & consumers among the respondents/sugarcane growers after imparting training.

Table 10.3.1: Area under sugar cane after training & part of the programme

Area	F	Per cent
< 2 acres	6	10.0
2 - 5 acres	31	51.7
5- 10 acres	18	30.0
> 10 acres	5	8.3
Total	60	100.0

Table SG 10.3.2: Production (in tons) after training & part of the programme

Tons	F	Per cent
< 50	4	6.7
50 - 100	2	3.3
100 – 200	16	26.7
200 – 300	18	30.0
> 300	20	33.3
Total	60	100.0

Table SG 10.3.3: Cane used for jaggery (in tons) after training & part of the programme

Tons	F	Per cent
< 50	4	6.7
50 - 100	2	3.3
100 – 200	16	26.7
200 – 300	18	30.0
> 300	20	33.3
Total	60	100.0

Table SG 10.3.4: Cane sold for the factory (in tons) after training & part of the programme

Tons	F	Per cent
< 50		
50 - 100		
100 – 200		
200 – 300		
> 300		
Total	60	100.0

Area under sugarcane has not increased greatly after imparting of training on improved sugarcane cultivation practices. It may be due to lower land holding, irrigation water scarcity; lack of finance etc. (Table SG 10.3.1). However, the cane production is increased tremendously after imparting training on improved sugarcane cultivation practices. With the same cultivable area, the percentage of farmers producing > 300 tons of cane per year increased from 20 Per cent to 33 Per cent, while, 200-300 tons of cane per year producing farmers increased from 18 Per cent to 30 Per cent (Table SG 10.3.2). Because of this increased cane yield, cane sold to jaggery unit also enhanced, but none of the respondents sold their cane to sugar factories, since they are getting higher cane price from the jaggery making units (Table SG 10.3.3 & 10.3.4).

SG 10.4: Socio-economic condition of the sugarcane growers.

Table SG 10.4.1: Type of House

	Frequency	Per cent
Katcha House	55	91.7
Pucca House (Concrete)	5	8.3
Total	60	100.0

Table SG 10.4.2: Ownership of house

	Frequency	Per cent
Own house	60	100.0

Table SG 10.4.3: Whether toilet is available

	Frequency	Per cent
Yes	60	100.0

Table SG 10.4.4: The soil is suitable for cultivation of quality cane

	Frequency	Per cent
Loamy	39	65.0
Clay	19	31.7
Clay/ Loamy	2	3.3
Total	60	100.0

All the respondents have their own house because of improved economic condition due to continuous growing of sugarcane. Among them, 92 Per cent are having Kaccha house and 8Per cent pucca house and all the houses are having toilet (Table SG 10.4.1. & 10.4.2).

In Mandya district sugarcane is grown in almost all types of soils. However, for realizing higher cane yield, more than 65 Per cent of respondents indicated that loamy soils are the best because, loamy soils hold more water and nutrients and drainage is also very good. While, for 32Per cent of the respondents, clayey soils are the best for sugarcane because of its higher water holding capacity (Table SG 10.4.4).

SG 10.5: The important management practices which enhanced the cane yield among sugarcane growers

Table SG 10.5.1Agronomic Practices adopted in Sugarcane cultivation by Farmers

	Percentage of Respondents			
Particulars	**Yes**	**No**	**No Answer/ Not applicable**	**Total**
Farmer have enough financial source	33.3	66.7		100.0
Undergone a training programme by park scientists	73.3	26.7		100.0
Improved varieties	70.0	3.3	26.7	100.0
Nutrient management	53.3	20.0	26.7	100.0
Wide row planting	11.7	61.7	26.7	100.0
Drip irrigation	10.0	63.3	26.7	100.0
Weed management	11.7	61.7	26.7	100.0
Water Management	13.3	60.0	26.7	100.0
Pest and disease management	25.0	48.4	26.7	100.0
Green manuring	1.7	71.7	26.7	100.0

Table SG 10.5.2: Provided soil testing technology in jaggery park

	Frequency	Per cent
No	60	100.0

More than 73Per cent of the respondents have undergone training on improved management practices in sugarcane by the jaggery park scientists, Department of Agriculture, NGOs etc. Most of the respondents (66.7Per cent) opined that they don’t have enough financial sources for scientific cultivation of sugarcane. Among the sugarcane yield improvement components, 70Per cent of the respondents answered that growing of improved varieties plays an important role in improving both cane yield and also jaggery yield. While, 53Per cent opened that nutrient management especially right type and right time of application of fertilizers plays an important role. The next best components helps enhancing cane yield and reducing cost of cultivation are wide row planting, drip irrigation, weed management , water management, integrated pest and disease management and green manuring (Table SG 10.5.1).

All the respondents answered that, soil testing facilities are not given at Jaggery Park and farmers have tested their soil samples in soil testing Laboratory, Department of Agriculture, Mandya (Table SG 10.5.2).

SG 10.6: Mode of transportation & time taken for transportation of harvested cane to jaggery units/sugar factory

Table SG 9.6.1: Method of transport of cane		
	Frequency	Per cent
Tractor	2	3.3
Bullock cart	37	61.7
Tractor and Bullock cart	21	35.0
Total	60	100.0

Most of the farmers (62Per cent) transport their cane by Bullock Cart from field to jaggery unit. Usually, the average time taken for transport is 36-48 hours. Hence, the quality of cane gets deteriorated and cane weight reduced. Hence, jaggery units are getting lower jaggery recovery and farmers are getting lower profit. Now a days for transport of cane from field to jaggery units tractors are used and this saved both time and cost (Table SG 10.6.1).

SG 10.7: Training undergone by the sugarcane growers on cultivation practices,

Table SG 10.7.1: training on Package of harvesting and post-harvest management

	F	Per cent
Cultivation practices from DOA, Mandya	11	18.3
Cultivation practices VC Farm, Mandya	31	51.7
Undergone at jaggery park	2	3.3
No Training undergone	16	26.7
Total	60	100.0

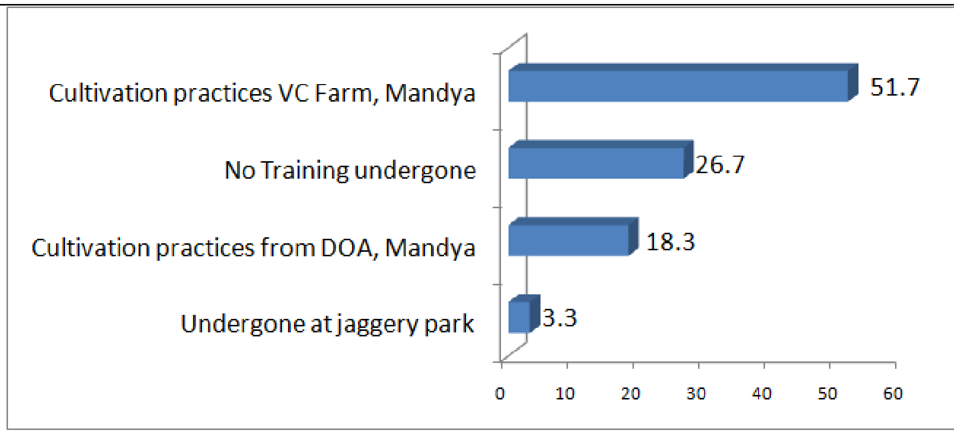


Fig: 10.7.1: Training on Package of harvesting and post-harvest management

The farmers are trained regarding improved sugarcane cultivation practices, harvesting, post-harvest management and packaging of jaggery from ZARS, V C, Farm (52Per cent), Department of Agriculture, Mandya (18Per cent) and only 3Per cent from Jaggery park. While, 27 Per cent of the farmers have not undergone any trainings (Table SG 10.7.1 & Fig SG.10.7 F .1).

SG 10.8: Basis for selection of seeds, fertilizers and pesticides by the sugarcane growers

Table SG 10.8.1: Percentage of adoption of technology from different agencies.

	F	Per cent
Based on AO suggestions	5	8.3
Based on experience	38	63.3
Based on other farmers suggestions	5	8.3
Based on scientific information	7	11.7
Based on suggestions from experts	3	5.0
As per fertilizer shop owner suggestion	2	3.3
Total	60	100.0

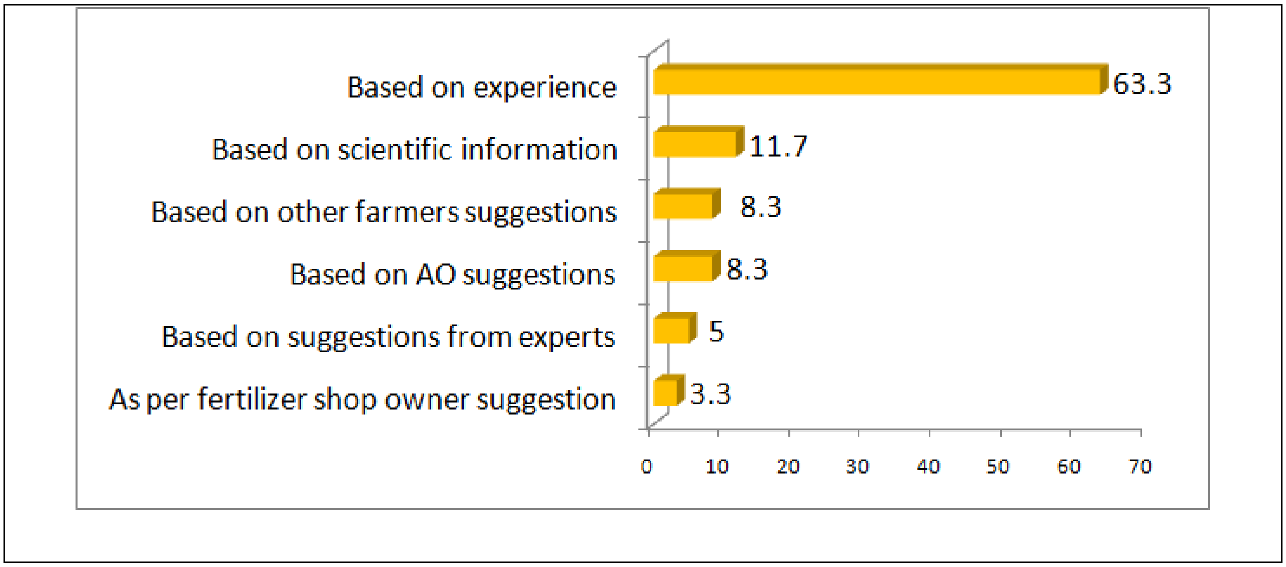


Fig SG 10.8 F1: Percentage of adoption of technology from different agencies

The selection of seeds, fertilizers, pesticides etc by the farmers is still based on their own experience (63 Per cent), while rest of them (36.7 Per cent) take suggestions from Local Agricultural Officers, progressive farmers, scientific bodies, sugarcane experts and fertilizer shop owners. This is one of the major reasons for lower yield of sugarcane in Mandya district and this need to be improved (Table 10.8.1).

SG 10.9: Source of information regarding the process of scientific cultivation

Table SG 10. 9.1: Sources of information for Sugarcanecultivation

	F	Per cent
Adopted from progressive farmers	7	11.7
Based on AO suggestions	3	5.0
Based on experience	26	43.3
Based on other farmers suggestions	4	6.7
Based on scientific information	5	8.3
Based on suggestions from experts	15	25.0
Total	60	100.0

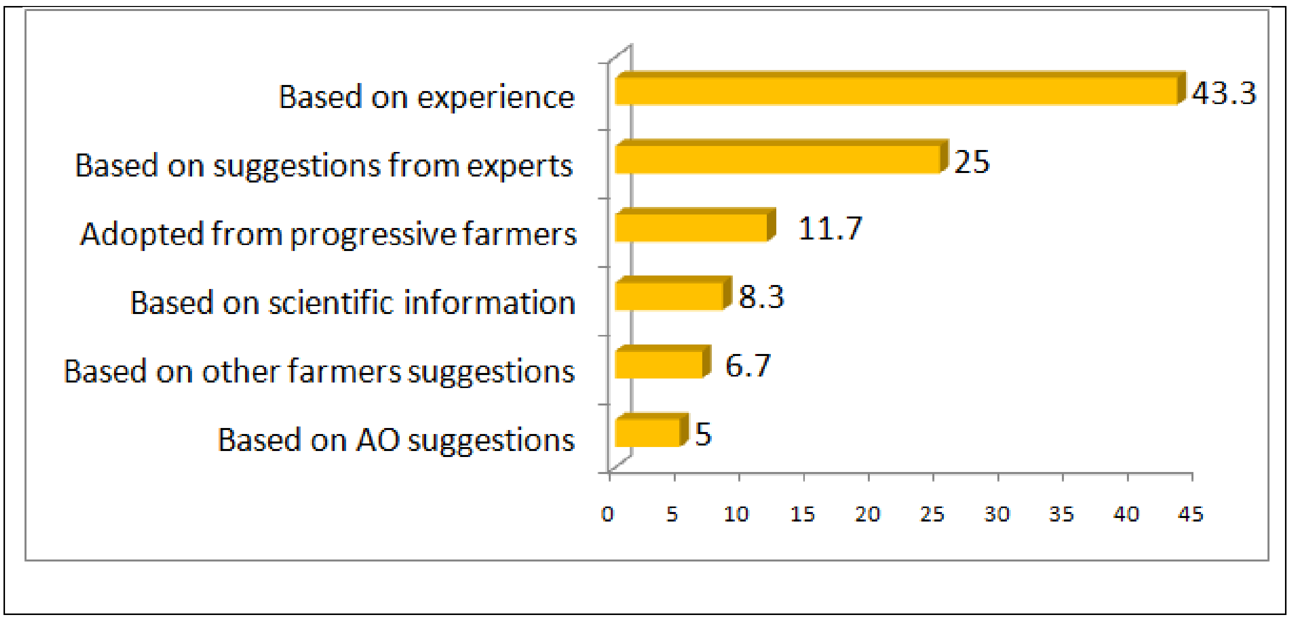


Fig SG 10.9. F1: Sources of information for Sugarcane cultivation

The process of scientific cultivation of sugarcane also followed similar trend where, majority of the farmers (43.3Per cent) grow their sugarcane based on their own experience, while, 25Per cent of the farmers consult sugarcane experts for growing sugarcane (Table SG 10.9.1 & Fig: SG 9 F1).

SG 10.10: The Sugarcane varieties more suitable for jaggery production in the region

Table SG 10.10.1: Sugarcane Varieties that are available at study area for jaggery

Variety	Frequency	Per cent
CO-62175, VCF-0517	1	1.7
CO-62175	3	5.0
CO-62175, CO-86032	27	45.0
CO-62175, CO-86032, VCF-0517	4	6.7
CO-62175, VCF-0517	2	3.3
CO-86032	1	1.7
CO-86032, VCF-0517	2	3.3
CO-86032, VCF-0517,COVI-99463	1	1.7
VCF-0517	1	1.7
VCF-0517, CO-62175	3	5.0
VCF-0517, CO-86032	10	16.7
VCF-0517, CO-86032, CO-419	1	1.7
VCF-0517, CO-86032, CO-62175	3	5.0
VCF-0517, CO-86032,COVE-99463	1	1.7
Total	60	100.0

Among the varieties, majority of the farmers opined that for getting higher cane yield, jaggery recovery and quality jaggery newly released variety VCF 0517 was found to be the best. The next best variety is Co 86032. While, majority of the sugarcane growing farmers in the Mandya district preferred Co 62175, average yielding and low sucrose content variety because of its wider adoptability in all the types of soil and environment (Table SG 10.10.1).

10.11 JPS: A SURVEY ON JAGGERY PROCESSORS FARMERS IN THE STUDY AREA (MANDYA)

Table JP 10.11.1 – Technological Information on Jaggery Processing

Crushing mills		
	Frequency	Per cent
Iron	55	91.7
No Answer	5	8.3
Total	60	100.0

Pre - Boiling		
	Frequency	Per cent
Yes	1	1.7
No	59	98.3
Total	60	100.0

Boiling		
	Frequency	Per cent
Yes	59	98.3
No	1	1.7
Total	60	100.0

Conventional type		
	Frequency	Per cent
Yes	59	98.3
No	1	1.7
Total	60	100.0

Traditional		
	Frequency	Per cent
Yes	4	6.7
No	55	91.7
22	1	1.7
Total	60	100.0

Others		
	Frequency	Per cent
No	60	100.0

Modified		
	Frequency	Per cent
Yes	57	95.0
No	3	5.0
Total	60	100.0

Methods of extraction, Metal used for the extraction		
	Frequency	Per cent
Steel	1	1.7
Iron	59	98.3
Total	60	100.0

Do you weigh the cane before crushing		
	Frequency	Per cent
Yes	60	100.0

Note: JPS: Jaggery Processors SurveyJP: Jaggery Processors

About 50 jaggery processors were surveyed to know the pros and cons of jaggery preparation in Mandya District. The survey revealed that, 91.7 per cent of respondents jaggery units are having Iron crushers. Whereas, 98.3 per cent of jaggery units are having pre-boiling and boiling units. Method of jaggery production is conventional type in 98.3 per cent jaggery units. In 7per cent of the jaggery units, traditional type of furnace is observed while, 95 per cent of jaggery units are having modified furnace especially Uttar Pradesh Model of furnace.

All most all the respondents weigh their cane before crushing. For crushing, 98.3per cent of the jaggery units are having Iron crushers and only one respondent is having Steel roller but not food grade steel. Most of the jaggery makers are using iron crushers because of higher juice extraction efficiency. But, in iron crushers hygiene is not maintained due to frequent rusting. Steel crushers even though they are having hygiene but most of the processor don't prefer because of lower extraction efficiency. (Table JP.10.11.1)

Table JP.10.11.2 – Sources of fuel in processing of jaggery

Fuel wood		
	Frequency	Per cent
Yes	4	6.7
No	55	91.7
22	1	1.7
Total	60	100.0

Bagasse only		
	Frequency	Per cent
Yes	60	100.0

Solar Power only		
	Frequency	Per cent
No	60	100.0

Tyres Tubes, Agriculture waste etc		
	Frequency	Per cent
Yes	26	43.3
No	34	56.7
Total	60	100.0

Mixture of all		
	Frequency	Per cent
No	59	98.3
22	1	1.7
Total	60	100.0

Bio Fuel		
	Frequency	Per cent
No	60	100.0

JP: Jaggery Processing:

All the jaggery units are using baggase as a source of fuel because it is available as by-product after cane crushing. In most of the jaggery units whatever the quantity of bagasse produced is enough for jaggery production. Only about 43.3per cent of jaggery makers are using fuel wood, tyres and tubes, and agriculture wastes (Coconut coir pith, fronds etc.) in addition to bagasse. Because, they still have traditional furnaces and this leads to lower fuel use efficiency.

Hence, the bagasse produced in the jaggery unit become in-sufficient. None of the respondents are using improved fuel sources *viz.*, solar power, bio-fuel *etc. Table JP.10.11.2*

Table JP. 10.11.3 – Striking end point and chemicals used in processing of jaggery

Chemicals used		
	Frequency	Per cent
Yes	56	93.3
No	4	6.7
Total	60	100.0

Organics used		
	Frequency	Per cent
Yes	53	88.3
No	7	11.7
Total	60	100.0

Organics + Chemicals		
	Frequency	Per cent
No	60	100.0

Striking point		
	Frequency	Per cent
Yes	13	21.7
No	47	78.3
Total	60	100.0

Boiling point		
	Frequency	Per cent
Yes	1	1.7
No	59	98.3
Total	60	100.0

Type of juice heating pan		
	Frequency	Per cent
Iron	42	70.0
Steel	18	30.0
Total	60	100.0

Type of pans available around Mandya for preparing jaggery		
	Frequency	Per cent
Iron	40	66.7
Steel	20	33.3
Total	60	100.0

Quality of jaggery which is better in the cont		
	Frequency	Per cent
Without Chemical	60	100.0

Almost all the jaggery Processors (93.3per cent) are using chemicals to impart attractive colour to the jaggery and also to improve the jaggery recovery. Chemicals used in jaggery processing are safolite, decolite, Hydrose, Chakke, Sodium bicarbonate, single super phosphate, urea, sugar kesar, *etc*. In addition to chemicals, 88.3per cent are also using organics clarificants. The important clarificants used by the jaggery makers are, Bhendi stem extract, coconut oil, castor oil *etc.* All the jaggery producers are using both the chemicals and organics. (Table JP .10.11.3)

To know the end point of the jaggery production, All most all the producers are using striking point as a end point of jaggery production and only one respondent is using boiling point as a end point and using thermometer to test the boiling point.

With respect to juice heating pan, 70per cent of the jaggery units are having iron pan and 30per cent of the units are having steel pan. But, steel pans are not food grade steel. For preparation of jaggery in and around Mandya district 66.7per cent of the units are having Iron pan and 33.3 per cent are steel pan.

All the respondents opined that quality of the jaggery is better in chemical free jaggery as compared to chemical jaggery. The jaggery producers are still following packaging of jaggery by using paper box and having awareness about new types of packaging systems.

Table JP. 10.11.4– Sources of moulds used in jaggery preparation

Moulds		
	Frequency	Per cent
Steel	2	3.3
Both	58	96.7
Total	60	100.0

Tin		
	Frequency	Per cent
No	60	100.0

Plastic		
	Frequency	Per cent
No	60	100.0

Organic, Sugarcane leaves		
	Frequency	Per cent
Yes	31	51.7
No	29	48.3
Total	60	100.0

Gunny bag, date leaves		
	Frequency	Per cent
No	60	100.0

More than 95per cent of the respondents are using both tin and wooden moulds in jaggery production. Tin moulds are commonly used to produce bucket jaggery and wooden mould to produce achu bella.

For packaging of the jaggery 51.7per cent of the jaggery makers are using organic sugarcane Trash as a packaging material, while 98.3per cent are using card board or paper boxes as a packaging materials. None of them are using plastic, gunny bags, date leaves, tin *etc.* because of their high cost and also their non-availability. (Table JP.10.11.4)

Table JP.10.11.5– Post Harvest Management of jaggery

Criteria for quality cane?		
	Frequency	Per cent
Age, Appearance	43	71.7
Age, Crop condition	11	18.3
Age, Date of planting	2	3.3
Age variety	3	5.0
Age, Brix, Appearance, Variety	1	1.7
Total	60	100.0

Construction bagasse drying unit		
	Frequency	Per cent
No	60	100.0

Type of testing		
	Frequency	Per cent
No	60	100.0

Cost of testing		
	Frequency	Per cent
No	60	100.0

Parameters to differentiate chemical free/ chemical jaggery		
	Frequency	Per cent
Colour, Taste, Keeping quality	53	88.3
Taste and Colour	6	10.0
Taste,Colour, Saltiness	1	1.7
Total	60	100.0

Keeping quality		
	Frequency	Per cent
1 month - Chemical free	3	5.0
2.5 month, Chemical free	1	1.7
Good in chemical free jaggery	3	5.0
good in organic jaggery	1	1.7
more in chemical free jaggery	7	11.7
One and half month for chemical jaggery	11	18.3
One month for chemical jaggery	32	53.3
Three month, Chemical free	2	3.3
Total	60	100.0

Table JP.10.11.5– Post Harvest Management of jaggery (continued...)

Type of packing of jaggery		
	Frequency	Per cent
A 1 Box	21	35.0
Paper box	34	56.7
Card board	4	6.7
Open	1	1.7
Total	60	100.0

Type of jaggery provided		
No	Frequency	Per cent
Solid	60	100.0

Introduced any new package system		
	Frequency	Per cent
Yes	1	1.7
No	59	98.3
Total	60	100.0

Any value addition due to new package system		
	Frequency	Per cent
No	60	100.0

Tests that can be done at home to check whether the jaggery one is using is chemical free or not		
	Frequency	Per cent
Colour, Taste and Keeping quality	47	78.3
Taste and Colour	13	21.7
Total	60	100.0

None of the respondent is having jaggery quality testing laboratory in jaggery making units, because of high cost involved and limited knowledge regarding jaggery quality testing procedures.

To assess quality of raw material i.e. sugarcane, 71.7per cent of the respondents use cane age and appearance as a criteria for selection. While, 18.3per cent use crop age and crop condition, 5.0per cent use crop age and variety, 3.3per cent use crop age and date of planting and 1.7per cent use crop age, brix readings through hand refractor meter, crop appearance and variety as a criteria for selection of quality cane for jaggery production. (Table JP.10.11.5)

All the respondents are having bagasse drying unit in their jaggery processing unit because bagasse is the major source of fuel and the performance of jaggery unit mainly depends on quantity and quality of bagasse available in the processing unit.

All the respondents felt that, the model chemical free jaggery unit is needed to impart training on production process and to create awareness about benefits of chemical free jaggery among the consumers, processors and traders

53per cent of the respondent opined that colour, taste and keeping quality are the important parameters to differentiate chemical free and chemical jaggery. While, 10per cent indicated taste and colour to differentiate chemical and chemical free jaggery. 1.7per cent respondents opined that salty taste as an indicator to differentiate chemical and chemical free jaggery. (Table JP.10.11.5)

Many of the respondents indicated that keeping quality is more in chemical free jaggery as compared to chemical jaggery. They indicated that chemical jaggery can be stored up to 30-45 days only. Whereas, chemical free jaggery can be stored up to 3-6 months.

For packing of jaggery, more than 95per cent of the respondents used paper box while 1.7per cent transport their jaggery openly. Al most all the jaggery units are producing solid, where as liquid and powder jaggery are being produced to limited extent based on indent from the consumer. (Table JP.10.11.5)

To know whether jaggery is made out of chemical or not in home 78.3per cent colour, taste and keeping quality while, 21.7per cent check taste and colour.

Table JP.10.11.6 – Justification for existence of Jaggery Park in Mandya

Need jaggery park in Mandya		
	Frequency	Per cent
Yes	60	100.0

Justification		
	Frequency	Per cent
Provide training to farmer to upgrade in use of unit	57	95.0
Provide training to farmer to upgrade in use of unit, To improve quality	3	5.0
Total	60	100.0

Jaggery park surrounding hygienic		
	Frequency	Per cent
Yes	60	100.0

According to the opinions of respondents 95per cent of the respondents opined that Jaggery Park established at ZARS, V. C. Farm, Mandya is highly relevant and very much needed to provide training to farmers and to upgrade its use by the respondent was up to only 5per cent and they have expressed that, it is needed to provide training to farmers to upgrade in use of unit only to improve quality of chemical free jaggery. (Table JP.10.11.6)

All the respondents opined that Jaggery Park surrounding is hygienic and maximum hygiene is maintained in crushing, boiling, cooling and moulding units and also in storage. Further they have also informed the survey team that they are in need of more and more technical information on short duration sugar rich verities of sugar cane, improved agronomy practices besides, advance technologies in jaggery processing, value addition and marketing.

Table JP. 10.11.7 - Jaggery processing units at a glance in Mandya district

Number of months in a year extract		
	Frequency	Per cent
4	5	8.3
5	1	1.7
6	7	11.7
7	6	10.0
8	18	30.0
9	2	3.3
Total	39	65.0
System	21	35.0
Total	60	100.0

Time taken for the crushing of one ton cane		
	Frequency	Per cent
30	5	8.3
35	7	11.7
40	14	23.3
45	32	53.3
60	2	3.3
Total	60	100.0

What is cost quality of jaggery per quintal		
	Frequency	Per cent
350	1	1.7
500	2	3.3
550	6	10.0
600	20	33.3
650	27	45.0
700	3	5.0
3300	1	1.7
Total	60	100.0

Most of the crushers in Mandya district are seasonal and they are running 4-9 months in a year. 30per cent of the units run up to 8 months, 11.7 per cent up to 6 months, 10 per cent up to 7 months, 8.3 per cent up to 4 months and only 3.3per cent running up to 9 months in a year.

To crush one tone of cane most of the units take 30-60 minutes depending up on type of crushers, type of motor and availability of labours. Among the units, 8.3per cent take 30 min, 11.7per cent take 35 min, 23.3per cent take 40 min, 53.3per cent take 45 min and 3.3per cent take 60 min. On an average 30-40 minute is enough to crush one tone of cane but in the survey, most of the units have taken 45 minutes due to lower crushing efficiency hence, there is need to improve the crushing efficiency.

The survey indicated that, to produce one quintal of jaggery, jaggery producers are investing 350 to 700 rupees. Among them, 1.7per cent investing 350 Rs., 3.3per cent investing 500 Rs., 10per cent investing 550 Rs., 33.3per cent investing 600 Rs., 45per cent investing 650 Rs., and 5.0per cent investing 700 Rs. The cost of jaggery production mainly depends on crushing efficiency, recovery percentage, labour efficiency etc. (Table JP.10.11.7)

Table JP. 10.11.8 -Economics of jaggery preparation

Solid - Fixed cost - Chemical Jaggery		
	Frequency	Valid Per cent
5500	1	16.7
6000	5	83.3
Total	6	100.0

Solid - Fixed cost - Non Chemical Jaggery		
	Frequency	Valid Per cent
6500	3	50.0
6700	1	16.7
7000	2	33.3
Total	6	100.0

Solid - Variable cost - Chemical Jaggery		
	Frequency	Valid Per cent
5500	4	8.5
6000	23	48.9
6500	12	25.5
7000	6	12.8
7500	2	4.3
Total	47	100.0

Liquid - Fixed cost - Chemical Jaggery		
	Frequency	Per cent
Not Applicable	60	100.0

Liquid - Variable cost - Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Solid - Variable cost - Non Chemical Jaggery		
Cost	Frequency	Valid Per cent
5000	2	4.8
5500	3	7.1
5800	4	9.5
6000	4	9.5
6500	16	38.1
7000	6	14.3
7500	5	11.9
7522	1	2.4
8000	1	2.4
Total	42	100.0

Liquid - Fixed cost - Non Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Liquid - Variable cost - Non Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Table JP.10.11.8 -Economics of jaggery preparation (Continued...)

Powder - Fixed cost - Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Powder - Fixed cost - Non Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Powder - Variable cost - Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Powder - Variable cost - Non Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Higher price ready to pay by trader & consumer		
	Frequency	Per cent
10 to 15	28	46.7
15 >	28	46.7
Above 20	4	6.7
Total	60	100.0

To produce one ton of jaggery 83.3per cent of respondents are investing Rs. 6000 rupees while, 16.7per cent are investing 5500 rupees as fixed cost. To produce one tone of chemical free jaggery, 50per cent investing 6500 Rs., 16.7per cent investing 6700 Rs. and 33.3per cent investing 7000 Rs of fixed cost.

With respect to variable cost, to produce one tone of chemical jaggery 8.5per cent investing 5500 Rs., 48.9per cent investing 6000 Rs., 25.5per cent investing 6500 Rs., 12.8per cent investing 7000 Rs. and 4.3per cent investing Rs.7500, while to produce non-chemical jaggery, 4.8 per cent investing 5000 Rs., 7.1 per cent investing 5500 Rs., 9.5 per cent investing 5800 Rs., 9.5 per cent investing 6000 Rs., 38.1 per cent investing 6500 Rs., 14.3per cent investing 7000 Rs., 11.9 per cent investing 7500 Rs. and 2.4per cent investing 8000 Rs.

The respondents felt that traders and consumers are ready to pay higher price for chemical free jaggery as compared to chemical jaggery. 46.7 per cent ready to pay 10-15 Rs. higher price, 46.7per cent ready to pay >15 Rs. higher price and 6.7per cent ready to pay >20 Rs. higher price. (Table JP.10.11.8)

Table JP. 10.11.9 - Man power requirement for jaggery processor

Solid - Man power - Chemical Jaggery		
	Frequency	Valid Per cent
6	11	22.0
7	8	16.0
8	25	50.0
9	2	4.0
10	2	4.0
12	2	4.0
Total	50	100.0

Liquid - Man power - Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Solid - Man power - Non Chemical Jaggery		
	Frequency	Valid Per cent
6	3	6.5
7	4	8.7
8	20	43.5
9	3	6.5
10	14	30.4
12	2	4.3
Total	46	100.0

Powder - Man power - Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Liquid - Man power - Non Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

Powder - Man power - Non Chemical Jaggery		
No	Frequency	Per cent
Not Applicable	60	100.0

To produce one ton of chemical jaggery, 6-12 labours are required varies from 6-12 members. Among them, 22per cent are using 6 labours, 16% are using 7 labours, 50per cent are using 8 Labours and 4per cent are using 9, 10 and 12 labours. While to produce chemical free jaggery, 6.5per cent using 6 labours, 8.7per cent using 7 labours, 43.5per cent using 8 labours, 6.5per cent using 9 labours, 30.4per cent using 10 labours and 4.3per cent are using 12 labours.(Table JP.10.11.9)

Table JP. 9.11.10 - Sources of energy in processing of jaggery

Amount of energy required for processing one ton sugarcane juice		
	Frequency	Per cent
400	1	1.7
450	2	3.3
500	6	10.0
550	1	1.7
600	6	10.0
650	8	13.3
700	23	38.3
750	11	18.3
800	1	1.7
Total	59	98.3
System	1	1.7
Total	60	100.0

For processing one ton of sugarcane juice, many of the jaggery units are using 400 – 800 kg of bagasse depending up on type of furnace and quality of bagasse. 38.3per cent of the jaggery units are using 700 kg of bagasse, 18.3per cent using 750 kg, 13.3per cent using 650 kg, other 10per cent using 600 kg and 10per cent are using 500 kg of bagasse to process one ton of sugarcane juice. (Table JP.10.11.10)

10.12. JT - A Survey on Experience in Jaggery Trading

Table JT 10.12.1: Since how long in this trade (in years)

	Frequency	Per cent
< 5 yrs	-	-
5 – 10 yrs	8	40
10 - 15 Yrs	4	20
> 15 Yrs	8	40
Total	20	100

Fig JT 10.12 F1: Do you know meaning chemical free jaggery

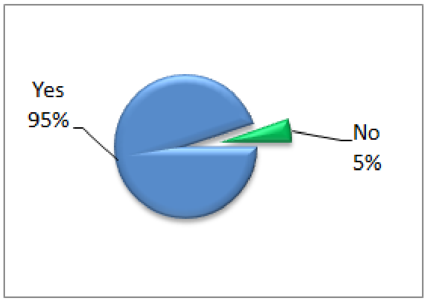


Table JT.10.12 2: Have you undergone training in Jaggery Park? Or importance of jaggery park in Mandya

	Frequency	Per cent
Yes	0	0
No	20	100
Total	20	

JT.10.12. F.2: Relevance of jaggery park in Mandya

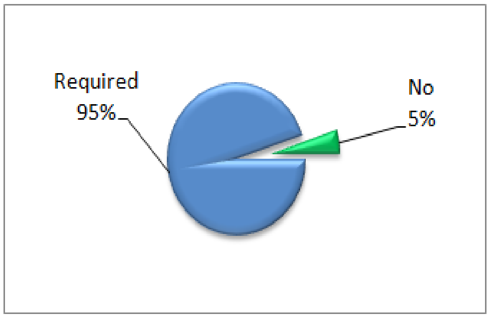


Table JT 10.12.3: Are you member of the jaggery park technical committee?

	Frequency	Per cent
Yes	0	0
No	20	100
Total	20	

Table JT 10.12.4: Number of meetings attended in a year

	Frequency	Per cent
Not Applicable	20	100
Total	20	

Table JT 10.12.5: Are we importing jaggery/ if so from where?

	Frequency	Per cent
Yes	0	0
No	20	100
Total	20	

JT: Jaggery Traders

Basic information on jaggery at Mandya

A Survey of Jaggery traders was conducted to know the status chemical free and chemical jaggery trading in the Mandya District. The survey results revealed that 40 Per cent of the traders are involved in jaggery trading since more than 15 years, while 20 Per cent involved in trading since from 10-15 years and 40 Per cent (Table JT 10.12.1). Most of the jaggery traders (95 Per cent) know about process of chemical free jaggery (Fig JT 10.12.1 F.1). None of the jaggery traders interviewed has undergone training programme on chemical free jaggery processing in Jaggery Park, V. C. Farm, Mandya (Table JT 10.12.2). But, 95 Per cent of the jaggery traders felt that, Jaggery Park situated at V. C. Farm, Mandya is very much essential to create awareness about chemical free jaggery and to provide training to jaggery processor regarding production of chemical free jaggery (Fig. JT 10.12.1.F. 2).

None of the jaggery traders included in the survey are the members of the Jaggery Park Technical committee and they have not attended any meeting at Jaggery Park (Table JT.10.12.3 & JT 10.12.4). All the respondents opined that, the sufficient quantity of jaggery is being produced in the Mandya district and hence, they have not imported any jaggery from neighbouring district (Table JT 10.12.5).

JT .10.13 - Characteristics of Jaggery

Table JT.10.13.1: Solid - Colour– Chemical Jaggery

	Frequency	Per cent
Good	20	100
Solid – Taste- Chemical Jaggery		
OK	3	15.0
Not Good	17	85.0
Total	20	100.0
Solid – Healthy – Chemical Jaggery		
Not Good	20	100.0

Table JT 10.13.3: Solid - Colour– Non Chemical Jaggery

	Frequency	Per cent
OK	18	90.0
Not Good	2	10.0
	20	100.0
Solid – Taste- Non Chemical Jaggery		
Not Good	20	85.0
Solid – Healthy– Chemical Jaggery		
Not Good	20	100.0

Table JT.10.13.2: Powder - Colour– Chemical Jaggery

	Frequency	Per cent
Not applicable	20	100
Powder – Taste- Chemical Jaggery		
Not applicable	20	100.0
Powder – Healthy – Chemical Jaggery		
Not applicable	20	100.0

Table JT 10.13.4: Powder - Colour– Non Chemical Jaggery

	Frequency	Per cent
Not applicable	20	100.0
Powder – Taste- Non Chemical Jaggery		
Not applicable	20	85.0
Powder – Healthy– Chemical Jaggery		
Not applicable	20	100.0

Table JT 10.13.5: Liquid - Colour– Chemical Jaggery

	Frequency	Per cent
Not applicable	20	100
Liquid – Taste- Chemical Jaggery		
Not applicable	20	100.0
Liquid – Healthy – Chemical Jaggery		
Not applicable	20	100.0

Table JT 10.13.6: Liquid - Colour– Non Chemical Jaggery

	Frequency	Per cent
Not applicable	20	100.0
Liquid – Taste- Non Chemical Jaggery		
Not applicable	20	85.0
Liquid – Healthy– Chemical Jaggery		
Not applicable	20	100.0

All the jaggery traders included in the survey opined that chemical jaggery is good with respect to colour, since it is very attractive with yellow to white –yellow colour. While, 85Per cent of the respondents indicated that, the taste is not good since it gives salty taste and 15Per cent of respondents opined that taste is satisfactory. All the respondents felt that chemical jaggery is not healthy because it contains sulphur, prepared under unhygienic condition and even keeping quality is very short (Table JT 10.13.1).

On the contrast, 90Per cent of the respondents indicated that colour of the chemical free jaggery is satisfactory since it is having brown to golden yellow colour, while, 10Per cent of respondents felt that colour is not good. But, all the respondents felt that taste of chemical free jaggery is excellent with good sweetness and is better for health, since it is not having any chemicals (Table JT 10.13.3). All the surveyed traders revealed that, they trade only solid jaggery and not liquid and powder jaggery (Table JT 10.13.5&10.13.2).

JT.10.14.-Taste & Hygienic of Jaggery express by traders in addition to keeping quality

Table JT.10.14.1: Colour - Chemical

	Frequency	Per cent
White Yellow	8	40.0
Yellow	10	50.0
White	2	10.0
Total	20	100.0

Table JT 10.14.2: Colour - Chemical free

	Frequency	Per cent
Black Brown	11	55.0
Brown	8	40.0
Brown to Golden yellow	1	5.0
Total	20	100.0

Table JT 10.14.3: Taste - Chemical

No	Frequency	Per cent
Sweet - Salty	20	100.0

Table JT 10.14.4: Taste - Chemical free

	Frequency	Per cent
Sweet	20	100.0

Table JT. 10.14.5: Storability - Chemical

	Frequency	Per cent
15 days	1	5.0
20 days	4	20.0
25 days	1	5.0
30 days	14	70.0
Total	20	100.0

Table JT 10.14.6: Jaggery park surrounding hygienic, certainly and surely better than the jaggery making units existing in the surrounding area

	Frequency	Per cent
Hygenically maintained	20	100.0

Table JT.10.14.7: Tests that can be done at home to check whether the jaggery one is using is chemical free or not

	Frequency	Per cent
Taste, Colour& Keeping quality	9	45.0
Taste and Keeping quality	11	55.0
Total	20	100.0

Among the respondents, 55Per cent felt that chemical free jaggery is black-brown in colour and 40Per cent respondent that it is brown in colour and hence, colour wise consumers do not prefer this product. Hence, there is urgent need to improve the colour of the chemical free jaggery (Table JT 10.14.2). Taste wise, chemical jaggery is sweet and salty while, chemical free jaggery is sweet in taste (Table JT 10.14.3 and JT 10.14.4).

With respect to storage, 70Per cent of the respondents indicated that chemical jaggery can be stored maximum by 30 days and 20Per cent indicated that the storability is only up to 20 days. While, chemical free jaggery can be stored upto 3 months (Table JT 10.14.5).

All the respondents indicated that, hygiene maintained in and around the Jaggery Park, Mandya is certainly and surely better than the jaggery making units existing in the surrounding area (Table JT 10.14.6).

To test whether jaggery is chemical or chemical free at home, 55Per cent respondents test taste and keeping quality while, 45 Per cent in addition to above parameters also test colour of the jaggery (Table JT 10.14.7).

JT 10.15 - Marketing, supply change system

Timely Delivery - Chemical

No	Frequency	Per cent
Yes	20	100.0

Timely Delivery - Chemical free

No	Frequency	Per cent
Yes	20	100.0

Adequate supply - Chemical

No	Frequency	Per cent
Yes	20	100.0

Adequate supply - Chemical free

No	Frequency	Per cent
Yes	20	100.0

Demand from consumer - Chemical

No	Frequency	Per cent
Yes	20	100.0

Demand from consumer - Chemical free

No	Frequency	Per cent
Yes	20	100.0

The survey data revealed that ample of credit facilities are available for trading both chemical and chemical free jaggery. There is a great demand in the market for chemical jaggery as compared to chemical free jaggery. Which is having dull golden brown colour with good keeping quality and good for human health. There is an adequate supply of both chemical and chemical free jaggery in the market based on supply and demand.

Basically, the demand for chemical jaggery has been created by traders and consumers based on its attractive white /yellow shining colour on the contrary the quality of jaggery processed out of using chemicals is having ill effect on health and there is a need for policy to ban the / stop processing of such jaggery wherever they are using industrial chemicals like safolite.

10.16. A SURVEY ON JAGGERY CONSUMERS IN THE STUDY AREA (MANDYA)

Socio economic status of the respondents

Table JC.10.16.1:Age group of the respondents

Age Group	Frequency	per cent
< 30 Yrs	13	26.0
30 – 40 Yrs	18	36.0
40 – 50 Yrs	8	16.0
> 50 Yrs	11	22.0
Total	50	

Table JC.10.16.2: Occupation of the respondents

	Frequency	per cent
Agriculturists	15	30.0
Employed	27	54.0
Business	0	0.0
Home makers/Students	8	16.0
Total	50	

Table JC.10.16.3: Educational Status of the respondents

	Frequency	per cent
Primary	2	4.0
Higher Secondary	11	22.0
PUC	3	6.0
Graduates	15	30.0
Post Graduates	16	32.0
Ph.D	3	6.0
Total	50	

Table JC.10.16.4: Dry Land

	Frequency	per cent
No dry Land	38	76.0
< 1.0 acres	1	2.0
1.0 – 2.00 acres	8	16.0
2.0 - 3 acres	1	2.0
> 3 acres	2	4.0
Total	50	

Note: JC = Jaggery Consumer

About 50 jaggery consumers were surveyed to know their preferences about the jaggery consumption. Most of the respondents are middle aged with 26per cent below 30 years, 36per cent between 30-40 years, 16per cent between 40-50 and 22per cent more than 50 years (Table JC.10.16.1). Among the consumers, 54per cent are employed and 30per cent are agriculturist (Table JC.10.16.2). While, the educational status of the respondents indicated that 62per cent of the consumers are graduates and 28per cent of the respondents have completed higher secondary/PUC (TableJC.10.16.3). Majority of the respondents are not having dry land (76 per cent) while, 24per cent of the consumers are having dry land, but among them majority of respondents (16 per cent) are having only 1-2 acres of land (TableJC.10.16.4).

JC.10.17: Awareness level about the chemical free jaggery & Jaggery Park among respondents

Table JC 10.17.1: Since how long you know this product (yrs)

	Frequency	per cent
< 2 yrs	2	4.0
2 – 4 yrs	29	58.0
4 - 6 Yrs	15	30.0
> 6 Yrs	4	8.0
Total	50	100

JC 10.17.1 F.1: Awareness of the jaggery park

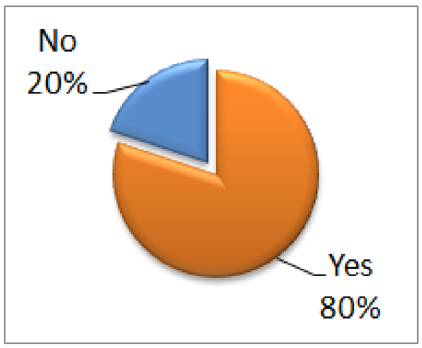


Table JC 10.17.2: How do you know the jaggery park?

	Frequency	per cent
Working in ZARS, Mandya	9	18.0
Working in Agriculture College, Mandya	3	6.0
Was working in Jaggery park	8	16.0
Visited during krishimela	6	12.0
Know by neighbours and friends	6	12.0
Others	18	36.0
	50	100

Table JC 10.17.3:Park is ideally located?

	Frequency	per cent
Yes	16	32.0
No Answer	34	68.0
Total	50	100

All the consumers are having awareness about chemical free jaggery/organic jaggery. Out of them, 58per cent of consumers know about this project since 2-4 years, 30per cent from 4-6 years, 8per cent from > 6 years and 4.0per cent from <2 years (Table JC 10.17.1). While, 80per cent of the respondents are aware about jaggery park situated at V C Farm, Mandya (JC 10.17.1 F1), because most of them working in ZARS, V C Farm, Mandya , College of Agriculture, V C Farm, Mandya and jaggery park. Others have visited jaggery park during Krishimela and about 48per cent know from the neighbours, friends and others (Table JC 10.17.2). About 32per cent of the respondents opined that jaggery park is ideally situated while, 68per cent of the respondents have not given their response (Table JC 10.17.3).

JC.10.18.: Difference between the chemical free and chemical jaggery with respect to colour, health and taste.

3.1 *Chemical Jaggery*

Table JC 10.18.1: Solid – Colour

	Frequency	per cent
Good	50	100
Solid – Taste		
OK	19	38.0
Not Good	31	62.0
Total	50	100.0
Solid – Healthy		
Not Good	50	100.0

Table JC 10.18.2 : Powder Jaggery

Powder – Colour		
	Frequency	per cent
OK	1	2.0
Not Applicable	49	98.0
	50	
Powder– Taste		
Not Good	1	2.0
Not Applicable	49	98.0
Total	50	100.0
Powder – Healthy		
Not Good	1	2.0
Not Applicable	49	98.0
Total	50	100.0

Table JC 10.18.3 Liquid Jaggery

Liquid – Colour		
	Frequency	per cent
Not Good	1	2.0
Not Applicable	49	98.0
	50	100
Liquid – Taste		
Not Good	1	2.0
Not Applicable	49	98.0
Total	50	100.0
Liquid – Healthy		
Not Good	1	2.0
Not Applicable	49	98.0
Total	50	100.0

10.19 ChemicalFree Jaggery

Table JC 10.19.1: Solid – Colour

	Frequency	per cent
Ok	48	96.0
Good	1	2.0
Not Good	1	2.0
Total	50	100.0
Solid – Taste		
OK	1	2.0
Good	49	98.0
Total	50	100.0
Solid – Healthy		
OK	2	4.0
Good	48	96.0
Total	50	100.0

Table JC 10.19.2 Poweder Jaggery		
Powder – Colour		
	Frequency	per cent
Good	1	2.0
Not Applicable	49	98.0
	50	
Powder– Taste		
Good	1	2.0
Not Applicable	49	98.0
Total	50	100.0
Powder – Healthy		
Good	1	2.0
Not Applicable	49	98.0
Total	50	100.0

Table JC 10.19.3 Liquid Jaggery

Liquid – Colour		
	Frequency	per cent
Good	1	2.0
Not Applicable	49	98.0
	50	
Liquid – Taste		
Good	1	2.0
Not Applicable	49	98.0
Total	50	100.0
Liquid – Healthy		
OK	1	2.0
Not Applicable	49	98.0
Total	50	100.0

Among the jaggery products, majority of the consumers responded that they know about only solid jaggery and only few of them are having awareness about liquid jaggery and powder jaggery. In solid jaggery the colour is good in chemical jaggery with yellow to white colour. While it is satisfactory to not good in chemical free jaggery with brown to black colour. While, the taste is good with sweetness in chemical free jaggery whereas the taste of chemical jaggery is not good due to higher salt and sulphur content. With respect to healthiness, chemical free jaggery found to be good as compared to chemical jaggery because it is free from all the chemicals (Table JC.10.19.3 &JC 10.19.1).

JC 10.20: Consumption pattern of jaggery among the consumers

Table JC 10.20.1: Quantity of Annual consumption of jaggery (in kg)

	Frequency	per cent
< 10	3	6.0
10 – 20	34	68.0
20 - 30	8	16.0
30 - 40	3	6.0
> 40	2	4.0
Total	50	100

Table JC 10.20.2: Amount of Annual consumption of jaggery (in Rs)

	Frequency	per cent
< 500	2	4.0
500 - 1000	31	62.0
1000 - 1500	11	22.0
1500 - 2000	4	8.0
> 2000	2	4.0
Total	50	100

About 68per cent of the respondents consumed about 10 to 20 kg jaggery per year, 16per cent consumed 20 to 30 kg, 6per cent consumed 30 to 40 kg and 6per cent consumed less than 10 kg of jaggery per year (Table JC 10.20.1).

About 62per cent of the respondents spent 500 to 1000 Rs. For purchase of jaggery per annum, 22per cent spent 1000 to 1500 Rs. 8per cent spent 1500 to 2000 Rs.4per cent spent more than 2000 Rs. And 4per cent of the respondent spent less than 500 Rs.(Table JC 10.20.2).

JC 10.21.: Marketing and price level of the chemical free jaggery

JC 9.21 F1: Source of purchasing

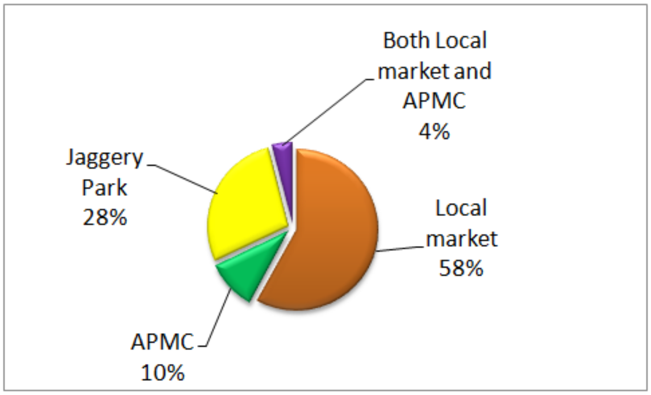


Table JC 10.21.1: Type of jaggery Purchased

	Frequency	per cent
Solid	50	100

Table JC 10.21.2: Extra price willing to pay for chemical free jaggery

	Frequency	Per cent
10 to 15	23	46.0
15 to 20	17	34.0
Above 20	10	20.0
Total	50	100.0

Table JC 10.21.3: Reason for willing to pay more price for chemical free jaggery

	Frequency	Per cent
Health	50	100.0

Table JC 10.21.4: Jaggery park surrounding hygienic

	Frequency	Per cent
Hygienically maintained	46	92.0
Nil	4	8.0
Total	50	100.0

About 58per cent of the respondents purchased chemical free jaggery from local market, 28per cent from Jaggery Park, 10per cent from APMC and 4per cent from both local market and APMC (JC 10.21 F1.). All the respondent purchased only solid jaggery in the market due to non availability of liquid and powder jaggery in the market (Table JC 10.21.1).

The chemical free jaggery is the most preferred among the respondents because of its quality and health benefits hence, they are willing to pay extra prize for chemical free jaggery. Among them 46per cent willing to pay Rs 10 to 15, extra price, 34per cent willing to pay15 to 20 Rs. and 20per cent willing to pay above 20 Rs. As extra price to chemical free jaggery (Table JC 10.21.2 to 10.21.3).

About 92 per cent of the respondents opined that jaggery park hygiene has been maintained in the surrounding of crushing units, processing and storage premises of the jaggery park. (Table JC 10.21.4).

JT 10.22. - Jaggery trading

Fig JT 10.22. F 1: Does there is progressive commission?

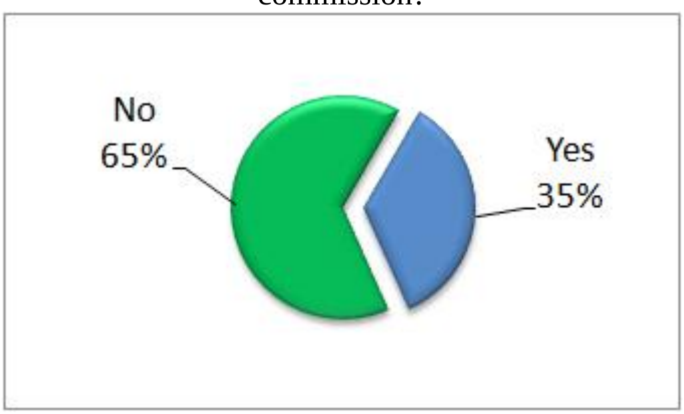


Table JT 10.22.1: Incentive are provided to trader (Per cent)

Percentage	Frequency	Per cent
1.5	1	5.0
2	11	55.0
2.1	1	5.0
2.5	7	35.0
Total	20	100.0

Table JT 10.22.2: Price – Chemical Jaggery

	Frequency	Per cent
Low	20	100.0

Table JT 10.22.3: Price - Chemical free Jaggery

	Frequency	Per cent
High	20	100.0

Table JT 10.22.4 :Credit facility – Chemical Jaggery

	Frequency	Per cent
Yes	20	100.0

Table JT 10.22.5: Credit facility - Chemical Free Jaggery

	Frequency	Per cent
Yes	20	100.0

About 65 per cent of the traders expressed that there is no progressive commission on sale of jaggery at APMC Yard. Besides its also observed that there is no incentive to any traders for disposal of jaggery. However, they have expressed that the chemical free jaggery is having an edge over chemically processed jaggery and there is no differentiation for credit facility to trade either of jaggery. Fig JT10.22 F.1

JT 10.23 - General information on sugarcane & Jaggery by traders

Table JT 10.23.1: Any other information on Sugarcane and Jaggery

	Frequency	Per cent
Chemical jaggery rate it ranging 35-36 Rs	1	5.0
Cost Rs 35-36 per kg, Packing jaggery by cover A-1 box	1	5.0
In case of organic jaggery marketing sale problem no one should take because of colour	1	5.0
Jaggery is packing by plastic covers, for bucket jaggery, Acchu - paper box	1	5.0
Jaggery rate - 35 Rs per 1 kg of chemical jaggery	1	5.0
Marketing problem in organic jaggery	1	5.0
Marketing problem in organic jaggery so, we are not going to rate	1	5.0
Organic jaggery have marketing problem	1	5.0
Organic jaggery is produced in limited extent based on indent	1	5.0
Organic jaggery is rate problem	1	5.0
Organic jaggery it produced in limited extent based on indent, Rate for chemical - 35-36 Rs	1	5.0
Organic jaggery Rs.40 per kg, Chemical jaggery 35-40 per kg	1	5.0
Per kg of chemical jaggery is 35-36 Rs, Only solid, bucket jaggery is made	1	5.0
Powdered and liquid jaggery are produced and traded in limited extent based on indent	1	5.0
Powdered jaggery and liquid jaggery are produced in limited extent based on indent	1	5.0
Rate of chemical jaggery it 34-36 Rs, Chemical free is 35-40 Rs	1	5.0
Rate ranging from 35-36 Rs	1	5.0
There is a too much of marketing problem in organic jaggery	1	5.0
Total	20	100.0

Many of the traders felt that demand for chemical free and organic jaggery is very meager because of unattractive colour and also due to higher price. The normal price for chemical jaggery is Rs. 35 per kg, while for organic or chemical jaggery it is around 60-70 Rs./kg. Most of the consumers preferred solid bucket shaped jaggery because of easy transportation. While, liquid and powder jaggery are processed to a limited extent based on indent from the consumers (Table JT 10.23.1).

JT 10.24 - Stratergies of Jaggery marketing

Table JT 10.24.1: Production, sale and utilization pattern of powdered jaggery, liquid jaggery and jaggery made into unique shapes

	Frequency	Per cent
Bucket jaggery - maximum extent	1	5.0
Bucket jaggery - more production	1	5.0
Bucket jaggery - more production, Acchubella-Small extent	1	5.0
Bucket jaggery - more production, Acchubella - small extent	1	5.0
Cube and box shapes jaggery are having high demand	1	5.0
Only solid jaggery is trading	1	5.0
Solid jaggery	11	55.0
Solid jaggery - Bucket, Shapped and cube shaped	1	5.0
Solid jaggery, Powdered jaggery-Limited extent	1	5.0
Solid-cube shaped bucked shaped	1	5.0
Total	20	100.0

Table JT10.24.2: Strategies adopted in creating demand for CFJ

	Frequency	Per cent
Need to creare awareness about organic jaggery	1	5.0
Need to create awareness about chemical free jaggery	2	10.0
Need to create awareness among consumers regarding chemical free jaggery	1	5.0
Need to create awareness among the consumers regarding chemical free jaggery	3	15.0
Need to create awareness among the consumers regarding organic jaggery	1	5.0
Need to create awareness in organic jaggery	1	5.0
Need to create demand for organic jaggery (Chemical free jaggery)	6	30.0
Need to extend market for chemical free jaggery	5	25.0
Total	20	100.0

Table JT 10.24.3: How you know jaggery park

	Frequency	Per cent
By business partner	1	5.0
By business partners	1	5.0
From business partners	5	25.0
From friends	3	15.0
From, friends	1	5.0
Not known	1	5.0
Visited jaggery park	7	35.0
Yes by friend	1	5.0
Total	20	100.0

At present there is a high demand for solid jaggery especially bucket shaped and cube shaped jaggery (Acchubella). While, liquid and powdered jaggery are prepared and sold to a limited extent based on indent (Table JT 10.24.1).

According to the respondents, strategies to be adopted to create demand for chemical free jaggery among the consumers are, need to create awareness about ill effects of chemical jaggery on human health, benefits of chemical free and organic jaggery among the consumers, need to train the jaggery processor regarding production of chemical free and organic jaggery and need to extend the market for chemical free jaggery (Table JT 10.24.2).

Many of the jaggery traders are having awareness about the Jaggery Park situated at V. C. Farm, Mandya. Among them 35Per cent visited jaggery park, 30Per cent know the jaggery park from business partners, and 15Per cent know about the park by friends (Table JT 10.24.3).

10.25. Observations on the visit to Public Sector units:

1. **Crop Production:** All the 3 Public Sector Institutions have standardized the Package of Practices (POP) for Crop Production i.e wider spacing, fertilizer dose, Drip Irrigation, inter cropping,but still the technology though good for enhancingthe productivity in sugarcane, their overall adoptability is yet to reach the farming community and there is a gap of about 75-80 per cent in the Transfer of technology and needs further strengthening by the line departments in order to take forward these beneficial technologies(Table No. 10.25.1)

2. **Soil Type:** Soils of Mudhol, Sankeshwar and Khollapur are medium black to clay loam which are highly fertile and highly suitable for growing Sugarcane and promote high juice quality. On the contrary, though the soils of Mandya region are equally suitable for sugarcane cultivation, they are medium to low in fertility and yield very low juice quality and recovery. (Table No. 10.25.1)

3. **Sugarcane Varieties:** The Sugarcane Varieties released by UAS(B), UAS(D) and RSJRS, Khollapur are having high sugar content suitable for jaggery processing. However,, when observed in the field, the Transfer of Technology (TOT) is only to the tune of 20-25 per cent and there is a gap of 75-80 per cent and much more needs to be carried out in taking this technology to the farmers in order to enhance the profitability of Jaggery farmers. as the quality of juice is dependent on cane varieties besides soil factors. (Table No. 10.25.1)

4. **Jaggery Processing:** The Jaggery Processing units established in all the Public Sector institutions have been established by following appropriate standards as recommended by IISR, Lucknow. The Equipments have been fabricated with steel (Food grade SS 304). The entire process of crushing, extraction, filtration, design of furnace, Juice concentration, cooling pit, determining striking point, pedaling/stirring, moulding and packing have been standardized by the respective institutions as per the local requirements. (Table No. 10.25.1)

5. **Jaggery Recovery:** The Jaggery recovery ranges from 10-12 per cent in northern parts of Karnataka while it was 9.5 - 11 per cent which was low in Southern Karnataka. The benefit of congenial weather parameters favouring high sugar accumulation in Northern parts is evident

as compared to Mandya region. However, the productivity in Mandya could be better utilized for processing of Jaggery all round the year which is unique to this region.

6. **Cost of Jaggery processing:** Cost of Processing of Jaggery is almost same in Khollapur and Northern part of Karnataka (Rs.650 to 700/q) while it was Rs.700/q in South parts of Karnataka.

7. **Hygiene:** Jaggery is a sweetener directly consumed by people and needs to have if most hygiene during the course of processing. it was surprising to note that all these institutions though have good hygiene standards still need improvement specifically during the course of packing and storage.In spite of higher processing charges it is observed that there is inadequacy of skilled man power in Mandya region compared to Northern parts of the state and Khollapur and this needs to be looked in to by Jaggery park scientists to train the Jaggery processers appropriately.

8. **Storage:** More research is needed on Storage of Jaggery. The storage facility created at jaggery parks of Mandya as well as Mudhol & Sankeshwar needs to be strengthened.

Table 10.25.1: Visit to public sector jaggery units in (UAS (Dharwad), RSJRS Kolhapur (MPKV, Rahuri) UAS (Bangalore), during 2017

Sl. no.	**Protocols / Places**	**UAS (D) Mudhol**	**UAS (D) Sankeshwar**	**RSJRS Kolhapur MPKV Rahuri**	**UAS (B) Mandya**	**Still there is a need for improvement in relation to spacing, fertilizer management and irrigation schedules in order to improve the yield & quality of cane through intercropping (enhanced profits) & wider spacing, Development of Agro techniques for mechanization sustainable practices of cane production**
A.	**CROP PRODUCTION**					
	Cultivation Practices					
1	**Spacing**	Annexure - 1	Annexure - 1	Annexure - 2	Annexure - 3	
2	**Fertilizer dose**	Annexure - 1	Annexure - 1	Annexure - 2	Annexure - 3	
3	**Inter cropping**	Annexure - 1	Annexure - 1	Annexure - 2	Annexure - 3	
4	**Drip irrigation**	Annexure - 1	Annexure - 1	Annexure - 2	Annexure - 3	
5	**Soil Type**	**Fertile black cotton soil**	**Light to deep black cotton soil**	**Light to deep black cotton soil**	**Red sand loam soils**	**Northern Karnataka & Kolhapur soils are favourable for better crop stand, yield and recovery .**
B	**CROP IMPROVEMENT**					
1	Varieties	Co 86032, CoSnK 7339, Co 91010 CoSnk 05101, CoSnk 05103	Co 86032, CoSnK 7339, CoC 671, Co 94012, CoSnk 05101 CoSnk 05103	Co 86032, Co 92005, CoM 0265*	Co 86032, Co 92005, Co 62175, Co 8371, VCF 0517, Co 7804	Co 92005 is low cane yielder. Still there is a gap though majority of cane varieties grown are sugar rich. However,, there is a need for short duration quality cane varieties with high sucrose for jaggery making
C	**POST HARVEST MANAGEMENT**					
1	Harvesting	Manual	Manual	Manual	Manual	In all the four places it is the practice of manual harvesting of cane which is detrimental in terms of quality of cane & recovery. More important by labour scarcity high cost of harvesting. Needs some more research in this

						direction
2	Duration (Months)	10-12, 12-14	10-12, 12-14	12-13.	12-16.	Short duration, high quality, cane varieties are needed to meet the requirement of all the planting seasons & supply of quality cane through out the year
3	Yield kg/ton of sugarcane	110-120	110-120	110-120	95-100	High jaggery yielding varieties, with higher purity in Northern Karnatak than Southern Karntaka, which are normally lower in jaggery recovery.
4	Jaggery Processing - Hygiene maintained	Steel SS 304	Steel SS 304	Steel SS 304	Steel SS 304	At all the four places, jaggery is processed as per recommaneded package of practices of IISR, Lucknow. However,, as per the international standards, preparation of jaggery through open pan is not advisable as it results in caramalization & carsinoginic for human consumption, Hence, steps shoud be initiated to shift towards preparation of jaggery by steam based jaggery preparation which is economical and viable in terms of quality, hygiene and enviorment. steam based jaggery boiling unit establishment at ZARS, Mandya is at final stage of testing which ensures higher heat efficiency, better hygienic, no caramalisation of juice and better quality of jaggery

5	Crushing duration (days)	90-120	90-120	60	90-120	
D	**JUICE EXTRACTION**					
1	Mill	SS 304 Steel Horizontal 3 rollers	SS 304 Steel Horizontal 3 rollers	SS 304 Steel Horizontal 3 rollers	SS 304 Steel Horizontal 3 rollers	Good quality. Since no iron contamination
2	Juice pH	4.8-5.3	4.8-5.3	5.2-5.4	4.8-5.2	Northern Karnataka juice requires less lime, At Mandya, requires more lime adding to the cost.
3	Furnace	Improved	Improved	Improved	Improved	Fuel efficient
4	Sources of fuel	Only Bagasse	Only Bagasse	Only Bagasse	Only Bagasse	Fuel efficient
5	Heat Loss (^{0}C)	250-300	250-300	250-300	250-300	Minimum loss, needs more research - Multi pan furnace for better heat efficiency
6	Structure of chimney	Scientific	Scientific	Scientific	Scientific	Better combustion, improved heat effeciency
7	Collection tank Steel/Iron	SS 304	SS 304	SS 304	SS 304	
8	Filtration: Primary - Secondary	Yes	Yes	Yes	Yes	
9	Pre Boiling	No	No	No	No	
10	Pan - Furnace pan and furnace improved	SS 304 steel pan, open	SS 304 steel pan, open	SS 304 steel pan, open	SS 304 steel pan, open	Improved furnace - IISc model. Still scope for improvement of furnace with respect to increase in fuel efficiency by bricketing of beggasse. Triple pan furnace is admisable under Southern Karnataka conditions for better clarification of juice for good quality jaggery
11	Clarificants - Chemicals -	Lime	Lime	Lime	Lime	To prepare chemical free jaggery, to impart

						good colour to jaggery
	Herbal -	Bhendi stem mucilage	Bhendi stem mucilage	Bhendi stem mucilage	Bhendi stem mucilage	
12	Striking points	115-118^0 C	115-118^0 C	115-118^0 C	115-118^0 C	Is determined by brix and real time thermo meter
13	Cooling pit	Exists, Granit Stone	Exists,Granit Stone	Exists, Kadapa Stone	Exists, Granit Stone	Granite cooling pit for hastening of cooling process
14	Moulds	Wooden, Tin	Wooden, Tin	Wooden, Tin	Wooden, Tin	Normally jaggery is moulded in wooden/tin mould resulting in contamination of cellulose/ tin. Needs further research
15	Storage	Facilities exist	Facilities exist	Facilities exist	Facilities exist	Good at all the places.
16	Packing - Shrink wrapping	Exists	Exists	Exists	Exists	Polythin food grade packing material used. Still needs further research on packing materials
17	Cost / qt jaggery (Lump)** including cane cost.	4000	4200	4250	4557	Mudhol, Sankeshwar & Kolhapur are almost similar At mandya it is due to lower jaggery recovery
18	Jaggery recovery per centage	11-12.	11-12.	11-12.	9.5 - 10.50	In case of continuation of open pan system of jaggery preparation, smaller size pans for easy workability may be designed. Automatic scum removal mechanisam is needed.
19	Juice Recovery %	55-60	60-65	55-60	55-60	Still scope to increase recovery, same as extraction
20	Pan material	SS 304 Steel	SS 304 Steel	SS 304 Steel	SS 304 Steel	Hygienic, less caramalisation
21	Pan No.	Two pans	Two pans	Two pans	Two pans	Higher recovery of jaggery, more jaggery

						yield
22	Boiling & Paddling	Manual	Manual	Manual	Manual	-
23	Crystal sugar used	Not used	Not used	Not used	Not used	-
24	Installed Jaggery production q/day capacity	25	20	25-30	20	Higher quality jaggery production per day compered to farmers units
25	Hygiene	Most hygienic condition	Most hygienic condition	Most hygienic condition	Most hygienic condition	
26	Storage & Transportation jaggery	storage facilities available	storage facilities available	storage facilities available	storage facilities available	Needs modification. Research on storage studies needed.
27	Jaggery price Rs./kg	45	45	55	60	

* Good for waterlogged conditions

** Manual harvesting increased cost of harvesting & reduced sugar yield and quality. Include sugarcane cost

* Note that the jaggery recovery of varieties - Co 62175- 95 kg, VCF 0517- 110 kg, Co 86032- 100 kg, Co419 - 90kg.

Hygeinic jiggery processing Plant at RSJRS Kolhapur

Sugarcame crushing and jiggery processing at Kolhapur(Farmers field)

10.25.2 Jaggery processing at farmers unit of Belgaum and Khollapur District during 2017

An overview (Summary)

Crop Production: The farmers of Belagavi and Khollapur have not fully adopted the Package of Practices for sugarcane cultivation i.e spacing wider (5´ row´ or 4´ row), fertilizer dose, surface irrigation and inter cropping. it was observed across the fields that the farmers have adopted only 20 per cent of the technology and still there is a gap of 80 per cent in the field of crop production.

The soils of both the places are light black loamy which are highly suitable for cultivation of sugarcane which results in high Sucrose accumulation.

Crop Improvement: The farmers at both the places have adopted cultivation of improved sugar rich varieties in the field. However,, there is need for short duration sugar rich varieties (10 months) suitable for planting in different seasons to meet the Jaggery requirement all round the year.

Post harvest Management: It is a known fact that the juice quality and recovery are dependent on post harvest management of cane. Inboth the places the post harvest technology adopted in sugarcane procurement is highly appreciable with quick transport from the place of harvesting to processing unit so that cane quality deterioration is prevented leading to high juice quality and jaggeryrecovery.

On the contrary they have failed to provide shelter/shade to the staling cane from sun leading to loss of cane weight, juice quality & recovery.

With regards to crushing efficiency, though the farmers have used high quality cane, mills are made of horizontal rollers made of mild steel/Iron resulting in metal iron contamination and affecting the quality, recovery and yield of Jaggery. Hence, this needs to be looked in to in order to enhance juice extraction from the existing 55-60 per cent to 60-65 per cent.

The Juice Quality: The quality of juice was good with higher brix of 18-20 and pH range of 5.8 to 6.2 indicating the goodness of the juice. Besides, it also requires less quantity of lime to neutralize the pH which would have resulted in inversion of sugars leading to poor quality jaggery. Consequently good quality of juice has facilitated in reducing the lime requirement for processing of jaggery. Further, it was alarming to note that the juice collection tanks were located in a shabby place with unhygienic conditions. This needs to be looked in to by the concerned departments.

Furnace & Heating: The Design of heating furnace, source of fuel, and structure of Chimney in all the processing units are of poor and unscientific standards leading to energy loss and improper/execess of heating of juice leading to caramilization and adding to the cost of production as the fuel demand increases. Besides, there is heavy loss of heating which could have been better utilized for primary heating of juice or drying of bagasse. Hence, there is gap of 40-50 per cent in transfer of technology and needs to be addressed by the Institution.

Pan materials: it was observed that in all the places in Northern Karnataka as well as Kolhapur (MH) the farmers have been using single pan made of mild steel/Iron with a motorized stirring/ peddling at Kolhapur while it was manual in Mudhol & Sankeshwar. As it is a known fact that open pan evaporation results in caramalization and contamination and needs to be replaced with food grade steel. Further pedalling with motorized unit will reduce labour cost besides preventing spilling over of juice, little extent and controlling of temperature to a greater extent. However, there is still scope to improve this technology.

It was observed that in almost all the processing units chemical as well as herbal clarificants were used liberally and needs to be regulated by the concerned authorities.

Jaggery recovery and production: At all places the Jaggery production per day ranged from 7 to 8q with a mean recovery % of 10-12% range besides there was very little difference from among varieties with Jaggery recovery Kg/ton which ranged from 110-120 Kg. However, there is still scope to improve productivity and recovery.

Table 10.25.2 Jaggery Processing at Farmer's Jaggery Units of Belgam & Kolhapur District during 2017

A.	CROP PRODUCTION	Mudhol	Sankeshwar	Bhuye	Bhuyegao	Kolhapur	Indrapur	Shiye	
	Spacing	4'	4'	4'	4'	4'	4'	4'	Wider Spacing has been accepted, practice of imbalanced fertilization is in practice. Still there is a gap of 50 per cent intercropping and Drip Irrigation
	Fertilizer dose	Imbalanced	Imbalanced	Imbalanced	Imbalanced	Imbalanced	Imbalanced	Imbalanced	
	Inter cropping	50 per cent	50 per cent	50 per cent	50 per cent	50 per cent	50 per cent	50 per cent	
	Drip irrigation	50 per cent	50 per cent	50 per cent	50 per cent	50 per cent	50 per cent	50 per cent	
	Soil Type	Light black to deep black cotton soil	Light black to deep black cotton soil	medium black & silt loam black soils	Black & silt loam black soils	Black & silt loam black soils	Black & silt loam black soils	Black & silt loam black soils	Grand growth of cane and quality juice
B	**CROP IMPROVEMENT**								
2	Cane Varieties	Co 91010 (ML), Co 7680, Co 86032 (ML), CoC 671 (E), CoSNK 07339 (ML) & CoSNK 812 (ML)	Co 91010, Co 7680, Co 86032, CoC 671, CoSNK 07339 and CoSNK 812	Co 86032, Co 92005	Co 86032, Co 92005	Co 86032, Co 92005	Co 86032, Co 92005	Co 86032, Co 92005	Sugar rich varieties. Good juice purity, ideal for jaggery. Research is needed to suit seasonal variations
3	Harvesting - Duration months	12-13.	12-13.	10-12.	10-12.	10-12.	10-12.	10-12.	Need more short duration varieties & Tissue culture technology to reduce duration & around the year planting of disease free sugarcane
C	**POST HARVEST MANAGEMENT**								
3 (a)	Mode of Transporation	Tractor	Tractor	Tractor	Tractor	Tractor	Tractor	Tractor	Leads to loss in weight and loss of juice quality
4	Cane Stalling	Open air	Open air	Open air	Open air	Open air	Open air	Open air	Exposed to sun, cane drying,

									results in low recovery
D	**JUICE EXTRACTION**								
5	Crushing mill	Horizontal roller, Iron	Horizontal roller, Iron	Horizontal roller, Iron	Horizontal roller, Iron	Horizontal roller, Iron	Horizontal roller, Iron	Horizontal roller, Iron	3 horizontal rollers Iron - direct contact with juice results in metal iron contamination and affects quality
6	Juice Recovery	55-60%	55-60%	55-58%	55-58%	50-55%	55-60%	50-55%	Low juice recovery, loss of sugar in bagasse and needs further improvement in mills.
7	Juice pH	4.9-5.2	4.9-5.2	5.2-5.4	5.2-5.4	5.2-5.4	5.2-5.4		As raw juice pH is near to neutral resulting in lesser lime requirement & cost of production. Lower juice pH is indication of immaturity of cane
E	**FURNACE CHIMNEY**								
8	Furnace type	Earthen bricks, local	Earthen bricks, local	Earthen bricks, local	Earthen bricks, local	Earthen bricks, local	Earthen bricks, local	Earthen bricks, local	Energy loss, good quality of jaggery is not obtained results in caramalisation, incurring additional expenditure on fuel
9	Sources of fuel	Bagasse	Bagasse	Bagasse	Bagasse	Bagasse	Bagasse	Bagasse	Poor fuel efficiency, needs appropriate boiling technology to increase energy efficiency
10	Heat Loss (^{0}C)	650-750	650-750	650-750	650-750	650-750	650-750	650-750	Scope to utilize the energy & Minimize the cost of
11	Structure of chimney	Unscientific	Unscientific	Unscientific	Unscientific	Unscientific	Unscientific	Unscientific	

									production. Needs guidance in this regard
F	**PAN MATERIAL**								
12	Pan material	Iron	Iron	Iron	Iron	Iron	Iron	Iron	Open pan evaporation results in caramalisation , contamination & makes jaggery unsuitable for consumptions which has carcinogenic effect
13	Pan No.	Single	Single	Single	Single	Single	Single	Single	Single/double pan needs to be modernized towards steam based jaggery preparation
G	**JUICE PROCESSING**								
14	Boiling & Stirring	Manual	Manual	Motorised	Motorised	Motorised	Motorised	Motorised	Reduces labour & scum spilling over, regulates temperature. Though it is prevalent, the efficiency can be further improved by sweetener over to additional steam boiling units
15	Clarificants a) Chemicals used	Lime, Hydros, Baking soda,	Lime, Hydros, Baking soda,	Lime, Phosphoric acid, Hydros, Baking soda, washing soda	Lime, Phosphoric acid, Hydros, Baking soda, washing soda	Lime, Phosphoric acid, Hydros, Baking soda, washing soda	Lime, Phosphoric acid, Hydros, Baking soda, washing soda	Lime, Phosphoric acid, Hydros, Baking soda, washing soda	Sodium hydrosulphite (hydros), Safolite/Decolite , Baking soda, washing soda, orthophosphoric acid, super phosphate and lime is not recommended still using but it should be banned. Use of castor oil should be avoided
16	b) Herbal	Bhendi	Bhendi	Bhendi	Bhendi	Bhendi	Bhendi	Bhendi	

17	Crystal sugar used	Use when sugar prices are low	Use when sugar prices are low	Use when sugar prices are low	Use when sugar prices are low	Use when sugar prices are low	Use when sugar prices are low	Use when sugar prices are low	should be discouraged/ban ned
18	Variety wise Jaggery recovery kg/ton	110-120	100-105	105-110	105-110	105-110	110-120	105-110	Scope to improve recovery through appropriate technology
19	Jaggery production q/day	7-8 q	5-7 q	7-8 q	7-8 q	5-7 q	7-8 q	7-8 q	Scope the improve per day production
20	Type of Mould	wooden	wooden	wooden mould, one kg Tin mould + muslin cloth, only 5kg tin mould no cloth	wooden mould, one kg Tin mould + muslin cloth, only 5kg tin mould no cloth	wooden mould, one kg Tin mould + muslin cloth, only 5kg tin mould no cloth	wooden mould, one kg Tin mould + muslin cloth, only 5kg tin mould no cloth	wooden mould, one kg Tin mould + muslin cloth, only 5kg tin mould no cloth	Though wooden moulds are hygienic & beneficial, still needs further research in this direction. Use of muslin cloth in tin moulds may lead to contamination of heavy metal
21	Mean Jaggery Recovery %	10-11%	11-12%	10-11%	10-11%	11-12%	10-11%	11-12%	As it is identified, as high recovery zone, climatic condition are highly suitable for higher sugar accumulation. Still scope to improve jaggery recovery through technology intervention
22	Processing cost Rs./q of jaggery	575-650	575-650	575-650	575-650	575-650	575-650	575-650	Higher side, needs further research in cost reduction
23	Hygiene	Maintain ed, not fully in all sections	Maintain ed, not fully in all sections	Maintain ed, not fully in all sections	Maintaine d, not fully in all sections	Maintain ed, not fully in all sections	Maintain ed, not fully in all sections	Maintaine d, not fully in all sections	Needs much more hygienic ambience for preparation of jaggery, except cooling pit with chappals - to be avoided.

									Hygienic jaggery can be obtained through steam based jaggery units
H. MARKETING									
24	Marketing	Local	Local	Local	Local	Local	Local	Local	Sold through APMC- needs clustering approach and strengthening of through e-marketing
25	Storage & Transportation on jaggery	Paper cartons, Open	Paper cartons, Open	Paper cartons, Open	Paper cartons, Open	Paper cartons, Open	Paper cartons, Open	Paper cartons, Open	Open, higher size jaggery of 5/10 kg should be packed and transported for marketing, need some more research
26	Jaggery price Rs./kg	60/kg	50-60	50-60	45-60	45-60	45-60	45-60	Still market intervention is needed
27	No. of crushing days	180-210	180-210	180-210	180-210	180-210	180-210	180-210	Some of the units running 300 days are crushing through out the year

Transportation: Quick mode of transportation - tractor with double trailor (12-15 ton/trip)

Quicker means of reaching the crushing units

ML: Midlate maturing E: Early Maturing

<u>Wider spaced sugarcane at RSJRS</u>

Jaggery processing at Kolhapur (Farmers Field)

Sugarcane transportation, Jaggery processing, jiggery moulding and drying at Kolhapur and Mudhol

10.25.3. Visit to Steam based jaggery preparation unit, Zero point stop, Athani, Belgavi district:

A steam based jaggery preparation unit has been established at Zero point stop, hipparagi, Athani taluk. Belgavi District by Mr. Narayana and his partners. The system is installed with the principle of Vacuum evaporation. Boilers for generation of steam has been installed for heating of sugarcane juice for jaggery preparation. The unit is preparing lump jaggery as well as powder jaggery. Four batches of sugarcane juice with each batch of 750 litre of juice for clarification is taken and it will be let into the evaporators after clarification in the open pans and used for jaggery preparation at a time. At the end of clarification in the open pans, the volume of juice would be reduced from 750 litre to 600 litres and the clarification will take 60 minutes. When the syrup is taken from the evaporators, the brix reads at 70 per cent. The process of evaporation in the evaporators for 2400 litres would take four hours time and the average recovery is 10 per cent. Variety Co 86032 with 12-13 months age is used for jaggery preparation in the plant. Sugarcane is procured at the rate of Rs. 2800/ton, with a premium price of Rs. 2950/ ton. The harvesting, loading & unloading and processing cost works out to Rs.950/ ton. The plant utilizes 12-15 tons of sugarcane to produce 10-15 quintal of jaggery per day. The lump jaggery is sold at Rs. 170/kg and powder jaggery at Rs. 180/kg. The Jaggery is sold at Bangalore in the brand name of Ruchikar Amrut Jaggery with the firm name Saalaxmi Agro Products Pvt. Ltd. Savadi. The plant can be contacted through Muttanagowda, Manager working in the plant with mobile no. 9902790558.

Steam Based jaggery preparation at Farmers Field, Athni

10.25.4 Sugarcane cultivation and Jaggery processing units of Mandya District:

Crop Production: Soils are suitable for optimum growth of sugarcane, sometimes it may result in stunted growth because of poor water handling capacity besides medium to low fertility status.

The package of practices recommended by VC Farm, Mandya with regard to variety suitable for jaggery preparation has spread to the tune of 20-25% and there is a gap of 75-80%. With regard to spread of the sugarcane varieties which are rich in sugar & short duration need to be developed and encouraged. Concerted efforts of Department of Agriculture, Sugar factories and University is required in this regard.

The Agronomic practices like wider spacing, fertilizer application, intercropping and drip irrigation though well accepted by the farming committee, they are still slow moving technologies in spite of their advantages. The spread of the technology is to the tune 20-25 per cent and there is gap of 75-80% and needs to be explored for the betterment of the farming community with regard to the enhanced productivity of cane, conservation of water, farm mechanization and improved profitability.

Jaggery Processing:

Post Harvest Management: It is observed that the cane harvested at the farmers' field is being transported through bullock cart leading to loss of tonnage and quality of juice besides extraction which reflects on jaggery quality and recovery. At all the jaggery processors have adopted crusher with 3 horizontal roller of MS/ Iron which is not recommended due to is contamination besides lower crushing efficiency. Therefore there is a need to educate jaggery processors to adapt improved technology suggested by Jaggery Park.

Juice Quality & Boiling: It is observed that the quality of Juice is lower with a pH range 4.8-5.2 necessitating the application of more lime for neutralization of pH in order to prevent inversion, improve jaggery recovery per centage and reduced the cost of jaggery production. Therefore efforts should be made to educate the farmers with a focus to attention of cultivation of sugar rich varieties in order to enhance better quality jaggery and productivity.

The boiling juice is by locally made Furnace which has low fuel efficiency adding to fuel cost and poor quality of jaggery due to differential heating. The boiling pans are made up of mild steel/iron which are multiple in nature i.e. 2-3 pans which are good enough to get better recovery and yield of jaggery. Such type of multiple pans are recommended to Mandya regions compared Northern Parts of Karnataka where single pan system still exists. This is due to high scum and pure quality of juice in Southern parts compared to Northern parts of the state. More research is needed in this direction.

Clarifications: It was observed during over visits that almost all Jaggery Processing units are using liberally quantities of herbal/ chemical clarificants which is determental to human health and need to be banned when such hazardous chemicals are used.

<u>Unhygienic Jaggery processing at Farmers field (Mandya)</u>

FGD By PI at APMC yard, Mandya and Chemcials used in Jaggery Processing

Table 10.25.4: Jaggery Processing at Farmers Jaggery Units of Mandya District during 2017

	Protocals	Hullenahalli	Hadya	Sunkathonnur	Byadarahalli	Chikkade	Kurahatti	Bevinakuppe	Malligere	**Remarks**
A	**CANE PRODUCTION**									
1	Spacing	**3'**	**3'**	**3'**	**3'**	**3'**	**3'**	**3'**	**3'**	Normal Spacing, Scope for adopting wider spacing, imbalanced fertilizer application, potential scope for inter cropping and drip irrigation
2	Fertilizer dose	Imbalanced	Imbalanced	Imbalanced	Imbalanced	Imbalanced	Imbalanced	Imbalanced	Imbalanced	
3	Inter cropping	Partially adopted	Partially adopted	Partially adopted	Not Adopted	Partially adopted	Not Adopted	Partially adopted	Partially adopted	
5	Drip irrigation	Partial (10%)	Partial (15%)	Partial (10%)	Partial (15%)	Partial (10%)	Partial (20%)	Partial (10%)	Partial (15%)	
5	Soil Type	Red sandy clay loam	Sandy loam	Red sandy clay loam	Red sandy loam	Red sandy loam	Red sandy loam	Sandy loam	Sandy loam	Optimum growth, sometimes stunted because of poor water holding capacity and fertility
	CROP IMPROVEMENT									
1	Cane Varieties	VCF 0517, Co 86032, Co 62175	Co 62175, Co 86032, VCF 0517	Co 62175, Co 86032, VCF 0517	Co 62175, Co 86032, VCF 0517	Co 62175, Co 86032, VCF 0517	Co 86032 Co 419	Co 62175, Co 86032, VCF 0517	Co 62175, Co 86032, VCF 0517	Major area under Co 62175 whih is a low sugared variety. Need to be replaced with sugar rich varieties
2	Harvesting - Duration - months	12-14.	12-14.	12-14.	12-14.	12-14.	12-14.	12-14.	12-14.	Need more sucrose rich short duration varieties,

										focused attention on tissue culture
	POST HARVEST MANAGEMENT									
1	Mode of Transportation	Bullock cart/ Tractor	Tractor/ bullock cart	Tractor / bullock cart	Tractor/ bullock cart	Tractor / bullock cart	Tractor/ bullock cart	Tractor / bullock cart	Tractor / bullock cart	Leads to loss in weight and loss of quality juice
2	Cane Stalling	Open air	Open air	Open air	Open air	Open air	Open air	Open air	Open air	Exposed to sun, results in cane drying and poor juice/ jaggery/ recovery
D	**JUICE EXTRACTION**									
1	Crushing mill	Horizonal roller, Iron	Horizonal roller, Iron	Horizonal roller, Iron	Horizonal roller, Iron	Horizonal roller, Iron	Horizonal roller, Iron	Horizonal roller, Iron	Horizonal roller, Iron	Iron horizontal rollers – direct contact with juice results in metal iron contamination, affects jaggery quality
2	Juice Recovery	50-55%	50-55%	55-58%	56-58%	55-58%	56-6%	50-55%	50-55%	Low juice recovery, loss of sugar in bagasse, needs further improvement in mills
3	Juice pH	4.8- 5.2	4.9-5.3	4.8-5.2	4.8-5.1	4.9-5.2	4.9-5.2	4.8-5.2	4.9-5.3	Early setting of invertiase activity leading to poor recovery & higher application of lime adding to cost

E	**FURNACE CHIMNEY**									
1	Furnace type	Local, Earthen bricks	Local, Earthen bricks	Local, Earthen bricks	Local, Earthen bricks	Local, Earthen bricks	Local, Earthen bricks	Local, Earthen bricks	1	Furnace type
2	Sources of fuel	Bagasse, coconut husk, coconut frond	Bagasse, coconut husk, coconut frond	Bagasse, coconut husk, coconut frond	Bagasse, coconut husk, coconut frond	Bagasse, coconut husk, coconut frond	Bagasse, coconut husk, coconut frond	Bagasse, coconut husk, coconut frond	2	Sources of fuel
3	Heat Loss (^{0}C)	600-700	600-700	600-700	600-700	500-600	500-600	600-700	600-650	Scope to utilize the energy & Minimize the cost of production. Needs guidance in this regard
4	Structure of chimney	Not fully scientific	Not fully scientific	Not fully scientific	Not fully scientific	Not fully scientific	Not fully scientific	Not fully scientific	Not fully scientific	
F	**PAN MATERIAL**									
1	Pan material	Iron	Iron	Iron	Iron	Iron	Steel*	Iron	1	Open pan evaporation results in caramalisation , contamination & makes jaggery unsuitable for consumption ,carcinogenic effect. Pans are made locally without standard specifications, besides there are risk of labour injuries during jaggery

										preparation.
2	Pan Nos	Multiple pan (3)	double pan	double pan	Multiple pan (3)	Multiple pan (3)	Multiple pan (3)	Multiple pan (3)	2	Multiple furnace is normally triple pan furnace, the yield in multiple pan is higher, the chances of caramalization is less & hygienic. All pans are made of iron and exept *
G	**JUICE PROCESSING**									
1	Boiling & Stirring	Manual	Manual	Manual	Manual	Manual	Manual	Manual	1	Increasing labour cost, caramalization, spilling over no uniform temperature resulting in poor quality of jaggery and yield loss
2	Clarificants a)Chemicals used	Liberaly use Hydros, Safolite/ Decolite, Baking soda, washing soda, super phosphate and lime.	Liberaly use Hydros, Safolite/Decolite, Baking soda, washing soda, super phosphate and lime	Liberaly use Hydros, Safolite/ Decolite, Baking soda, washing soda, super phosphate and lime	Liberaly use Hydros, Safolite/ Decolite, Baking soda, washing soda, super phosphate and lime	Liberaly used Hydros, Safolite/ Decolite, Baking soda, washing soda, super phosphate and lime	Liberaly use Hydros, Baking soda, washing soda, lime as per recommendation	Liberaly used Hydros, Safolite /Decolite, Baking soda, washing soda, super phosphate and lime	Liberaly use Hydros, Safolite /Decolite, Baking soda, washing soda, super phosphate and lime	Steps are to be initiated to ban jaggery prepared out of hazardous chemicals which are carcinogenic. Needs advertisement regarding quality of jaggery. Use of Castor oil should be discouraged and coconut oil
	b) Herbal	Bhendi	Bhendi	Bhendi	Bhendi	Bhendi	Bhendi	Bhendi	Bhendi	

										recommende d
3	Addition of Crystal sugar	Adding 20-25 % Sugar	Adding 20-25 % Sugar	Adding 20-25 % Sugar	Adding 20-25 % Sugar	Addin g 20-25 % Sugar	No	Adding 20-25 % Sugar	No	Should be discouraged
4	Jaggery production q/day	10-15.	10-15.	15-20.	15-20	8-10.	8-10.	10-12.	10-12.	Optimum production, still there is scope to improve the production
5	Type of Moulds	wooden/ Zinc Bucket	wooden/ Zinc Bucket	wooden/ Zinc Bucket	wooden/ Zinc Bucket	woode n/ Zinc Bucket	wooden / Zinc Bucket	woode n/ Zinc Bucket	wooden / Zinc Bucket	Though wooden moulds are hygienic & beneficial but still needs further research in this direction. The tin moulds used may lead to contaminatio n of heavy metal (tin)
6	Mean Jaggery Recovery %	8-9.	8-9.	8-9.	9-10.	8-9.	9-10.	8-9.	8-9.	Scope to evolve/breed sugar rich varieties. New varities. VCF 0517 released may cover the major area.
7	Processing cost Rs./q of jaggery	600-700	600-700	600-700	600-700	600-700	600-700	600-700	600-700	Higher side, needs further research in cost reduction
8	Hygiene	Unhygie nic	Unhygien ic	Unhygie nic	Unhygie nic	Unhyg ienic	hygienc e except mouldin g	Unhygi enic	Unhygi enic	Unhygenic and unscientific

	H. MARKETING									
	Marketing	Local	Local	Local	Local	Local	Organised market channel	Local	Local	Sold through APMC-needs clustering approach and strengthening through e-marketing
1	Storage & Transportation of jaggery	Paper box, 5 kg & above, carry openly	Paper box, 5 kg & above, carry openly	Paper box, 5 kg & above, carry openly	Paper box, 5 kg & above, carry openly	Paper box, 5 kg & above, carry openly	Paper box, 5 kg & above, carry openly	Paper box, 5 kg & above, carry openly	Paper box, 5 kg & above, carry openly	No appropriate storage structures and needs some more research & guidelines
2	Cost of jaggery / q including cost of cane.	3500-4000	3500-4000	3500-4000	3500-4000	3500-4000	3500-4000	3500-4000	3500-4000	Cost of production is high because of low recovery and high labour cost.
3	No. of crushing days	180-220	180-220	180-220	180-220	180-220	180-220	180-220	180-220	Some of the units run 300 days, are crushing through out the year

* Note that the jaggery recovery of varieties - Co 62175- 95 kg, VCF 0517- 110 kg, Co 86032-100 kg, Co419 - 90kg, / ton of cane

Sugarcane cultivation practices (wider spacing, Drip Irrigation and intercropping at farmers field) Mandya.















VRI


10.26. Chemical Analysis of Jaggery

Physical and chemical properties of chemically processed jaggery and chemically free processed jaggery of Mandya is presented in the table – 10.26.1

Jaggery is a solid natural product obtained by concentrating on sugarcane juice after clarifications at various stages of processing. It is traditionally, commercialized in blocks of different shapes and size. This food stuff can be considered as a whole sweetener as it preserves most of the compounds present in sugarcane juice, and therefore it is expected that its nutritional value is higher than that of refined sugar.

The objectives of the evaluation study is to determine the physical and chemical properties of the jaggery processed at farmer's field as well as research station to compare them for quality parameters. During the course of survey visit to the jaggery processing unit operated by the farmers six lot s of the jaggery from chemically processed unit and six lots of jaggery from chemically free processed jaggery and one from Mandya jaggery park were individually collected and analysed for their variability among samples and among lots. The samples were collected randomly from the farmer's jaggery processing units by adopting proper care by putting the samples of one kg each into a double layered plastic covers and numbered and were sent for analysis for national accredit laboratory Nikhil analytical and Research Laboratory (central Govt. Approved for Agmark) Sangli, Maharastra. The data on chemical analysis of jaggery have been pooled and presented in the table – 10.26.1

The moisture, protien, ash, reducing sugars and sucrose were determined by adopting the procedure as out lined in AOAC (1990), methods for sugar and sugarcane analysis. The results are being reported on Oven dry basis (except moisute) in gram per 100 grams of samples. The Nitrogen content was multiplied by 6.25 % to calculate the protein concentration in the sample. Minerals like potassium, Calcium, Phosphorous, Magnesium and Iron were estimated by using atomic absorption spectro meter.

Results: the chemical analysis of three jaggery reveal that both physical and chemical of both type of jaggery i.e. chemically processed jaggery, chemical free jaggery and the jaggery processed at VC Farm, Mandya. almost all are identical with few variations here and there for their properties and when compared to stipulated normal values are the standard jaggery (Table 9.6.1) the most significant part of the analysis is that the chemically processed jaggery has an higher amount of sulphur di oxide 69.8 ppm which is far above the recommended level of food standard (50 ppm by FASSI, 2011) which is the major concerned to the consumer. The increased sulphur di oxide content in this sample may be due to liberal use of chemicals which are not recommended for bleaching the jaggery. (Annexure 5)

Table No: 10.26.1. Comparison of chemical jaggery and chemical free jaggery in the study area of Mandya

Sl. No.	Parameters	Unit	Value				
A	**Nutritional Value**		**Chemical**	**Chemical free**	**VC Farm Mandya**	**FASSI Standard**	
						GR 1	**GR2**
	Moisture	%	7.62	7.19	6.57	**5	**7
	total minerals	%	1.97	1.98	1.42	**1.5	**2
	Crude Protein	%	1.097	1.77	1.02	*0.4	
	Crude Fat	%	0.18	0.21	0.23		
	Crude Fiber	%	0	0	00		
	Carbohydrate	%	89.14	88.88	90.76		
	Energy	Kcal/100 g	362.6	364.5	369.2	*400	
B	**Others (Sugars, etc)**						
	Sucrose (on Dry Basis)	%	72.3	75.8	76.6	**80	**70
	Reducing Sugar (On Dry Basis)	%	14.2	11.5	9.9	**10	**20
	Total (Invert) sugar (On Dry Basis)	%	90.6	91.2	90.5	**90	**90
	Sulphur Dioxide	Ppm	69.8	8.2	3.2	**50	**50
	pH (5%Solution)	-	6.1	6.0	5.9	*5.9	
	Extraneous and insoluble Matter	%	0.24	0.44	0.1	**0.3	**0.3
C.	**Metals**						
	Calcium	%	0.07	0.14	.40	*0.00114	
	Magnesium	%	0.13	0.13	.09		
	Potassium	%	0.45	0.67	.95		
	Sodium	Mg/100g	15.8	20.9	14.2		
	Iron	Ppm	40.1	25.3	13.4	*0.008%	
	Phosphorous	%	0.14	0.10	.09		
D	**Physical Parameters**						
	Texture	-	Amorphous	Amorphous	Amorphous		
	Colour	-	Yellow	Golden Brown	Golden Brown		

- **GR= Grade, ** =FASSI 2011, * GOI Standard 1990**

10.27. Sensory evaluation of Jaggery Samples

Jaggery samples such as chemical free sample (A) and Chemically processed samples (B) which is procured from the local Mandya market were subjected to sensory evaluation by regular consumers of jaggery, who are well versed with the jaggery taste and usage (n=50). The panel members for sensory evaluation consisted of staff of ZARS, V.C. Farm, Mandya as well as consumers of Mandya urban and rural places. Panelists were provided with coded samples along with glass of water and instructed to rinse and swallow water between samples. Panalists were given written as well as oral instructions regarding evaluation procedure and asked to evaluate the products for acceptability based on its appearance, color, taste, texture and overall acceptability on nine point hedonic scale, where in 9= like extremely, 8= like very much, 7= like moderately, 6= like slightly, 5= neither like nor dislike, 4= dislike slightly, 3= dislike moderately, 2= dislike very much, 1= dislike extremely.

Table 10.27.1. Sensory scores of Jaggery samples.

Sensory characters	A	B	F-value	SEm±	*CD @ 5%*
Appearance	7.0	8.1	*	0.11	0.30
Colour	6.5	8.4	*	0.12	0.33
Texture	7.6	5.2	*	0.19	0.54
Flavour	8.1	4.3	*	0.22	0.62
Taste	8.2	3.9	*	0.21	0.60
OAA	8.4	5.6	*	0.14	0.40

A-Chemical free jaggery, B- Chemically processed jaggery (Market sample), N=50.

The mean sensory scores for two types of *Jaggery* are depicted in Table 1. The mean scores of sensoryparameters such as colour, appearance, taste, texture and overall acceptabilitysignificantly differed with respect to two types of jaggery samples. The appearance and colour parameters (8.1 and 8.4) were significantly more for chemically processed jaggery (B) as it appears creamiest bright yellow in colour compared to chemical free jaggery (7.0 and 6.5). The taste of chemical free jaggery (8.20) was superior compared to chemically processed jaggery (3.9).Even the texture and flavour components which are the important parameters foracceptability significantly differed with respect to two types of jaggery tested and were found to behighest for chemical free jaggery (7.6 and 8.10).The overallacceptability (OAA) scores depicted that the chemical free jaggery was highly acceptable (8.40).On the other hand, the chemically processed jaggery was scored 5.6 on a 9 point hedonic scale. Even though the appearance and colour parameters were significantly superior for chemically processed jaggery, the other sensory parameters such as taste, texture and flavour were significantly high for chemical free jaggery, hence over all acceptability scores were significantly more for chemical free jaggery (A) indicating that the chemical free jaggery was liked very much (8.6) in terms of sensory quality by the consumers. The study conducted by Naik *et al*, (2014) on sensory evaluation of *officinale*enriched jaggery for different attributes indicated significant (P > 0.05) difference between control and enriched jaggery of different sugarcanevarieties for color, texture, hardness and taste. Even the research conducted by Unde *et al*, (2011) showed that the coarse jaggery powder having particle size in the range 0.500-0.078 mm was found more acceptable among all other powdersizes after storage period of six months in terms of its chemical properties and organoleptic characteristics when evaluated on a 9-point hedonic scale. Similar line of work conducted by Chand *et al*,(2011) on quality evaluation of Jaggery chocolate under various storage conditions revealed that, the colour, taste, texture, flavour and overall acceptability scores were found to be in range of 6–8.5when evaluated for its sensory characteristics on 1–10 scale. Hence it is concluded that the chemical free jaggery (A) was found to be highly acceptable in spite of its dark colour, indicating that it is liked by consumers because of its superior taste, texture and flavour characteristics.

XI. Reflection and Conclusion

1. The establishment of jaggery parks in the Southern and Northern parts of Karnataka are highly relevant to meet the farmers requirement of research related issues of sugarcane cultivation and jaggery processing. These institutes have met their objectives partially when compared to the amount spent on infrastructure and technology development. Both the institutes have failed in outreach activities to farmers for transfer of technology developed at the respective institutes. However,, efforts should be made to activate these institutes by strengthening the initiated PPP Model for the benefit of farming community.
2. All the (20) processing units of jaggery at farmers' field are outdated and few have developed one or two improved components of scientific jaggery processing. However,, there is urgent need for modernization of jaggery processing units in terms of crushing, furnace technology, boiling pans (Preferably steel grade) and cooling pits, in addition to replacing the tin/aluminium moulds.
3. Need of improvements in furnace and chimney at farmers (20) units in tune with technology standardized at jaggery parks.
4. The jaggery processors (20 units) were found to use liberal quantities of chemical clarificants which have harmful effects on human health. They use more than required in order impart temporary attractive colour which fetches more price. Therefore there is an urgent need for banning such processed jaggery for human consumption.
5. There are not much value added products developed by the parks and needs to be re looked. (Solid, Liquid and Powder)
6. Almost all Majority of processers (20) expressed their difficulty in getting un interrupted power supply, skilled labour, technical know how
7. The cost of jaggery Production was high in small jaggery processing units as compared to medium and large units because labour cost.
8. In case of jaggery processing the share of sugarcane cost in the total cost was estimated to be more than 70 per cent in both the organic as well as conventional jaggery processing.

9. The jaggery processing units were found to cursh sugarcane for a period of 180- 220 days in a year. The annual employment potential in jaggery processing unts was estimated to be about 2000 many days/ unit in the Mandya area
10. The colour, taste, structure, hardness, shape and size of the jaggery plays predominant role in price determination during the auction
11. Marketing issues at Mandya are complex and traders dominated and needs modernization in light of e marketing.
12. Labour cost forms the lion share of the total cost of processing jaggery. The cost of labour for processing jaggery excluding the cost of sugarcane in the farmers jaggery units of the study area was computed to be Rs. 575-650/ quintal of jaggery for chemically processed ones and it was Rs. 525 for chemical free jaggery. The total cost of processing including sugarcane and other costs works out to Rs. 3500-4000 in farmers jaggery units and it was Rs. 3472/ quintal in jaggery park.
13. The comparative study between jaggery processing and supply of cane to sugar mills, it has shown that sugarcane for jaggery processing was highly profitable than selling the cane to sugar mills with B:C ratio of 2.15 to 2.45 to 1.6 to 1.75 respectively.
14. It is estimated from the study that there is major scope to export organic / chemical free jaggery to the international markets at competitive rates.
15. Fluctuations of jaggery prices, high commission charges, lack of separate market for chemical free jaggery, lack of grading facility and market openings are the major marketing issues expressed by traders and farmer processors.

Sugarcane growers

- Most of the farmers in Mandya district (> 50%) are small and marginal farmers with a land holding of 0-5 acres. Only 18.3 % of the farmers are having >10 acres of land.
- The area under sugarcane did not increased due to imparting of trainings to farmers about scientific method of sugarcane cultivation. However,, the productivity increased substantially after getting training.
- All the farmers took part in the survey sold their cane to jaggery units since, they get higher cane price and also due to non-functioning of sugarcane factories in Mandya.
- More than 90% of the respondents are having kachha house and only 8% are having pucca house. All of them are having toilets in their house.
- The most suited soil for sugarcane is loamy soil (>60% respondents opined) followed by clay.
- More than 65% of the respondent indicated that they not having financial support/credit facilities to adopt improved management practices.
- More than 50% of the respondents opined that, improved varieties and nutrient management are the important technologies which contributed more towards yield improvement.
- All the respondents indicated that there was no provision for soil sample analysis in Jaggery Park, hence they getting their soil sample analysed from Department of Agriculture.
- More than 60% of the respondents transport their cane through bullock cart and about 33% transport through both bullock cart and tractor. While, only 3% are using tractor.
- More than 50% of the respondents undergone training on scientific sugar cultivation at ZARS, V. C. Farm, Mandya and 18% in Department of Agriculture. While, 27% did not undergo any training.
- About 63% of the respondents selected seeds, fertilizers, chemical etc based on their own experience, while, 11% based on scientific information.
- For obtaining higher yield and recovery 45% of the respondents opined that Co 62175 and Co 86032 are the best varieties and 16% of the respondents indicated that VCF 0517 and Co 86032 are the better varieties.

Jaggery processor

- ❖ About 98% of the respondents are using iron crushers for extraction of juice.
- ❖ Most of the jaggery units are running for about 7-8 months in a year.
- ❖ 98% of the respondents are not having pre-boiling units.
- ❖ 98% of the respondents are having conventional type of boiling units.
- ❖ 95% of the respondents are using modified furnaces especially UP model while only 7% are having traditional type of furnace.
- ❖ All the respondents are using baggase as a source of fuel and 44% are using agricultural waste like coconut fronts, husk etc. as a source of fuel.None of them are using solar power and biogas.
- ❖ 93% of the respondents are adding liberally (indiscriminate) chemicals to enhance colour and recovery of jaggery and only 7% are not using any chemicals.
- ❖ 88% of the respondents are adding organics especially bhendi mucilage to remove scum and only 12% are not using organics.
- ❖ 78% of the respondents use striking point as an indicator point for end of jaggery preparation, while, only one respondent was using thermometer to check the boiling point and end of jaggery preparation.
- ❖ 97% of the respondents are using both wooden and zinc sheet moulds while, only 3% are using steel moulds.
- ❖ None of the respondents are having jaggery quality testing units in their jaggery unit.
- ❖ For assessing the quality of cane 72% of the respondents used age and appearance of the crop and 18% used age and crop condition.
- ❖ All the respondents have constructed bagasse drying yard in their jaggery units.
- ❖ All the respondents opined that the jaggery park in Mandya is very much needed to impart trainings to the farmers, traders and consumers regarding importance of production of chemical free jaggery.
- ❖ 98% of the respondents are using iron crushers for extraction of juice.
- ❖ Most of the jaggery units take 40-45 mints to crush one tone of cane.
- ❖ The average cost involved in the preparation of one quintal of jaggery Rs. 400-450/-.
- ❖ The keeping quality of jaggery is more in chemical free jaggery (2-3 months) is compared to chemical jaggery (<1 month).

- ❖ Almost all the respondents are using paper box or card board box as a packaging material.
- ❖ The amount of energy required for processing of one tone of sugarcane juice is 700-750 kg bagasse.
- ❖ 70% of the respondents are using iron heating pans and 30% are using steel heating pans.
- ❖ To produce one tone of chemical jaggery Rs. 6000 is required while, for producing chemical free jaggery Rs. 6500 is required.
- ❖ 6-8 labours are required for producing one quintal of chemical jaggery and 8-10 labors are required for producing one quintal of chemical free jaggery.
- ❖ More than 90% of the respondents are ready to pay 10-15 rupees higher price for chemical free jaggery.

Jaggery Consumers

- ❖ Among the consumers, 54% are employed and 30% are agriculturist.
- ❖ Majority of the respondents are not having their own land (76%) while, 24% of the consumers are having their own land, but among them majority of respondents (16%) are having only 1-2 acres of land.
- ❖ All the consumers are having awareness about chemical free jaggery/organic jaggery out of them, 58% of consumers know about this project since from 2-4 years.
- ❖ While, 80% of the respondents are aware about Jaggery Park situated at V C Farm, Mandya.
- ❖ About 32% of the respondents opined that jaggery park is ideally situated while, 68% of the respondents did not answer.
- ❖ Among the jaggery products majority of the consumers answered that they know about only solid jaggery and only few of them are having awareness about liquid jaggery and powder jaggery. In solid jaggery the colour is good in chemical jaggery with yellow to white colour. While it is ok to not good in non-chemical jaggery with brown to black colour. While, the taste is good with sweetness in chemical free jaggery whereas the taste of chemical jaggery is not good and bad smell.
- ❖ About 68% of the respondents consumed about 10 to 20 kg jaggery per year.
- ❖ About 62% of the respondents spent 500 to 1000 Rs. For purchase of jaggery per annum.

- About 58% of the respondents purchased chemical free jaggery from local market, 28% from Jaggery Park.
- Among the respondents 46% willing to pay 10 to 15 Rs. Extra price and 34% willing to pay15 to 20 Rs.
- About 92 % of the respondents opined that jaggery park surroundings has been maintained hygienically (in crushing, processing and storage of jaggery).

Jaggery Traders

- The survey results revealed that 40% of the traders are involved in jaggery trading since more than 15 years and 40% since 5-10 years.
- Most of the jaggery traders (95%) know about processing of chemical free jaggery. None of the jaggery trader's undergone training programme on chemical free jaggery processing in Jaggery Park, V. C. Farm, Mandya. But, 95% of the jaggery traders felt that, Jaggery Park situated at V. C. Farm, Mandya is very much essential to create awareness about chemical free jaggery and to provide training to jaggery processor regarding production of chemical free jaggery.
- 85% of the respondents indicated that, the taste is not good in chemical jaggery. All the respondents felt that chemical jaggery is not healthy because it contains sulphur, prepared under unhygienic condition and even keeping quality is very short.
- 90% of the respondents indicated that colour of the chemical free jaggery is ok. But, all the respondents felt that taste of chemical free jaggery is excellent.
- Among the respondents, 55% felt that chemical free jaggery is black-brown in colour and 40% responded that it is brown in colour and hence, consumers do not prefer this product.
- With respect to storage, 70% of the respondents indicated that chemical jaggery can be stored maximum by 30 days. While, chemical free jaggery can be stored upto 3 months.
- The survey data revealed that ample of credit facilities are available for trading both chemical and chemical free jaggery.
- All the respondents indicated that, hygiene maintained in and around the Jaggery Park, Mandya is certainly and surely better than the jaggery making units existing in the surrounding area.

- To test whether jaggery is chemical or chemical free at home, 55% respondents test taste and keeping quality while, 45% in addition to above parameters also test based on colour of the jaggery.
- Many of the traders felt that demand for chemical free and organic jaggery is very meager because of unattractive colour and also due to higher price. The normal price for chemical jaggery is Rs. 35 per kg, while organic or chemical jaggery it's is around 60-70 Rs./kg.
- At present there is a high demand for solid jaggery especially bucket shaped and cube shaped jaggery (Acchubella).
- According to the respondents, strategies to be adopted to create demand for chemical free jaggery among the consumers are, need to create awareness about ill effects of chemical jaggery on human health, benefits of chemical free and organic jaggery among the consumers, need to train the jaggery processor regarding production of chemical free and organic jaggery and need to extend the market for chemical free jaggery. Further they added that chemically processed jaggery should be banned with immediate effect.
- Many of the jaggery traders are having awareness about the Jaggery Park situated at V. C. Farm, Mandya. Among them 35% visited jaggery park, 30% know the jaggery park from business partners, and 15% know about the park by friends.

Conclusion

The jaggery is a vital sweetener, usually known as "medicinal sugar" and nutritionally it is comparable with honey. It is superior over sugar, since it contains about 80-85% sucrose, 5-15% reducing sugars, proteins, fats, vitamins, minerals (calcium, iron, phosphorus, magnesium, potassium and traces of zinc and copper (which are not available in sugar). Jaggery is utilized for production of several Ayurvedic medicines for various diseases. The medicinal and nutritive values, quality and taste of jaggery can effectively be improved by adding appropriate value addition.

The various steps, involved in jaggery processing are: harvesting, pre-cleaning and crushing of canes, filtration, clarification (Herbal), heating, boiling and concentration of cane juice, cooling of concentrated cane juice (slurry), moulding of slurry, packaging, storage and marketing of jaggery (Fig-5.18.1 and Fig-5.18.2). The jaggery should be produced in very clean tidy and hygienic conditions i.e. free form insects, ants, flies, bacteria, fungi etc. The use of injurious chemicals should be avoided and herbal clarificants should be used for clarification of cane juice. Mandya district is known as jaggery bowl of Karnataka consequent to its potential to produce its own branded jaggery as Mandya jaggery throughout the year. However, in recent pasts there is considerable reduction in production of jaggery due to non-functioning of processing units, non availability of quality canes due to continuous drought labours scarcity and erratic power supply. Hence, looking its potential there is a need for revival of all aspects of jaggery processing in order to meet the futuristic requirement the jaggery processing unit needs to be revived and modernized and up scaled. Hence, it is very much essential to uplift the industry through technological revolutions for improved grade and quality of juice extraction, efficient heat utilization furnaces (bricketing/palliating of besggasse enhances the efficiency by 50%), steel grade boiling pans moulds advanced packaging techniques quality control and hygiene issues in view of the national an international standards, demand and supply, the government support is very much needed.

Limitations/ constraints/ challenges in Evaluation Study

1. The entrepreneurship and managements capability is very low among rural youth.
2. Group approach is also a sound lacuna in rural area.
3. One of the major bottle necks is that the farm produce is a seasonal activity and requires suitable processing machinery for different farm produces during different periods of the year.
4. Paucity of funds to start and running the units.

XII. Recommendations

The recommendation have been classified under 3 headings viz, A. Researchable issues, B. Administrative issues, C. Policy issues.

A. Researchable issues:

1. Development of sugar rich cane varieties, agro techniques, effective marketable sugarcane based cropping system with differential maturity duration in order to meet the cane requirement for jaggery industry through out the year under changed climatic conditions and crop diversification.
2. Strengthening of seed production for sugar rich varieties suitable for jaggery production.
3. Development of suitable technology for preparation of jaggery from immature/over aged cane for changed climatic situation.
4. Training on quality cane and jaggery processing at regional levels
5. To develop organic clarificants ready to use vegetable clarificants for quality jaggery to use vegetable clarificants for quality jaggery to meet consumer's demand of niche metro and international markets.
6. Jaggery processing unit must address with HACCP norms for hygiene and quality of processed products
7. Automation and development of efficient sugarcane crushing, juice storage and transportation system.
8. To develop high combustion and efficient heat furnaces for optimal fuel (pellets /brickets)uses and device surplus bagassse for pulp and paper production
9. The R & D work should be initiated to develop quality parameters for export promotion of traditional sweetener products in niche area market.
10. Develop technology for alternative uses of scum for value added products and diversified uses
11. Develop efficient cane crushing system for 65-70% juice extraction efficiency.
12. Automation of juice handling and transportation to boiling pans for maintaining products hygiene and quality of jaggery. The vegetative and eco-friendly clarificants should be used to minimize harmful effect of chemicals.

13. Solar and bagasse co-power gerenration system needs research .
14. Develop high combustion, vacuum-cum-open pan hybrid furnaces for optimal fuel efficiency and divert surplus baggasse for pulp and paper production
15. Efforts should be made to develop semi-automatic, mobile jaggery processing units on pilot basis in rural areas.
16. Research work should be initiated to develop quality parameters, protocols matching FSSAI, AGMARK abd ISO 22000:2005 for export promotion of jaggery products for niche markets.

B. Administrative Issues:

1. Encourage co-operative processing, storage packaging and e marketing infrastructure for jaggery in potential area.

2. Strict enforcement of existing sugarcane area regulations by government agency under each sugar mill jurisdiction.

3. Regulatory authority/ body to govern the hygiene of jaggery processing premises

4. Chemical free jaggery does not have a niche market. Awareness to be created among the producers and consumers alike on ill effects of chemical jaggery and health benefits of chemical free jaggery.
5. Soft loan for establishing and modernizing standard jaggery processing units in the cane production zone.

C. Policy Issues:

1. Banning of chemically processed Jaggery by using **Sodium formaldehyde sulphoxylate ((Decolite and safolite))** (A textile bleaching agent) though appropriate regulations by food and civil supply department besides mass propaganda through mass media like AIR, TV and News papers.

2. Jaggery as a tool in public distribution system (PDS) for improvement of the health of school children and people of rural areas besides pregnant women.

3. Establishment of Farmer's produce promotion society (FARPO): a model to Rejuvenate rural economy and self employment opportunities for rural youth in jaggery processing (Punjab Model)

4. Convert unorganized sector into organized sector by forming jaggery manufacturers association at national and regional levels. SHG's / co-operatives should be formed to protect the interest of cane producers and jaggery processors.

5. Competitive wage, health packages and insurance schemes should be announced and implemented for labours working in jaggery producing units.

6. Pilot small scale units of pulp and paper making form bagasse and other wastage material should be integrated with economically viable jaggery units in rural areas.

7. Evaluation questions and sub questions: As per ToR

SI	***Evaluation questions (Inclusive and not exhaustive):***	***Findings***
1.	Has the chemical free Jaggery preparation unit, the Jaggery Park V.C. Farm, Mandya and the trainings provided by it in making chemical free Jaggery made any impact on Jaggery unit owners, APMC Merchants and consumers with regards to going in for only chemical free Jaggery production, Marketing and consumption?	**Yes.** About 95% of traders state that chemical free jaggery though dull in colour, tastes good while chemically processed jaggery is having salty with lesser sweetness besides sulphur smell and poor keeping quality.
2	Are the Jaggery sellers and its consumers aware about the fact that chemicals are used in making Jaggery? Are they aware of the chemicals used and/or its ill effects on human health?	Jaggery sellers know the fact of liberal use of chemicals during the processing of jaggery to impart white colour which is market driven. While majority of consumers do not know about the use of harmful chemicals in processing of jaggery. The traders are fully aware of ill effects of chemicals used in jaggery processing. On the contrary the consumers do not know the ill effects of chemically processed jaggery thus, there is an urgent need to bring awareness to the public through mass media. (Doora Dharshan, All India Radio, News Paper etc.)
3	Does chemical free Jaggery have a different taste or appearance than usual Jaggery prepared with the usage of chemicals? (perception of Jaggery users may be used to answer this)	Yes. Chemical free jaggery taste is liked by the consumers which has good taste but dull golden colour which do not attract the consumers but still fetches higher price in the select markets compared to chemically processed jaggery which has attractive white colour with high demand in APMC market in spite of its ill effects on human health.
4	Are the Jaggery sellers and its consumers paying or willing to pay a higher price for chemical free Jaggery? If no, why not? If yes, what percentage more than the price of usual Jaggery are they paying, and what is the scope further in willingness to pay, for chemical free Jaggery?	**Yes.** Both sellers and consumers are ready to pay higher price for chemical free jaggery because of its chemical free nature, high quality, taste and keeping quality. On the contrary the jaggery to the market is in short supply and needs to be up scaled.

5	What are the hygiene issues in the Jaggery making units existing in the surroundings?	At present the jaggery units of farmers engaged in preparation of jaggery are producing jaggery under most unhygienic conditions. The units have kaccha housing with mud flooring and tiled house with opening from all ends. As a result, insects (ants, cockroach, honey bees and wasps), rodents etc., will invade into the units making the jaggery so prepared unfit for consumption. The juice conveyance is in the open ducts which attracts insects and microbes. Overall ambience is under most unhygienic condition which is prone to easy contamination besides jaggery moulding units that is in the cooling pit the maintenance is unhygienic
6	Is hygiene in the Jaggery Park certainly and surely better than the Jaggery making units existing in the surroundings?	**Yes.** Jaggery park maintenance is highly hygienic. Indeed, the park is having food grade steel crusher, food grade stainless steel tank and food grade stainless steel boiling pans besides, a cooling pit with granite flooring. In addition, only organic clarificants are being used to remove the scum and improve the quality of jaggery.
7	What are the views of Jaggery making unit owners on using chemical clarificants vis a vis herbal clarificants in Jaggery processing?	At present, the jaggery prepared in the farmers jaggery unit is sold through APMC. The demand is for pure white bleached jaggery in APMC. As a result, the farmers prefer to prepare white bleached jaggery which can be done only through the use of chemicals. Use of unripe, over aged and lodged sugarcane for jaggery preparation which necessitates the use of chemicals for easy removal of scum to give a bleached colour to jaggery. That is why farmers prefer to use chemicals in jaggery processing. Some farmers also use herbal clarificants in addition to chemical clarificants.
8	What are the opinion of Jaggery sellers and consumers of Jaggery about using herbal clarificants in Jaggery processing?	Jaggery sellers as well as consumer strongly recommend only for use of herbal clarificants which is good for health point of view.
9	Does chemical free Jaggery have a longer	**Yes.**

	shelf life than usual Jaggery prepared with the usage of chemicals? If yes, how much longer or shorter and why?(perception of Jaggery users may be used to answer this)	Use of chemicals like sodium hydrosulphite (hydros), sodium formaldehyde sulphaxilate (safolite), sodium bicarbonate (baking soda) sodium carbonate (washing soda) by virtue of sodium chemicals make the jaggery more hygroscopic. Depending on the season and relative humidity in the atmosphere jaggery absorbs moisture which makes it watery as a result of inversion of sucrose. Hence, the shelf life of chemical jaggery (30-45 days) is less than chemical free jaggery (90-100 days).
10	What has been the production, sale and utilization pattern of powdered Jaggery, Liquid Jaggery and Jaggery made into unique shapes and sizes?	Though the products like liquid jaggery, powder jaggery are having high quality with higher sugar content, the cost of production is on the higher side. However, due to its good keeping quality and ease of the usage, products need to be encouraged through proper extension methodologies and government incentives.
11	Which States and districts (outside Karnataka and in Karnataka) are the main purchasers of chemical free Jaggery produced in the Jaggery Park?	The major states procuring chemical free jaggery from jaggery park are Rajasthan, Gujarat, Maharashtra, Kerala, Andra Pradesh, West Bengal and Orissa.
12	Which Sugarcane varieties are better for Jaggery making from the point of view of Jaggery yield and quality as per Jaggery making unit owners of Mandya?	The varieties viz., VCF 0517, Co 86032, Co 8371 and Co 92005 have been found to be suitable for jaggery preparation from the point of view of jaggery yield and quality.
13	Is there a control mechanism (legal and procedural) for checking the usage of harmful chemicals in the making of Jaggery and the hygiene aspect in the process of making Jaggery? If not, what mechanism can be suggested? Please elaborate.	Yes. Food safety and Standards Authority of India (FSSAI) under the Ministry of health Government of India is authorized to make inspection to jaggery units on hygiene aspects and take legal action if units do not comply.
14	Please detail a few tests that can be done at home to check whether the Jaggery one is using is chemical free or not.	9. While preparing coffee or tea, during boiling of milk if chemical jaggery is added to milk, it will spoil the milk whereas in chemical free jaggery this will not happen. 10. If jaggery is of pure bleached white colour, apparently it is chemical jaggery. 11. If jaggery is tasted, chemical jaggery will give salty taste. 12. Chemical free jaggery will emanate

		good flavour while chemical jaggery will give off flavour 13. Chemical free jaggery attracts small ant species (ನಜ್ಜಿರ) 14. If jaggery is stored for a month or so, chemical jaggery is likely to be watery. 15. Laboratory test (chromatography) can reveal the actual chemical/s present in jaggery 16. Jaggery if immersed in water, if impurities are there in jaggery it will settle at the bottom or float on the surface. This is a simple test to know the inert matter present in jaggery
15	Has the present Jaggery Park fulfilled its objectives? Is a good case made out for having a few more Jaggery Parks in Karnataka? If no, Why not? If yes, what further inputs need to be provided?	The establishment of jaggery parks in the Southern ZARS, V.C. Farm, Mandya under UAS, Bengaluru and Northern Mudhol & Sankeswar under UAS Dharward. parts of Karnataka are highly relevant to meet the farmers requirement of research related issues of sugarcane cultivation and jaggery processing. These institutes have met their objectives partially when compared to the amount spent on infrastructure and technology development. Both the institutes have failed in outreach activities to farmers for transfer of technology developed at the respective institutes. However, efforts should be made to activate these institutes by strengthening the initiated PPP Model for further up scale is the need of the hour . In addition, based on the facts and figures available, it is felt that there is no need for having another jaggery park in the state instead, the present parks may be strengthened with technical and financial support. in order to make use of huge infrastructure for benefit of farming community

XIII. Status of Sugarcane and Jaggery Production and Scope for Modernizing Jaggery Industries in Mandya District (Concept Map)

Jaggery a Traditional unrefined wholesome sugar product is known all over the world (FAO 2007). jaggery is unrefined natural sugar that is produced without adding any chemicals. More than 70% of the total world jaggery production is from India. Jaggery is popularly known as the “medicinal sugar” ⍰ and is nutritionally comparable with honey. It has been used as a sweetener in Ayurvedic Medicine for 3000 years. Indian Ayurvedic medicine considers jaggery to be beneficial in treating throat and lung infections. While refined sugar mainly consists of glucose and fructose, jaggery contains glucose and sucrose. But jaggery also has minerals and vitamins which lacks in the refined sugar. The mineral content of jaggery includes calcium, phosphorus, magnesium, potassium and iron and traces of zinc and copper. The vitamin content includes folic acid and B-complex vitamins. Thus, other than that it is a good source of energy, it also prevents rheumatic afflictions; prevents disorders of bile; helps in relieving fatigue, relaxation of muscles, nerves and blood vessels; maintains blood pressure and reduces water retention; increases hemoglobin level and prevents anemia. Bakery and confectionery products are furnished with nutrients, vitamins, and proteins.

As the major producer of Jaggery, the country has recognized as one of the leading traders and exporters of Jaggery to the world. India exported 2,92,212.03 MT of jaggery and confectionery products to the world for the worth of Rs. 1,289.26 crores during the year 2015-16. Major Export Destinations (2015-16): Nigeria, Nepal, United Arab Emirates Kenya and Sudan.

India is the largest consumer and the second largest producer of sugar in the world. Sugar industry is the second largest organized sector industry in the country (Singhal, 2003). Among the sugar yielding crops like sugarcane, sugar beet, palms and sorghum, sugarcane is the most important. During the past five decades though sugarcane production has increased around three-fold, the sugar recovery has not shown any upward trend. It has always been hovering around 10 per cent (Nerkar, 2004). Therefore, the Indian sugar industry, presently, is facing a tough competition in the international market. The cost of sugar production in India is about 30 percent higher than the international market price. The demand for sugar in the country by 2050 will be 36.0 million tonnes for which the sugarcane production has to be 500 million tones.

Jaggery is a golden yellow to dark brown, coarse, wholesome, traditional, unrefined sugar obtained by concentrating the sugarcane juice (Jagannadha Rao et al., 2007). It is produced almost in 25 countries under different names,the most common ones being jaggery (South Asia), panela (Latin America), muscovado (Philippines) and kokuto (Japan) with an estimated production of 10-11 million tones per year (FAO,2007).In the early 1930's, nearly 2/3rd of sugarcane production was utilized for production of jaggery and khandsari, which are the natural mixture of sugar and molasses. With the introduction of sugar mills and their multiple growth, better standard of living and higher per capita income, the sweetener demand has shifted to white sugar which contains purely sucrose (99.7%). In spite of this, still, at present (2012-13) about 14.2% of cane produced is being utilized for producing jaggery and khandsari (Anonymous, 2014 b and 2014 c), which is a dominant cottage industry in rural India, engaging over 2.5 million people. However, being in the small-scale sector, these two sectors are completely free from controls and taxes, which are applicable to the sugar sector.

To asses the future scenario, the National Commission on Agriculture(1976) estimated that, by 2020 AD, the per capita consumption of sweeteners would increase to about 40 kg per annum from the current level of 22.6 and the country's population to 1218 million. Thus, the country would need about 50.75 million tonnes of sweeteners, of which jaggery and khandsari would be about 23.75 million tonnes against today's (2011-12) production level of 6.0 to 6.5 million tones (Jagannadha Rao et al., 2009). Thus, there are strong indications that the jaggery and khandsari cottage industry would continue to play an important role in processing sugarcane at rural level and in creating employment opportunities to the millions of people in rural areas.

Keeping in view of the above facts and to meet the growing demand of population for sweeteners, to generate employment and income earning opportunity for providing livelihood security to the small and marginal farmers and unemployed rural youth, jaggery production may be increased at large scale with improved technology.

Crop Pattern in Mandya: sugarcane is an important commercial crop of the state which is having highest net returns per rupee invested (69%) as compared to Paddy (15%), Maize, Ragi or other cereal crops cultivated in the command area, more so in Mandya region. Hence, the farmers are forced to take up cane cultivation inspite of hardship in raising crop the particularly from the point of view of its duration and water guzzling nature leading to longer gestation period for returns on investment. This is because of non availability of labour and unparallel returns of cereals/pulse production systems.

Area Jurisdiction

Mandya District comprises of seven taluks with a geographical area of 498244 ha with net sown area of 189090 ha out of which sugarcane occupies 16.81 per cent of area (31800 ha.) From among the taluks Maddur, Mandya, K.R. Pet and Srirangapatna of the predominant sugarcane growing taluks with a productivity potential of 110.7 tons/ha and with a production of about 1 lakh tons of jaggery. It is observed that the District produce 35.24 lakh tons of cane with six functional sugar mills in the district. The mills absorb 68.13 per cent of sugarcane for sugar extraction (22.25 lakh tons) with 32 per cent of cane being diverted for jaggery making (Anon., 2014). Further, it is observed that there is a wide gap between the jaggery processed and arrival of it for sale in the APMC market.

Table 13.1.1: Area, Production and Productivity of Sugarcane and Jaggery Production in Mandya District

Taluk	Area (ha)	Production (tons)	Productivity (t/ha)	Jaggery Production (tons)
K.R. Pet	4500	508500	113	14644.80
Maddur	6500	715000	110	20592.00
Malavalli	2500	275000	110	7920.00
Mandya	7200	792000	110	22809.60
Nagamangala	100	11000	110	316.80
Pandavapura	6500	728000	112	20966.40
Srirangapatna	4500	495000	110	14256.00
Mandya District	**31800**	**3524500**	**110.71**	**101505.60**

In the early 1990s there were nearly 5000 jaggery units in Mandya District but at present, the number has dwindled to <1000. Out of which hardly 50 per cent of them are functional due to the reasons *viz.*,number of jaggery boiling units has reduced gradually because of market fluctuations over the years.Open boiling is followed in the preparation of jaggery in the jaggery units of farmers which is an age old method. The ambience of these jaggery units is most unhygienic. Further, industrial chemicals like hydrose (sodium hydrosulphite), Sodium formaldehyde sulphoxylate (Chakke), baking soda, washing soda, urea, SSP, etc., Most of these chemicals are used in very high doses during jaggery preparation. These chemicals pose serious health hazards to human beings. In addition, the jaggery so prepared has a very short shelf life.

The industry has greatest potential in absorbing the local artisan & labour force for processing of jaggery and generate employment to the tune of 20 lakh man days for a duration of 210-270 days in an year. Hence, jaggery processing industry which is a cottage industry needs to be modernized on top priority in order to ensure regular flow of income in the CCA besides prevention of migration.

Jaggery is an unrefined nutritional sugar from sugarcane, which can be processed by adopting two methodologies *viz.*, open pan system and steam based jaggery preparation. Indeed, the steam based jaggery processing is the most advance technology which is eco friendly besides yielding better quality jaggery which is nutritionally rich because of indirect heating of juice. Besides it is highly economical in terms of labour as well as fuel. Thus, this technology needs to be up scaled in order to encash the export potential of jaggery.

Technology intervention for scientific jaggery production

Parameter	Existing	Intervention
Soil type:	Saline alkali patches, sodic soils – 1000 ha. leads to poor quality jaggery and less keeping quality. Yield levels in these soils are drastically reduced to half the potential. Yield level of 20-25 ton/ac. So it is advisable to reclaim these problematic soils and go for cane cultivation.	Yield increase by soil reclamation by 40t/ac. 15 ton/ac yield increase, resulting in good quality jaggery of 4 t/ac – yield a quality of jaggery increased by 37%. 2500 acre x 15 t/ac = 37500 tons of sugarcane =3375 of jaggery
Spacing	Narrow spacing (2-2.5 feet) without intercropping	wide row planting (4’x1 or 5 x 1 or 6x 1) and intercropping – Enhances soil organic carbon icrease in yield by 10-15 %
Drip irrigation	Conventional surface irrigation	10000 ha. under drip – yield increase by 25 % = 1.0 lakh tons of sugarcane = 35% for jaggery making = 35000 tons =3150 tons of jaggery
Harvesting of cane	Harvesting leaving 1 node above the ground	Harvesting to the base of the plant results in yield increase by 2.0 tons/ha= 1830 tons
Pre cleaning	Arrest the growth of microbes and	Improves the quality of juice and jaggery

	reduces inversion	
Staling of cane	Cane staling results in deterioration in quality and yield	2 days staling results in 1 drop in sugar content Total for the district @ 1% = 1015 tons of jaggery increase can be expected apart from maintenance of quality
Crushing of cane	55% recovery of juice	Up to 65 per cent increased in juice extraction results in 10% addition of juice = 2% addition of jaggery =2030 tons of jaggery in the district
Filtration of juice	No filtration	Filtration of juice results in better colour and quality of jaggery. Devoid of impurities like mud, trash etc.,
Clarification of juice	Chemicals like hybrids washing soda, baking soda etc., are used. Shelf life in only 30 days	Chemicals pose health hazardous on consumption. Herbal clarificants can be used for better quality and production of chemical free health jaggery. Shelf life can be extended up to 90 days
Furnace efficiency	Efficiency is low. Bagasse produced is not sufficient for jaggery making. Incur extra cost on additional fuel to the tune of Rs. 1-1.5 lakh per annum.	Improved furnace will enhance fuel efficiency. 1.50-1.75 kg bagasse/kg. Jaggery is the fuel requirement. Avoids additional expenditure
Packing	Transport jaggery in open. Dust, dirt and microbes will invade	Polyolyfene packing at right moisture content. Enhances shelf life
Storage	In open condition without packing. Invasion of microbes, dirt, dust etc., Reduced shelf life of < 30 days	Packaged jaggery stored in well ventilated go downs – improves the shelf life up to 90 days and sustains quality
Marketing	APMC market. Fetches lower price, sometimes will not even cover breakeven point	Niche market for chemical free jaggery. Fetches higher profit

Jaggery Units at Mandya:

At present jaggery units have a production scale of 10 q of jaggery/day by consuming 10 tons of sugarcane with injudicious use of chemicals. Jaggery production involves in expenditure of Rs. 2500/ton of cane and Rs. 800 of processing cost of jaggery. As a result a quintal of jaggery incurs expenditure of Rs. 3300. Jaggery price in the market is highly volatile. In most of the occasions jaggery price in the APMC market runs at Rs. 3000-3300/q. This situation pushes the farmers to a condition where in even the cost incurred will not be covered with chemical jaggery production. Off course, the jaggery price sometimes reaches Rs. 4000-4500 during certain part of the year during which time there will be greater demand for sugarcane, the farmers may sell cane at higher price ever @ Rs. 300/ton. This escalates the cost of jaggery production. This trends continues till the next years cane production is released to the market and restores the original cane and jaggery price. Normally the off seasons for jaggery production elsewhere in the country would June-August during which period cane is available only in Karnataka and Maharashtra areas. This can be encashed for jaggery production and sale to other parts of the country.

Modernizations of jaggery units:

The jaggery units at present at Mandya are obsolete and out dated. The crusher efficiency has to be increased for 65 per cent extraction from the present extraction of 55 per cent. Crushers have to be modified for extraction of more cane juice to avoid loss of sugar in bagasse. The conveyance of juice is under most unhygienic conditions. Conveyance and collection of juice in stainless steel pipes/containers is required instead of conveyance in the open channels done at present. Juice boiling pans have to be fabricated with food grade stainless steel instead of Iron/MS. The chances of contamination of metal iron are high when Iron/MS is used for fabrication.

Cooling pits have to be designed with materials for early and fast cooling of syrup, granite/ marble may be used for this purpose for hastening the cooling.

For designing of furnace it is better to use heat resistant bricks for higher heat efficiency. Improved furnace will save energy thereby additional expenditure on fuel can be minimized.

Hence, the functional jaggery units in Mandya districts either have to be modernized with additional establishment of steam based jaggery preparation units. The budget requirement for these activities as under

13.1 Open pan system (Existing farmers' jaggery units)

Capacity - 1 ton/day

Parameters	**Amount/ Units**
Equipment cost (Rs. in lakh)	
Crusher	3.50
Pans, Chimney, Mould etc.,	5.00
Building	3.50
Total	**12.00**
500 jaggery units are required with crushing capacity of 10 tons/day (1 ton of jaggery) for 240 days of crushing per year	
Modernizing existing jaggery units @ Rs. 6 lakh/ unit= 500 x 6	3000

13.2 Steam boiling units:

Steam boiling is a novel method of jaggery preparation by utilizing steam generated from the boiler for boiling of juice using evaporators with the main aim of production of hygienic quality chemical free jaggery.

Following are some of the advantages that could be achieved in steam boiling.

1. Effective Scum removal: In the production of organically processed jaggery removal of scum is important and for clarification only organic clarificants and flocculants are used. Gradual heating of juice will allow ample time to remove the scum and other suspended materials in the juice.

2. Evaporator in the system under closed boiling enhances fuel efficiency and steam from evaporators is recycled for preheating and heating of juice. This also improves the fuel efficiency.

3. The down time of the plant, auxiliary power consumption of the equipment etc., are greatly reduced.

4. The hygiene and safety of the workmen are ensured.

Evaporators:

Sugarcane juice after initial clarification is let in to the evaporators for further evaporation of moisture in the juice till it is taken to the final pan before moulding.

Time Span: Rate of evaporation of water is more in evaporators with steam compared to open pan boiling. This is because of the fact that the surface area exposed is more when juice is passed through the tubes containing steam. This results in faster evaporation of water from the juice. The surface area exposed in open pans is lesser which results in more time for evaporation of same quantity of water. In the evaporators the vapour can be collected and recycled where as in open pan it is not possible.

Fuel Efficiency: The package boilers have the fuel efficiency up to 72 per cent whereas in the open pan boiling it is merely 35 per cent. In addition, the steam boiling has got other advantages like hygienic conditions, good working environment, thermal efficiency and recovery of vapour which can be condensed for refeeding into the boiler. The comparison and contrast of important parameters of steam boiling and open pan boiling are as follows

Advantages of Evaporator:

1. Heat transfer isquick because of condensation of steam

2. Since surface area provided is more, rate of heat transfer is higher, as a consequence the efficiency is also high.

3. Since the juice is divided into thin vertical columns, the surface contact for heat transfer naturally increases

4. Heat transfer by convection is very fast

5. Time required in evaporator to attain required temperature, brix, viscosity etc. is very less

The Jaggery prepared from the steam boiling would result in higher quality Jaggery under most hygienic conditions. The plant set up at Jaggery Park has installed capacity of producing one quintal of Jaggery per boiling.

To set up steam boiling unit Rs 45 lakh is to be invested and for the entire Mandya district 134 such units are required for the present jaggery production level.

Parameter	**Amount/ Unit**
Equipment cost (Boiler, Evaporators etc.,)	Rs. 35 lakh
Building	Rs 10 lakh
Total	**Rs. 45 lakh/unit**
35 tons of cane @ 3 tons/day of jaggery x 240 days	8400 tons of cane
Model units of steam boiling	134 units
Total budget estimate	**Rs. 60.30 crores**

Export Potential:

Per capita consumption of sucrose in India is much lower (15 kg) compared to developed countries (50 kg). Major share (above 75%) of sucrose consumption in rich countries has been through manufactured foods. To over-come the problems posed by excess sucrose consumption, many of the countries are serious in looking for alternative sweeteners from sugarcane crop. In India, Jaggery is one such eco friendly sweetener which contributes more than 70% to the production of the world. It is exported to many countries like, Bangladesh, Great Britain, Canada, Chili, Egypt, Fiji, Iran, Kuwait, Malaysia, Nepal and USA.

Quality jaggery and its value added products such as jaggery chocolate and confectionaries made of various contributions of cereals, it is possible to significantly increase export of jaggery in solid, powder and liquid forms.

Table-13.1.2: Total Export of Jaggery and Confectioneries

Export	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**Average**
Qty in ‘000 MT	72.36	207.69	246.57	266.47	198.27
Value in crore Rs.	323.00	764.22	917.60	1,136.88	785.43

However, in Mandya district considering the total jaggery production of 117189 tons if model jaggery plants are set up in the district good quality chemical free/organic jaggery can be produced so that 50 per cent of the jaggery so produced (around 50000 tons) can find way to the international market which can bring the exchequer a whooping Rs. 20000 million. This can come to the rescue of large number of ailing farmers who are totally depending on the jaggery industry and industry per se.

Cost of Sugarcane production and Jaggery processing:

The cost of sugarcane production for a plant crop works out to Rs. 188731/ha and for ratoon crop it is Rs. 136457/ ha.

Cost on purchase of sugarcane is the major component in chemical free jaggery preparation and next comes the skilled labour for jaggery processing. Other costs include lime and bhendi stem, electricity etc. The cost of lump jaggery production works out to Rs. 3472/ quintal whereas it is slightly higher for powder jaggery (Rs. 3747/quintal).

Table-3:Cost of Jaggery Processing at Jaggery Park, V.C. Farm, Mandya during 2017

	Types of Jaggery			
Particulars	**Lump (Solid)**	**Powder**	**Liquid**	**Jaggery by Outsourcing Agency**
Cane procurement/ton	2300	2300	2300	2300
Lime @ 400 g/juice from one ton	7	7	7	7
Bhandi 1 kg/ juice from one ton	15	15	15	15
Coconut oil- 80 ml/batch	20	20	20	20
Labour /quintal of Jaggery	525	800	525	525
University lease charges/ton	-	-	-	567
Electricity charges Rs. /quintal	50	50	50	50
Diesel, oil, grease & maintenance of machineries and equipments Rs. /quintal	25	25	25	25
Packing charges @ Rs.2.5/kg	250	250	-	250
Bottling charges @ Rs.50/kg	-	-	6500	-
Preservatives	-	-	200	-
Bagasse fuel charge Rs. 150/kg	225	225	225	225
Depreciation cost Rs./ton	5	5	5	5
Technology charge Rs./ton	50	50	50	50
Total cost	**3472**	**3747**	**9922**	**4039**
Total Returns @10% recovery for solid & powder Jaggery and 13% recovery for liquid Jaggery	6000	7000	19500	6000
Bagasse 150 kg/ ton @ Rs 2/kg	225	225	225	225
Scum @ 3 % @ Rs 1/kg	30	30	30	30
Ash @1 % = 2 kg/ ton	5	5	5	5
Total Returns	**6260**	**7260**	**19760**	**6260**
Net Returns	**2026**	**2826**	**9356**	**1459**

Price of Lump jaggery @ Rs. 60/kg Price of Powder jaggery @ Rs. 70/kg
Price of Liquid jaggery @ Rs. 150/kg *Cost of sugarcane @ Rs. 2300/ ton, coconut coil @ Rs. 300/kg, Bhendi @ Rs. 5/kg, Bagasse @ Rs. 1.50/kg, labour @ 400/ man day
Note: These rates are as per the UAS (B) norms. The returns of outsourcing agency depends on selling price of jaggery by the agency

13.3: Feasibility of Organic Farming in Sugarcane.

Sugarcane cultivation by adopting organic farming practices has a great potential in processing chemical free jaggery in context of todays demand looking at its health benefits. However, such a production system can be practiced by adopting farmer's produce promotion society (FAPRO) a highly feasible model to rejenuate rural economy and self employment opportunity for rural youth by looking at the export potential for organically processed jaggery in the international erina, as discussed in the earlier para (Table 13.1.2). Besides, the Jaggery units have ample opportunities to generate employment in the rural area. The average crushing period noted in the study area was about 200 days in a year. Each processing unit provides 8-12 man days of employment per day. Thus each jaggery processing unit generates about 1600-2400 man days of employment in the rural area at very low cost. Therefore, jaggery processing sector has vast potential to improve the socio-economic status of farmers and strengthen the rural economy. In addition it has nutritional as well as nutricical values which is present in jaggery needs to be exploited for betterment of farming community.

The FAPRO Concept is a working model to incalcaluate work culture among rural youths and enables them to process and self market their own farm produce. Indeed, such type of system has been experimentally proved to be as a successful model in the state of Punjab wherein about 300 farmers are operating jaggery units by the FAPRO Members and as proved to be economical viable and sustainable. The same model may be implemented in the state of Karnataka for promote in organic jaggery processing.

Table 4: Cost of cultivation for sugarcane – Plant crop

Sl. No.	Particulars of operation	Labour/Input requirement	Unit cost (Rs.)		Total value (Rs.)
		Unit	Physical unit required		
1.	**Preparatory tillage**				
	a. Disc ploughing and harrowing	Tractor	20 hours	600/hour	12000
	b. Ploughing and passing cultivator	Bullock pair	05	450/pair	2250
	c. Opening of ridges and furrows	Bullock pair	05	450/pair	2250
2.	**Manures and manuring**				
	a. FYM		25 t/ha	600/t	15000
	b. Transportation and application of FYM	Labours	33	150/labour	4950
	c. Fertilizers	Urea SSP MOP	550 kg 625 kg 210 kg	265/50 kg 335/50 kg 786/50 kg	2915 4438 3301
	d. Application of fertilizers (3 times)	Labours	40	150/labour	6000
3.	**Seeds and sowing**				
	a. Seed setts		7.5 t	2970/t	26425
	b. Sett harvesting, transportation, detrashing and sett preparation	Labours Bullock pair	25 2	150/labour 450/pair	3750 900
	c. Sett treatment - Bavistin	 Labours	1.0 kg 10	700/kg 150/labour	700 1500
	d. Spreading, irrigation and planting	Labours	40	150/labour	6000

4.	**Inter cultivation, earthing up and after care**				
	a. Chemical weed control – Atrazine Spraying of herbicides	Labours	2.5 kg 6	450/kg 150/labour	1125 900
	b. One hand weeding (light)	Labours	20	150/labour	3000
	c. Harrowing and passing cultivators	Bullock pair	5	450/pair	2250
	d. Final earthing up and mending furrows	Labours	25	150/labour	3750
5.	**Irrigation (Approx. 40 irrigations)**	Labours	100	150/labour	15000
6.	Harvesting and marketing				
	a. Harvesting, bunding and loading to lorry	Labours	250	150/labour	37500
	b. Transportation charges		125 tonnes	100/t	12500
	c. Miscellaneous	Labours	25	150/labour	3750
Interest on paid out cost @ 14% for half of the period of growth for 1,18,404					16577
Total variable cost					172154
Total cost					**1,88,731**

Table 5: Cost of cultivation for sugarcane – Ratoon crop

Sl. No.	Particulars of operation	Labour/Input requirement		Unit cost (Rs.)	Total value (Rs.)
		Unit	Physical unit required		
1.	**Preparatory tillage**				
	a. Plot cleaning and stubble shaving	Labours	45	150/labour	6750
	b. Gap filling	Labours	35	150/labour	5250
	c. Shoulder breaking	Bullock pairs	10	450/pair	4500
2.	**Manures and manuring**				
	a. FYM		25 t/ha	600/t	15000
	b. Transportation and application of FYM	Labours	33	150/labour	4950
	c. Fertilizers d. Application of fertilizers (3 times)	Urea SSP MOP Labours	550 kg 625 kg 210 kg 40	265/50 kg 335/50 kg 786/50 kg 150/labour	2915 4438 3301 6000
4.	**Inter cultivation, earthing up and after care**				
	e. Chemical weed control – Atrazine Spraying of herbicides	 Labours	2.5 kg 6	450/kg 150/labour	1125 900
	f. One hand weeding (light)	Labours	20	150/labour	3000
	g. Harrowing and passing cultivators	Bullock pair	5	450/pair	2250
	h. Final earthing up and mending furrows	Labours	25	150/labour	3750
5.	**Irrigation (Approx. 40 irrigations)**	Labours	100	150/labour	15000
6.	Harvesting and marketing				
	e. Harvesting, bunding and loading to lorry	Labours	210	150/labour	31500
	f. Transportation charges		110 tonnes	100/t	11000
	g. Miscellaneous	Labours	25	150/labour	3750
Interest on paid out cost @ 14% for half of the period of growth for Rs. 79,129					11078
Total variable cost					125379
Total cost					**1,36,457**

Annexure - 1

ಕಬ್ಬು: ಕೃ.ವಿ.ವಿ ಧಾರವಾಡ

ಕಬ್ಬು ರಾಜ್ಯದ ಪ್ರಮುಖ ವಾಣಿಜ್ಯ ಬೆಳೆಯಾಗಿದ್ದು, ನೀರು ಬಸಿದು ಹೋಗುವಂತಹ ಮಧ್ಯಮ ಕಪ್ಪುಮಿಶ್ರಿತ ಮಣ್ಣು ಈ ಬೆಳೆಗೆ ಸೂಕ್ತ.ದೇಶದಲ್ಲಿ ಈ ಬೆಳೆಯನ್ನು 5.06 ದಶಲಕ್ಷ ಹೆಕ್ಟೇರ್ ಕ್ಷೇತ್ರದಲ್ಲಿ ಬೆಳೆಯುತ್ತಿದ್ದು, ಒಟ್ಟು ಉತ್ಪಾದನೆ 361.10 ದಶ ಲಕ್ಷ ಟನ್ ಇರುವುದು.ರಾಜ್ಯದಲ್ಲಿ ಈ ಬೆಳೆಯನ್ನು 4.20 ಲಕ್ಷ ಹೆಕ್ಟೇರ್ ಕ್ಷೇತ್ರದಲ್ಲಿ ಬೆಳೆಯುತ್ತಿದ್ದು 379.0 ಲಕ್ಷ ಟನ್ ಉತ್ಪಾದನೆ ಇದ್ದು, ಸರಾಸರಿ ಉತ್ಪಾದಕತೆಯು ಪ್ರತಿ ಎಕರೆಗೆ 38 ಟನ್ ಇರುವುದು (2013–14).

ತಳಿಗಳ ವಿವರ

ತಳಿಗಳು	ಅವಧಿ (ತಿಂಗಳು)	ನಾಟಿ ಮಾಡುವ ಕಾಲ
	ಅಲ್ಪಾವಧಿ	
ಸಿಓಸಿ–671	10–11	ಅಕ್ಟೋಬರ್–ನವ್ಹೆಂಬರ್
ಸಿಓ–94012	–ಸದರ–	ಜುಲೈ–ಅಗಸ್ಟ್
*ಎಸ್‌ಎನ್‌ಕೆ–044	–ಸದರ–	–ಸದರ–
	ಮಧ್ಯಮಾವಧಿ	
ಸಿಓ–86032 (ನಯನ)	12–14	ಜುಲೈ–ಅಕ್ಟೋಬರ್ ನವ್ಹೆಂಬರ್–ಫೆಬ್ರುವರಿ ಅಕ್ಟೋಬರ್–ನವ್ಹೆಂಬರ್ ಜನವರಿ–ಫೆಬ್ರವರಿ
ಎಸ್‌ಎನ್‌ಕೆ–632 (ವಲಯ–8)	12–13	ವರ್ಷ ಪೂರ್ತಿ

*ಬಿಳಿ ಉಣ್ಣೆ ಹೇನು ನಿರೋಧಕ ತಳಿ

ಸೂಚನೆ: ಮಾರ್ಚ್‌ದಿಂದ ಜೂನ್ ತಿಂಗಳವರೆಗೆ ನಾಟಿಮಾಡುವುದು ಸೂಕ್ತವಲ್ಲ.

ಬಿತ್ತನೆಗೆ ಬೇಕಾಗುವ ಬೇಸಾಯ ಸಾಮಗ್ರಿಗಳು (ಪ್ರತಿ ಎಕರೆಗೆ)

ಅ. ಬೀಜದ ತುಂಡುಗಳು

- 8–10 ತಿಂಗಳ ರೋಗರಹಿತ ನಾಟಿ ಕಬ್ಬಿನ ತುಂಡುಗಳನ್ನು ಉಗಿ ಉಷ್ಣೋಪಚಾರ ಎ.ಎಸ್.ಟಿ. ಘಟಕದಲ್ಲಿ 50^0 ಸೆಂ. ನಲ್ಲಿ ಒಂದು ತಾಸು ಉಪಚರಿಸಿ ಉಪಯೋಗಿಸಬೇಕು ಅಥವಾ ಉಪಚರಿಸಿ ಬೆಳೆಸಿದ ನಾಟಿ ಕಬ್ಬಿನಿಂದ ತುಂಡುಗಳನ್ನು ಆಯ್ಕೆ ಮಾಡಬೇಕು.
- ಕಾರ್ಬನ್‌ಡೈಜಿಮ್ 50 ಡಬ್ಲ್ಯೂ.ಪಿ. (ಶೇ. 0.1 ಪ್ರಮಾಣದಲ್ಲಿ) 100 ಗ್ರಾಂ + ಕ್ಲೋರ್‌ಪೈರಿಪಾಸ್ 20 ಇ. ಸಿ. (ಶೇ. 0.1 ಪ್ರಮಾಣದಲ್ಲಿ) 100 ಮಿ.ಲೀ. + ಯೂರಿಯಾ 100 ಗ್ರಾಂ ಇವುಗಳನ್ನು 100 ಲೀಟರ್ ನೀರಿನಲ್ಲಿ ಹಾಕಿ 10 ನಿಮಿಷ ಬೀಜೋಪಚಾರ ಮಾಡಬೇಕು.
- ಎಕರೆಗೆ 10,000 ದಿಂದ 14,000 ಮೂರು ಕಣ್ಣಿನ ತುಂಡುಗಳು ಬೇಕಾಗುತ್ತವೆ.

ಆ. ಸಾವಯವ ಗೊಬ್ಬರ

10 ಟನ್ ಕೊಟ್ಟಿಗೆ ಗೊಬ್ಬರ ಅಥವಾ
1 ಟನ್ ಎರೆಹುಳು ಗೊಬ್ಬರ ಅಥವಾ
5 ಟನ್ ಮಳ್ಳಿಗೊಬ್ಬರ (ಪ್ರೆಸ್‌ಮಡ್ ಕಾಂಪೋಸ್ಟ್)

ಸೂಚನೆ: ಸಾವಯವ ಗೊಬ್ಬರದಲ್ಲಿ 4 ಕಿ. ಗ್ರಾಂ ಅಜೋಸ್ಪಿರಿಲಂ + 4 ಕಿ. ಗ್ರಾಂ ರಂಜಕ ಕರಗಿಸುವ ಸೂಕ್ಷಾಣುಜೀವಿಗಳನ್ನು ಬೆರೆಸಿ, 2 ರಿಂದ 3 ವಾರ ಮೊದಲು ಮಣ್ಣಿನಲ್ಲಿ ಸೇರಿಸಬೇಕು.

ಇ. ಹಸಿರೆಲೆ ಗೊಬ್ಬರ: ನಾಟಿ ಮಾಡುವ ಪೂರ್ವದಲ್ಲಿ ಸಾಲು ಬಿಟ್ಟು ಸಾಲಿನ ಎರಡು ಮಗ್ಗಲು ಸಣಬನ್ನು ಅಥವಾ ಡೈಂಚಾ ಅಥವಾ ನವಧಾನ್ಯಗಳ (ಹೆಸರು, ಅಲಸಂದಿ, ಸೋಯಾಅವರೆ, ಉದ್ದು, ಕಡಲೆ, ಗುರೆಳ್ಳು, ಬಿಳಿಎಳ್ಳು, ರಾಜಗಿರಿ ಮತ್ತು ಕೋತಂಬರಿ) ಮಿಶ್ರಣವನ್ನು ಬಿತ್ತಿ, ಬೆಳೆ 45 ರಿಂದ 50 ದಿನಗಳಾದ ಸಾಲಿನಲ್ಲಿ ಮುಗ್ಗು ಹೊಡೆದು ಮುಚ್ಚಬೇಕು. ಸಾಧ್ಯವಾದರೆ ಇದೇ ರೀತಿ ಮತ್ತೊಂದು ಹಸಿರೆಲೆ ಬೆಳೆ ತೆಗೆದುಕೊಳ್ಳುವುದು ಉತ್ತಮ.ಎಕರೆಗೆ 24 ಕಿ. ಗ್ರಾಂ ಬೀಜ ಬೇಕಾಗುತ್ತದೆ.

ಈ. ರಾಸಾಯನಿಕ ಗೊಬ್ಬರ

ಸಾರಜನಕ	100 ಕಿ. ಗ್ರಾಂ
ರಂಜಕ	30 ಕಿ. ಗ್ರಾಂ
ಪೋಟ್ಯಾಷ್	75 ಕಿ. ಗ್ರಾಂ

ಸೂಚನೆ

- ಶೇ. 10, ಸಾರಜನಕ ಪೂರ್ತಿ ರಂಜಕ ಮತ್ತು ಪೋಟ್ಯಾಷ್ ಪೋಷಕಾಂಶಗಳನ್ನು ನಾಟಿ ಮಾಡುವಾಗ ಸಾಲುಗಳು ಮಧ್ಯದಲ್ಲಿ ಒದಗಿಸಬೇಕು. ಉಳಿದ ಸಾರಜನಕವನ್ನು ಮೇಲುಗೊಬ್ಬರವಾಗಿ ನಾಟಿಮಾಡಿದ
  6 ನೇ ವಾರಕ್ಕೆ ಶೇ. 20
  10 ನೇ ವಾರಕ್ಕೆ ಶೇ. 30
  14 ನೇ ವಾರಕ್ಕೆ ಶೇ. 40 (ಬೋದು ಒಡೆಯುವಾಗ)

ಸಾರಜನಕದ ಕೊರತೆಯಾದಾಗ ಎಲೆಗಳು ಹಳದಿಯಾಗುತ್ತವೆ. ಆದರೆ ಎಷ್ಟರಮಟ್ಟಿಗೆ ಎಲೆಗಳು ಹಳದಿಯಾದಾಗ ಸಾರಜನಕ ಕೊಡಬೇಕು ಎನ್ನುವುದನ್ನು ನಿರ್ದರಿಸುವಲ್ಲಿ ಎಲೆ ಬಣ್ಣದ ಪಟ್ಟಿ ಬಳಕೆ ಬಹಳ ಉಪಯುಕ್ತ.ನಾಟಿಯಾದ 45 ರಿಂದ 240 ದಿನಗಳವರೆಗೆ, ಪ್ರತಿ 15 ದಿನಗಳಿಗೊಮ್ಮೆ ಎಲೆಯ ಬಣ್ಣದ ಅಳತೆಮಾಡಬೇಕು.ಬೆಳೆಯ ಮೇಲಿನಿಂದ ಸಂಪೂರ್ಣವಾಗಿ ತೆರೆದ ಮೂರನೆ ಎಲೆಯ ಮಧ್ಯಭಾಗವನ್ನು ಸರಿಹೊಂದುವ ಬಣ್ಣದ ಛಾಯೆಯ ಮೇಲಿಟ್ಟು ಹೋಲಿಸಿ ಐದು ಕಡೆ ನೋಡಿ ಬಣ್ಣವನ್ನು ನಿರ್ಧರಿಸಬೇಕು.ಎಲೆಯ ಬಣ್ಣ ಪಟ್ಟಿಯ ಸರಾಸರಿ 5 ನೇ ಸಂಖ್ಯೆಗಿಂತ ಕಡಿಮೆಯಾಗಿದ್ದಲ್ಲಿ ಪ್ರತಿ ಸಾರಿ ಎಕರೆಗೆ 20 ಕಿ. ಗ್ರಾಂ ಸಾರಜನಕವನ್ನು ಮೇಲುಗೊಬ್ಬರವಾಗಿ ಕೊಡಬೇಕು.

ಸೂಚನೆ:

1. ಎಲೆಯ ಬಣ್ಣ, ಪಟ್ಟಿಯ 5 ನೇ ಸಂಖ್ಯೆಗಿಂತ ಹೆಚ್ಚಾಗಿದ್ದಲ್ಲಿ ಸಾರಜನಕ ನೀಡುವ ಅವಶ್ಯಕತೆಯಿಲ್ಲ. ಎಲೆ ಬಣ್ಣದ ಪಟ್ಟಿಯ ಬಳಕೆಗೆ ಸೂಚನೆಗಳು ಹಾಗೂ ಇತರೆ ಮಾಹಿತಿಗಾಗಿ ಭತ್ತದ ಬೆಳೆಯ ಪುಟ ಸಂಖ್ಯೆ 23 ರಿಂದ 24 ನ್ನು ನೋಡಬೇಕು.
2. ಈ ತಾಂತ್ರಿಕತೆಯನ್ನು ಈ ಕೆಳಗಿನ ತಳಿಗಳಲ್ಲಿ ಬಳಸಬಹುದು.
   ಸಿಓಸಿ 671, ಸಿ.ಓ.94012, ಸಿಓಎಮ್ 265, ಎಸ್ಎನ್‌ಕೆ 814 ಮತ್ತು ಸಿಓ 92005

ಉ. ಲಘು ಪೋಷಕಾಂಶಗಳ ಬಳಕೆ

ಮಣ್ಣು ಪರೀಕ್ಷೆಗನುಸಾರವಾಗಿ ಕೊರತೆಯ ಲಕ್ಷಣ ಕಂಡುಬಂದಾಗ ಈ ಕೆಳಗಿನ ಲಘು ಪೋಷಕಾಂಶಗಳನ್ನು ಒದಗಿಸಬೇಕು.

ಪೋಷಕಾಂಶ	ರಸಗೊಬ್ಬರ	ಮಣ್ಣಿಗೆ ಒದಗಿಸುವುದು (ಕಿ.ಗ್ರಾಂ/ ಎ)	ಸಿಂಪರಣೆ ಮೂಲಕ (ಪ್ರಮಾಣ)
ಕಬ್ಬಿಣ	ಕಬ್ಬಿಣದ ಸಲ್ಫೇಟ್	8–10	ಶೇ. 0.25–0.5
ಸತುವು	ಸತುವಿನ ಸಲ್ಫೇಟ್	8–10	ಶೇ. 0.2–0.5
ತಾಮ್ರ	ತಾಮ್ರದ ಸಲ್ಫೇಟ್	4–6	ಶೇ. 0.1–0.2
ಮಾಲಿಬ್ಡಿನಂ	ಅಮೋನಿಯಂ– ಮೊಲಿಬ್ಡೇಟ್	0.4–0.8	ಶೇ. 0.02–0.05
ಮ್ಯಾಂಗನೀಸ್	ಮ್ಯಾಂಗನೀಸ್ ಸಲ್ಫೇಟ್	4–6	ಶೇ. 0.2–0.5
ಬೋರಾನ್	ಬೋರ್ಯಾಕ್ಸ್	0.4–2.0	ಶೇ. 0.1–0.2

ಊ. ನಾಟಿ ಮಾಡುವುದು: ಭೂಮಿಯನ್ನು ಎರಡು ಮೂರು ಬಾರಿ ಚೆನ್ನಾಗಿ ಉಳುಮೆ ಮಾಡಿ ನಾಟಿಗೆ ಸಿದ್ಧಪಡಿಸಿ 90 ಸೆಂ. ಮೀ.ಅಂತರದ 15–25 ಸೆಂ.ಮೀ.ಆಳವಾದ ಸಾಲು ಮತ್ತು ಬೋದುಗಳನ್ನು ಮಾಡಬೇಕು.ನಂತರ ಬೀಜೋಪಚಾರ ಮಾಡಿದ ಉತ್ತಮ ಕಣ್ಣುಗಳುಳ್ಳ ತುಂಡುಗಳನ್ನು ಸಾಲಿಗೆ ನೀರು ಬಿಟ್ಟು ಸಾಲಿನಲ್ಲಿ ತುಳಿಯಬೇಕು.

ನಾಟಿ ಪದ್ಧತಿಗಳು

1. ಆಳವಾದ ಕಪ್ಪು ಭೂಮಿಯಲ್ಲಿ 90 ಸೆಂ. ಮೀ. ಅಂತರದ ಬೋದು ಮತ್ತು ಸಾಲುಗಳನ್ನು ಮಾಡಬೇಕು.
2. ಮಧ್ಯಮ ಆಳದ ಕಪ್ಪು ಭೂಮಿಗೆ 60 ಅಥವಾ 90 ಸೆಂ. ಮೀ. ಸಾಲುಗಳನ್ನು ಮಾಡಿ, ಎರಡು ಸಾಲು ನಾಟಿ ಮಾಡಿ ಒಂದು ಸಾಲು ಹುಸಿ ಬಿಡಬೇಕು. ಅದರಲ್ಲಿ ಅಂತರ ಬೆಳೆಗಳನ್ನು ಲಾಭದಾಯಕವಾಗಿ ಬೆಳೆಯಬಹುದು. ಈ ಪದ್ಧತಿಯಲ್ಲಿ ಇಳುವರಿ ಕಡಿಮೆಯಾಗದೆ, ಅಂದಾಜು ಶೇ. 40 ಊಷಂಔ ನೀರಿನ ಉಳಿತಾಯ ಆಗುವುದು. ಅಗಲದ ಸಾಲು ಪದ್ಧತಿಯಲ್ಲಿ 120 ಸೆಂ. ಮೀ. 150 ಸೆಂ. ಮೀ. ಅಥವಾ 180 ಸೆಂ. ಮೀ. ಅಂತರದಲ್ಲಿ ಒಂದು ಸಾಲನ್ನು ರಿಡ್ಜರದಿಂದ ತೆಗೆದು ಅದರಲ್ಲಿ ಒಂದು ಕಣ್ಣಿನ ಕಬ್ಬಿನ ಸಸಿ ಅಥವಾ ಕಬ್ಬು ನಾಟಿ ಮಾಡುವುದರಿಂದ ಸಾಲುಗಳ ಮಧ್ಯ ಅಂತರ ಬೆಳೆಗಳನ್ನು ಲಾಭದಾಯಕವಾಗಿ ಬೆಳೆಯಬಹುದಲ್ಲದೇ, ಹನಿ ನೀರಾವರಿಗೆ ಅನೂಕೂಲವಾಗುವುದು.
3. ಕೆಂಪು ಭೂಮಿ ಮತ್ತು ನೀರಿನ ಕೊರತೆಯಿದ್ದಲ್ಲಿ ಗುಣಿ ನಾಟಿ ಪದ್ಧತಿ ಲಾಭದಾಯಕ. ಒಂದು ಮೀಟರ್ ಉದ್ದ, ಒಂದು ಮೀಟರ್ ಅಗಲ ಮತ್ತು 45 ಸೆಂ. ಮೀ. ಆಳದ ಗುಣಿಗಳನ್ನು ತೆಗೆಯಬೇಕು. ಗುಣಿಗಳು ಸಾಲಿನಿಂದ ಸಾಲಿಗೆ 90 ಸೆಂ.ಮೀ. ಹಾಗೂ ಸಾಲಿನಲ್ಲಿ 45 ಸೆಂ. ಮೀ. ಅಂತರ ಇರುವಂತೆ ನೋಡಿಕೊಳ್ಳಬೇಕು. ಗುಣಿಯ ತಳ ಭಾಗದಲ್ಲಿ 15 ಸೆಂ. ಮೀ. ಮಣ್ಣನ್ನು ಹಾಕಿ ನಂತರ 15 ಸೆಂ. ಮೀ. ಹಾಗೂ 4 ಸೆಂ. ಮೀ. ದಪ್ಪ ಕಾಂಪೋಸ್ಟ್ ಮತ್ತು ಹಸಿರೆಲೆ ಗೊಬ್ಬರ ಹಾಕಬೇಕು. ಇನ್ನುಳಿದ 15 ಸೆಂ. ಮೀ. ಸ್ಥಳದಲ್ಲಿ ಉಳಿದ ಮಣ್ಣು, 150 ಗ್ರಾಂ ಯೂರಿಯಾ, 130 ಗ್ರಾಂ ಸೂಪರ್ ಫಾಸ್ಫೇಟ್ ಮತ್ತು 85 ಗ್ರಾಂ ಮ್ಯುರೇಟ್ ಆಫ್ ಪಷಂಟಊಚಿಷಾಳನ್ನು ಸೇರಿಸಬೇಕು. ಇಂತಹ ಪ್ರತಿಯೊಂದು ಗುಣಿಯಲ್ಲಿ ನಾಟಿ ಮಾಡಲು ಎರಡು ಕಣ್ಣುಗಳುಳ್ಳ 20 ಬೀಜದ ತುಂಡುಗಳನ್ನು ಉಪಯೋಗಿಸಬೇಕು. ಸಾಲಿನಿಂದ ಸಾಲಿಗೆ ಇರುವ 90 ಸೆಂ. ಮೀ. ಸ್ಥಳವನ್ನು ನೀರು ಬಿಡಲು ಕಾಲುವೆಯನ್ನಾಗಿ ಬಳಸಬೇಕು. ಪ್ರತಿ ಎರಡು ಗುಣಿ ಸಾಲುಗಳ ನಂತರ ಕಾಲುವೆಯನ್ನು ಮಾಡಿ ಉಪಯೋಗಿಸಬೇಕು. ಒಂದು ಎಕರೆಗೆ ಸುಮಾರು 1460 ಗುಣಿಗಳು ಬೇಕಾಗುತ್ತವೆ.

ನೀರಾವರಿ

* ನಾಟಿ ಮಾಡಿದ ಮೇಲೆ 8 –10 ದಿನಕ್ಕೆ ತೆಳುವಾಗಿ ನೀರು ಕೊಡಬೇಕು.
* ಹವಾಗುಣಕ್ಕೆ ಅನುಗುಣವಾಗಿ ಭೂಮಿಯ ಗುಣಮಟ್ಟ ಅನುಸರಿಸಿ ಈ ಕೆಳಗೆ ತಿಳಿಸಿದಂತೆ ನೀರು ಕೊಡುವುದು ಉತ್ತಮ.

ಅ. ಮೊಳಕೆ ಒಡೆಯುವಾಗ (8–35 ದಿನಗಳವರೆಗೆ) 7 ದಿನಕ್ಕೊಮ್ಮೆ

ಬ. ಮರಿ ಒಡೆಯುವಾಗ (36–100 ದಿನಗಳವರೆಗೆ) 10 ದಿನಕ್ಕೊಮ್ಮೆ

ಕ.ಬೆಳವಣಿಗೆ ಹಂತದಲ್ಲಿ (101–270 ದಿನಗಳವರೆಗೆ) 7 ದಿನಕ್ಕೊಮ್ಮೆ

ಡ. ಮಾಗುವಾಗ (271–365 ದಿನಗಳವರೆಗೆ) 15 ದಿನಕ್ಕೊಮ್ಮೆ

ನೀರಿನ ಸಂಗ್ರಹ ಕಡಿಮೆಯಿದ್ದಲ್ಲಿ ಸಾಲು ಬಿಟ್ಟು ಸಾಲು ನೀರು ಹಾಯಿಸಬೇಕು.

ಬೇಸಿಗೆಯಲ್ಲಿ ಬರದ ನಿರ್ವಹಣೆ

- ಸಾಲು ಬಿಟ್ಟು ಸಾಲಿನಲ್ಲಿ ರವದಿಯನ್ನು ಹಾಕಬೇಕು ಹಾಗೂ ಖಾಲಿ ಇರುವ ಸಾಲುಗಳಲ್ಲಿ ನೀರು ಹಾಯಿಸಬೇಕು.
- ಒಂದು ಕಿ. ಗ್ರಾಂ ರವದಿ ಕಳಿಸುವ ಸೂಕ್ಷ್ಮಾಣುಜೀವಿಗಳನ್ನು ಪ್ರತಿ ಟನ್ ರವದಿಗೆ ಹಾಕಬೇಕು.
- ಕೊನೆಯ ನೀರು ಕೊಡುವಾಗ ಎಕರೆಗೆ 20 ಕಿ. ಗ್ರಾಂ ಪೋಟ್ಯಾಷ್ ಗೊಬ್ಬರವನ್ನು ಕೊಟ್ಟು ಎಲ್ಲ ಸಾಲುಗಳಿಗೆ ರವದಿ ಹೊದಿಸಬೇಕು.
- ಶೇ. 2.5 ಯೂರಿಯಾ ಅಥವಾ ಶೇ. 2.5 ಮ್ಯುರಿಯೇಟ್ ಆಫ್ ಪೋಟ್ಯಾಷ್ ದ್ರಾವಣವನ್ನು ಬರದ ಸಮಯದಲ್ಲಿ ಪ್ರತಿ 15–20 ದಿನಕ್ಕೊಮ್ಮೆ ಎಲೆಗಳ ಮೇಲೆ ಸಿಂಪರಣೆ ಮಾಡಬೇಕು.

ಕಬ್ಬಿನಲ್ಲಿ ಹನಿ ನೀರಾವರಿ ಮತ್ತು ರಸಾವರಿ: ಕಬ್ಬು ಮುಖ್ಯವಾದ ವಾಣಿಜ್ಯ ಬೆಳೆಯಾಗಿರುವುದರಿಂದ ಹನಿ ನೀರಾವರಿಯನ್ನು ವಲಯ 3 ಮತ್ತು 8 ರಲ್ಲಿ ಸುಲಭವಾಗಿ ಅಳವಡಿಸಿಕೊಳ್ಳಬಹುದು. ಹನಿ ನೀರಾವರಿ ಪದ್ಧತಿಯಲ್ಲಿ ನೀರನ್ನು ಉಳಿತಾಯ ಮಾಡಬಹುದಲ್ಲದೆ, ವಿದ್ಯುತ್, ರಸಗೊಬ್ಬರ ಮತ್ತು ಕೃಷಿ ಕಾರ್ಮಿಕರ ವೆಚ್ಚವನ್ನು ಕಡಿಮೆ ಮಾಡಬಹುದು. ಕಬ್ಬಿನಲ್ಲಿ

ಹನಿನೀರಾವರಿಯನ್ನು ಅಳವಡಿಸುವುದರಿಂದ ಖರ್ಚು ಹೆಚ್ಚಾದರೂ ಉಳಿತಾಯವಾದ ನೀರಿನಿಂದ ನೀರಾವರಿ ಕ್ಷೇತ್ರವನ್ನು ದ್ವಿಗುಣಗೊಳಿಸಿ ಇದರ ವೆಚ್ಚವನ್ನು 2 ರಿಂದ 3 ವರ್ಷಗಳಲ್ಲಿ ಮರಳಿ ಪಡೆಯಬಹುದು.ಆದ್ದರಿಂದ ಕಬ್ಬಿನಲ್ಲಿ ಹನಿ ನೀರಾವರಿ ಮತ್ತು ರಸಾವರಿ ಪದ್ಧತಿಯನ್ನು ಸೂಕ್ತವಾಗಿ ಅಳವಡಿಸಬಹುದು.

ಕಬ್ಬಿನಲ್ಲಿ ಹನಿ ನೀರಾವರಿ ಪದ್ಧತಿಯಿಂದ ಶೇ.40 ರಷ್ಟು ನೀರನ್ನು ಉಳಿತಾಯ ಮಾಡಬಹುದು. ಹನಿ ನೀರಾವರಿ ಪದ್ಧತಿಯಲ್ಲಿ ಸಾಮಾನ್ಯ ಸಾಲುಗಳ ಪದ್ಧತಿಗೆ ಬದಲಾಗಿ 60–180–60 ಸೆಂ.ಮೀ (2–6–2 ಅಡಿ) ಜೋಡು ಸಾಲು ಪದ್ಧತಿಯನ್ನು ಅಥವಾ 5, 6, 7 ಅಡಿ ಅಂತರದ ಒಂದೇ ಸಾಲಿನಲ್ಲಿ ಅಳವಡಿಸುವುದರಿಂದ 6 ಅಡಿ ಅಂತರದಲ್ಲಿ ಒಂದು ಲ್ಯಾಟರಲ್ ಪೈಪನ್ನು ಅಳವಡಿಸಬಹುದು. ಹನಿ ನೀರಾವರಿಯಲ್ಲಿ ನೀರನ್ನು ಪ್ರತಿ ದಿನಕ್ಕೊಮ್ಮೆ ವಿವಿಧ ಹಂಗಾಮಿನಲ್ಲಿ ಕೋಷ್ಟಕದಲ್ಲಿ ತಿಳಿಸಿದಂತೆ ಒದಗಿಸಬೇಕು.

ಕೋಷ್ಟಕ: ಕಬ್ಬಿನಲ್ಲಿ ಪ್ರತಿ ಮೂರು ದಿವಸಗಳಿಗೊಮ್ಮೆ ಹನಿ ನೀರಾವರಿಗೆ ಬೇಕಾಗುವ ಸಮಯ

ತಿಂಗಳು	ಸರಾಸರಿ ಪ್ರತಿ ತಿಂಗಳು ಆವಿಯಾಗುವ ನೀರಿನ ಪ್ರಮಾಣ (ಮಿ. ಮೀ.)	ಕ್ರಾಪ್ ಫ್ಯಾಕ್ಟರ್ (ಕೆ. ಸಿ. ವ್ಯಾಲ್ಯು)		ಆವಿಯಾಗುವ ನೀರಿನ ಪ್ರಮಾಣಕ್ಕನುಸರಿಸಿ ಹನಿ ನೀರಾವರಿಗೆ ಪ್ರತಿ 3 ದಿನಗಳಿಗೊಮ್ಮೆ ಬೇಕಾಗುವ ಸಮಯ (ನಿಮಿಷಗಳಲ್ಲಿ) (ಡ್ರಿಪ್ಪರ್‌ಗಳಲ್ಲಿ ಹರಿಯುವ ನೀರಿನ ಪ್ರಮಾಣ 4 ಲೀ/ಘಂಟೆಗೆ)					
				ಹಂಗಾಮು ಪೂರ್ವ ನಾಟಿ (ಖ)			ಹಂಗಾಮಿನಲ್ಲಿ ನಾಟಿ (ಖಖ)		
		1 ನೆಯ ಹಂಗಾಮು	2 ನೆಯ ಹಂಗಾಮು	ಸಾಮಾನ್ಯ ಪದ್ಧತಿ	ಜೋಡು ಸಾಲು ಪದ್ಧತಿ		ಸಾಮಾನ್ಯ ಪದ್ಧತಿ	ಜೋಡು ಸಾಲು ಪದ್ಧತಿ	
				(90 ಸೆಂ. ಮೀ.)	60–120–60 (ಸೆಂ. ಮೀ.)	60–180–60 (ಸೆಂ. ಮೀ.)	(90 ಸೆಂ. ಮೀ.)	60–120–60 (ಸೆಂ. ಮೀ.)	60–180–60 (ಸೆಂ. ಮೀ.)
ಜನವರಿ	2.7	0.60	–	64	128	170	–	–	–
ಫೆಬ್ರುವರಿ	3.5	0.60	0.6	89	177	237	84	168	224
ಮಾರ್ಚ್	4.4	0.85	0.6	162	325	433	105	211	281
ಏಪ್ರಿಲ್	5.8	0.85	0.9	197	394	525	207	415	553
ಮೇ	6.1	1.00	0.9	243	486	648	219	439	585
ಜೂನ್	4.3	1.00	1.1	171	343	457	186	372	496
ಜುಲೈ	3.1	1.15	1.1	151	303	404	135	269	359
ಆಗಸ್ಟ್	2.6	1.15	1.15	123	246	328	120	240	320
ಸೆಪ್ಟೆಂಬರ್	2.8	1.15	1.15	129	258	344	126	258	343
ಅಕ್ಟೋಬರ್	3.2	1.15	1.15	106	287	382	147	293	391
ನವೆಂಬರ್	2.5	0.85	0.85	64	179	238	100	171	337
ಡಿಸೆಂಬರ್	2.5	0.85	0.85	89	170	227	83	167	223

ಕಬ್ಬಿನಲ್ಲಿ ರಸಾವರಿ: ಕಬ್ಬಿನ ಬೆಳೆಗೆ ಶಿಫಾರಸ್ಸು ಮಾಡಿದ ಶೇ 10 ರಷ್ಟು (10 ಕಿ.ಗ್ರಾಂ/ಎ) ಸಾರಜನಕ ಮತ್ತು ಪೋಟ್ಯಾಷ್ (7.5 ಕಿ.ಗ್ರಾಂ/ಎ) ಹಾಗೂ ಪೂರ್ಣ ರಂಜಕ (30 ಕಿ.ಗ್ರಾಂ/ಎ –ಪಾಸ್ಪರಿಕ್ ಆಸಿಡ್), 10 ಕಿ.ಗ್ರಾಂ/ಎ ಫೆರಸ್ ಮತ್ತು ಸತುವಿನ ಸಲ್ಫೇಟ್ ಒದಗಿಸುವ ರಸಗೊಬ್ಬರಗಳನ್ನು ಮೂಲ ಗೊಬ್ಬರವಾಗಿ ನಾಟಿ ಮಾಡಿದ ಮೊದಲ ಒಂದು ತಿಂಗಳಲ್ಲಿ ಹನಿ ನೀರಾವರಿ ಮುಖಾಂತರ ಕೊಡಬೇಕು. ನಂತರ ಶಿಫಾರಸ್ಸಿನ ಶೇ.90 ಬಘುಂಔ ಸಾರಜನಕ (90.5 ಕಿ.ಗ್ರಾಂ) ಮತ್ತು ಶೇ. 90 (67.5 ಕಿ.ಗ್ರಾಂ) ರಷ್ಟು ಪೋಟ್ಯಾಷ್ ಪೋಷಕಾಂಶಗಳನ್ನು ಯೂರಿಯಾ ಮತ್ತು ಬಿಳಿಬಣ್ಣದ ಮ್ಯುರೆಟ್ ಆಫ್ ಪೋಟ್ಯಾಷ್ ರೂಪದಲ್ಲಿ ರಸಾವರಿ ಮೂಲಕ ನಾಟಿ ಮಾಡಿದ 2ನೇ ತಿಂಗಳಿನಿಂದ 8 ಕಂತುಗಳಲ್ಲಿ ಪ್ರತಿ ತಿಂಗಳಿಗೆ (64 ಕಿ.ಗ್ರಾಂ ಯೂರಿಯಾ+ 36 ಕಿ.ಗ್ರಾಂ ಬಿಳಿಬಣ್ಣದ ಮ್ಯುರೆಟ್ ಆಫ್ ಪೋಟ್ಯಾಷ್) ಗೊಬ್ಬರಗಳನ್ನು ವೆಂಚುರಿ ಮೂಲಕ ಹನಿ ನೀರಾವರಿಯಲ್ಲಿ ಕೊಡಬೇಕು.

ANNEXURE -2

RSJRS, Kolhapur

PP-Sugarcane cultivation:

India Coordinated Research project on Post Harvest Engineering Technology,

Regional Sugarcane and Jaggery Research Station, Kolhapur

JAGGERY PRODUCTION TECHNOLOGY

I) Pre Harvest Technology

1) Soil: Well drained soils, medium to deep. Avoid the salty, alkaline and calcareous soil,

2) Recommended varieties:

i) Early maturing- CoC671, Co8014, Co 7219 and Co 92005 (released)

3) Fertilizer application: For better jaggery quality 20% reduction in nitrogen fertilizer is recommended while phosphorus and potash fertilizers should be applied as per recommendations for sugarcane crop.

4) Irrigation: Excess irrigation as well as moister stress affects the quality of jaggery. Irrigation to sugarcane crop should be applied considering the season and type of soil. Sugarcane crop should not be irrigated minimum 15 days before harvesting.

5) Sugarcane harvesting: Sugarcane crop should be harvested for jaggery when juice brix is more than 21^0 . The cane crop should be harvested close to the ground level and top of 2-3 immature internodes should not be used for jaggery production. Detrashed clean sugarcane should used for crushing.

II) Post Harvest Technology

1) Cane crushing: After harvesting the sugarcane should be crushed as early as possible. The sugarcane staling period should not be more than 12 hrs., in any case. For crushing, horizontal three roller crusher having juice extraction efficiency about 65 % may be selected. The extracted juice should be cleaned by using two stage filtration system. The juice from collection tank is pumped into overhead tank for natural settling. After juice from storage tank to the boiling pan it should passed through nylon cloth for filtration.

2) Juice boiling: Fro boiling of juice, improved Kolhapur type chimney chulhan (Furnace) is used. Generally 1000 liter of juice is taken in boiling pan for jaggery processing. Dried cane bagasse used as fuel for boiling. The pH of fresh juice ranges between 5.2 to 5.4 needs to be raised upto 6.5-7.0. The alkaline pH juice facilitate the coagulation of suspended impurities of gummy colloidal substances. It also helps to avoid inversion of sugar. For this purpose lime solution (prepared by dissolving lime @ 150-200 g in 5 liters of water for 1000 liter of juice) is added in cane juice.

3) Juice clarification For clarification of juice, the vegetative clarificants, okra plant (wild species) stalk extract is used. This extract is prepared by crushing 2 kg of okra plant stalk and soaking in 15 liters of water. The filtered extract is added in juice for clarification. At 85^0 C temp., the nitrogenous impurities in juice stats coagulate and float on surface as black scum which is removed by strainer.

To avoid effect of excess nitrogen and lime on jaggery colour, the arsenic free phosphoric acid is applied @ 150-200 ml/ 1000 liter of cane juice. The phosphoric acid should applied accurately otherwise excess quantity will make the jaggery more soft. Removal of second golden scum should be carried out during boiling as and when it appears on top of juice.

4) Juice concentration: After clarification of juice, when temperature rises to about 99^0 to 100^0 C the juice begins to froth. To control excess frothing and to avoid loss of juice due to overflowing, continuous stirring is applied by churner. After defrothing, juice get concentrated and at 103^0 – $105^{0\ C}$ temperature the liquid jaggery stage is attained. The liquid is further concentrated and edible oil @ 200ml / 1000 liter of juice is mixed. Application of edible oil helps to increase temperature of liquid without caramelization. The electronic thermometer with 1 m long sensor attached to the boiling pan is used for accurate recording of juice temperatures at different stages.

5) Jaggery cooling and Moulding: At $118^0 \pm 0.5^0$ C temperature of liquid the jaggery stage is observed. This stage could be ascertained by jaggery ball test. Immediately at this stage, the boiling pan is removed from furnace and hot jaggery is poured in cooling oit. Generally cooling pit size. 91/2' x 91/2' x 1/2' are constructed in ground and lined on all sides with kadappa tiles. During cooling, two stirrings are applied to hot jaggery with wooden ladles. This stirring application helps to improve colour and granularity of jaggery. Before the temperature of jaggery drops down to 76^0C, the hot jaggery mass is filled in different size moulds as per market demand. After complete cooling, jaggery is removed from moulds and allowed to dry for 48 hrs.

Pilot Plant For Production of Quality Jaggery

Year of establishment of the pilot plant: 2003-2004.

Cost of establishment of the pilot plant: Rs. 7.50 lakhs

Grants sanctioned by AICRP on Post Harvest Technology, Ludhiana

(Indian Council of Agriculture Research, New Delhi)

Salient features:

- As per the directives from the ICAR,.all the equipments, machineries, accessories required for jaggery processing have been fabricated from stainless steel (304 grade) and wherever required from the food grade plastic material.
- Jaggery production in clean and hygienic conditions
- Consistency in quality of jaggery production
- Labour and time saving operations
- Fuel saving due to energy efficient furnaces and two pan system
- Utilization of waste heat of flue gases by routing beneath second pan
- Minimization of risk and hazards during jaggery production
- Ideal plant layout – sequent ional arrangement and installation of equipments with best utilization of minimum space.

Technical Information :

A) General Information

Production process	:	Batch type process
		Duration ~ 2 hrs
Capacity	:	500 liter juice processing per batch
Production per batch	:	Solid jaggery – 105 kg or Liquid jaggery -120 kg

B) Information on equipment

Sugarcane crusher	:	Horizontal, three roller (SS 319)
		Crushing capacity – 600 kg/hr
		Juice extraction % - 65 %
		Operated by 5 HP electric motor
		'V' belt and pully arrangement
		Cane requirement/batch – 770 kg

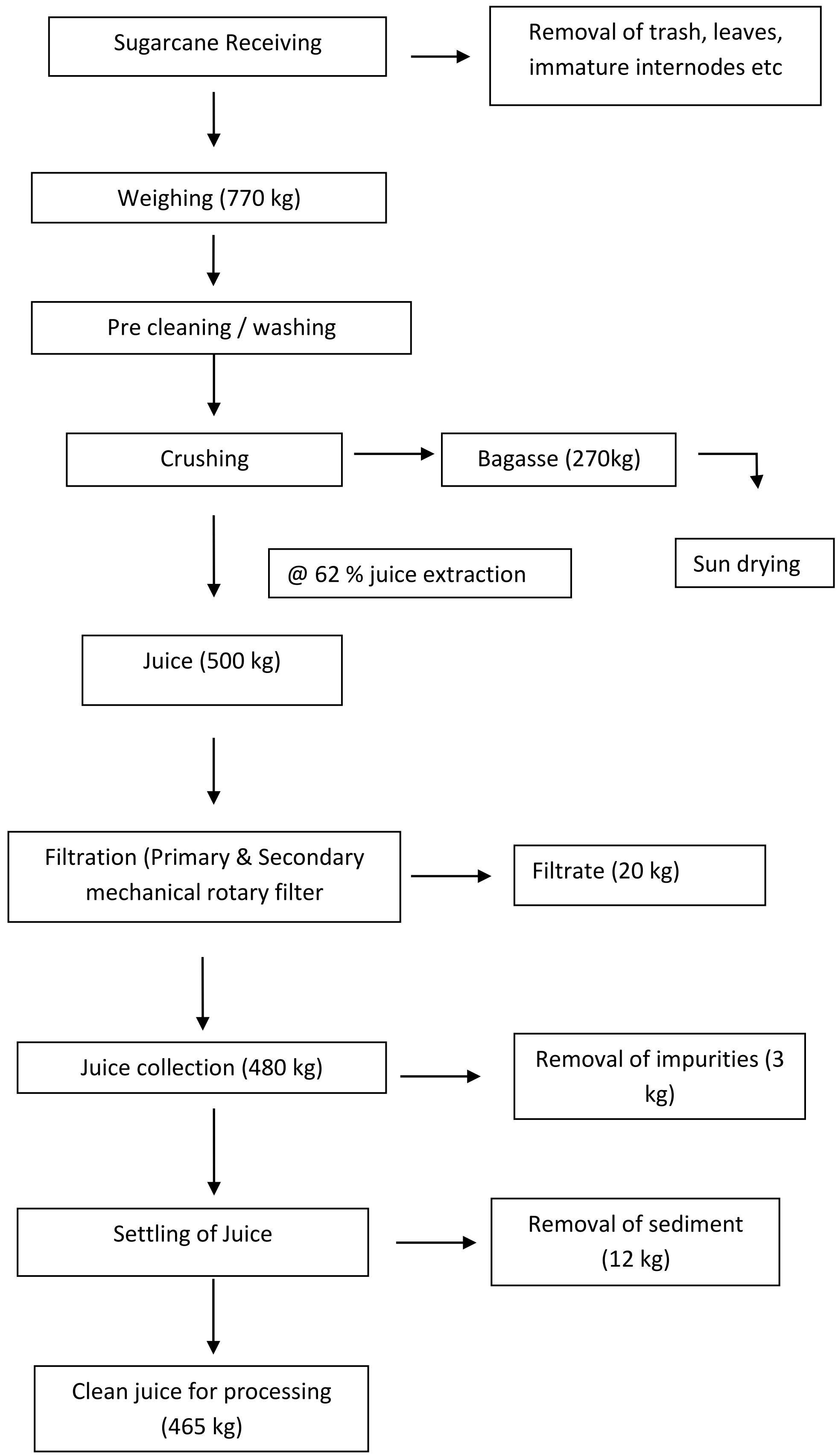
		Crushing time – 90 minutes
Filtration system	:	Two stage filtration a) Primary filter – SS, 4mm dia b) Mechanical rotary – SS sieve 0.5 mm covered over inclined rotary drum.
Boiling pan tipping	:	Two stainless steel pans, Cap. 500 liter. a) Pre heating or gutter pan, shape-rectangular heating surface area, Fabrication SS 304, 14 gauge, size 2000 x 600 x 660 mm b) Concentrating main pan, shape – regular circular, two valves at bottom for jaggery discharge, fabrication – SS 304, 14 gauge, size 2000 x 6600 x 400 mm
Boiling pan tipping	:	Frame – wheel – track arrangement for carrying the pan up to cooling pit. Lifting of pan and tilting of pan is carried out simultaneously.
Furnace	:	Modified Kolhapur type chimney chulhan, constructed from 'B' class fire bricks, provided with ash grate ash pit for better combustion efficiency. Damper and gates provision for control over natural draught, provision for forced draught system. Dia. – 1500 mm, Ht. 900 mm. Flue passage – 400x400 mm, carries hot exhaust air to pre heating pan, take turn at an angle of 45^0 before get connected to chimney. Provision of by pass gate and damper. Chimney – Bottom – 1650 x 1650 mm Top – 900 x 900 mm, Ht. – 6100 mm. Door provision for removal of ash.
Juice collection tank	:	SS 304, 18 gauge, circular, capacity – 500 lit. Dia – 1100mm, Ht. 900 mm, Conical bottom, provided with ball valve at bottom for cleaning lid provision
Juice Settling tank	:	SS 304, 18 gauge, circular, capacity – 600 lit. with lid,

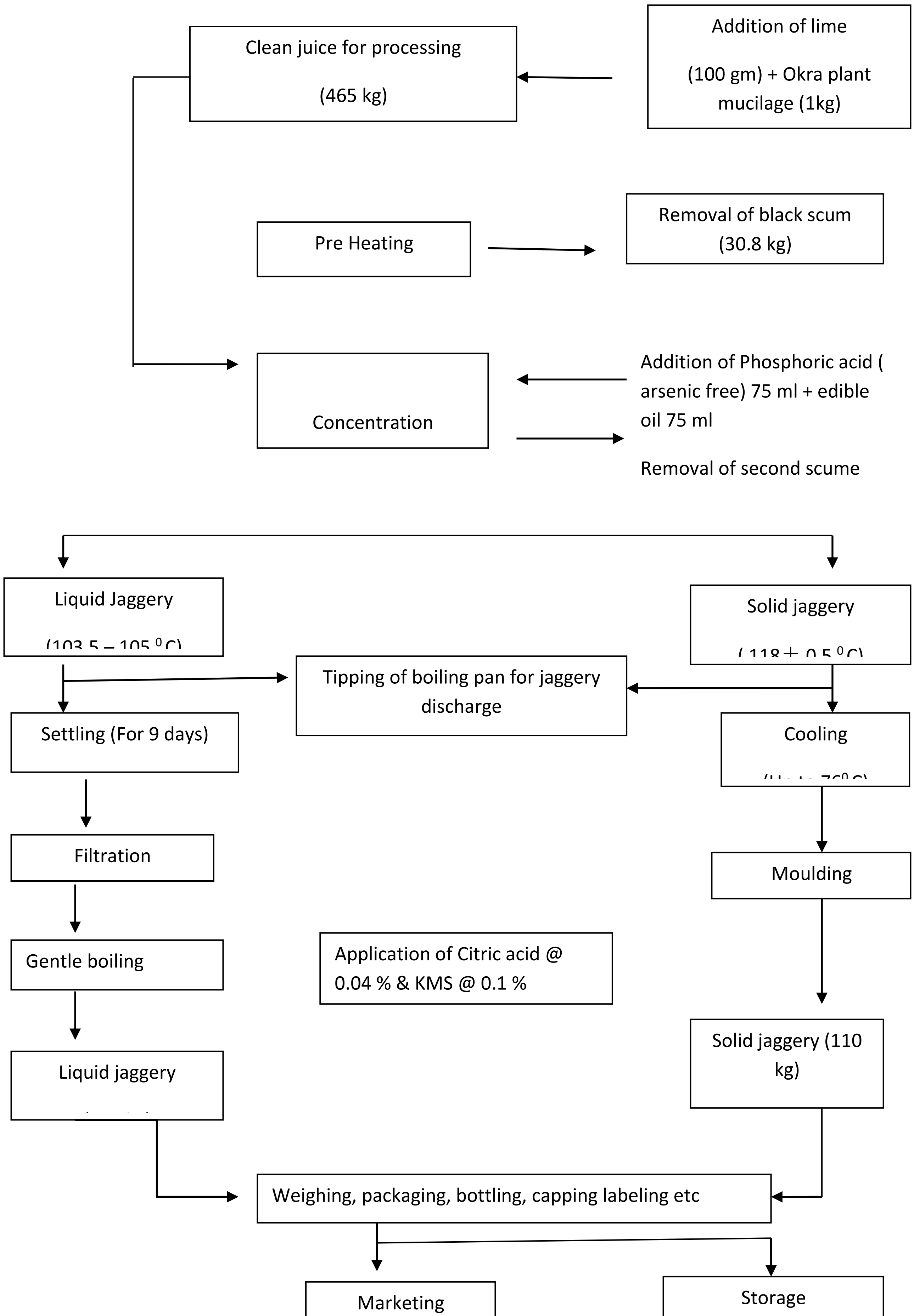
		Dia – 900mm, Ht. 1000 mm, Taper bottom for collection of sediment/impurities at one side with minimum juice loss, two separate ball valves for discharging clean juice and impurities
Liquid jaggery settling tank	:	SS 304, 18 gauge, circular, capacity – 300 lit. with lid,
		Dia – 700mm, Ht. 900 mm, taper bottom, two ball valves at bottom
Liquid jaggery storage tank	:	SS 304, 18 gauge, circular, capacity – 600 lit. with lid,
		Dia – 900mm, Ht. 1000 mm, taper bottom, two ball valves at bottom
Cooling pan	:	SS 304, 16 gauge, rectangular tray type shape length –
		200 mm, width – 1500mm, Ht. – 150 mm, 6 rings placed at top.

C) Jaggery Processing Accessories

a) Jaggery moulds	:	SS 304, 22 gauge, bucket shape, 10 kg, 5 kg, 2 kg and 1 kg capacities
b) Strainer	:	SS 304, 22 gauge, Soccer shaped for main boiling pan and square tray descending bottom for pre heating pan.
c) Scrapper	:	SS 304, 12 gauge, scraper plate
		i) Long handled – 25 mm OD, 1500mm long, SS pipe for stirring purpose.
		ii) Short handled – 25 mm OD, 1200 mm long for filling 5 and 10 kg moulds
		iii) Short handled - 25 mm OD, 450 mm long for filling 1 and 2 kg moulds.
d) Scum strainer	:	SS 304, 18 gauge, circular Dia. – 431 mm, ht – 500 mm with 100 mm dia., SS screen and tap at bottom.

Flow Chart of Jaggery Processing and Material Balance




Clean juice for processing
(465 kg)
Addition of lime
(100 gm) + Okra plant mucilage (1kg)
Pre Heating
Removal of black scum (30.8 kg)
Concentration
Addition of Phosphoric acid (arsenic free) 75 ml + edible oil 75 ml
Removal of second scume
Liquid Jaggery
(103.5 – 105 ⁰C)
Solid jaggery
(118 ± 0.5 ⁰C)
Tipping of boiling pan for jaggery discharge
Settling (For 9 days)
Cooling
Filtration
Moulding
Gentle boiling
Application of Citric acid @ 0.04 % & KMS @ 0.1 %
Solid jaggery (110 kg)
Liquid jaggery
Weighing, packaging, bottling, capping labeling etc
Marketing
Storage

Annexure - 3

ಕಬ್ಬು (ಎಲ್ಲಾ ಪ್ರದೇಶಗಳು)

ಕಬ್ಬು ರಾಜ್ಯದ ಮುಖ್ಯವಾದ ಆರ್ಥಿಕ ಬೆಳೆಗಳಲ್ಲಿ ಒಂದು, ಮುಖ್ಯವಾಗಿ ರಾಜ್ಯದ ದಕ್ಷಿಣ ಭಾಗದ ಮಂಡ್ಯ, ಮೈಸೂರು, ಚಾಮರಾಜನಗರ ಮತ್ತು ದಾವಣಗೆರೆ ಜಿಲ್ಲೆಗಳಲ್ಲಿ ಈ ಬೆಳೆ ಕೇಂದ್ರೀಕೃತವಾಗಿದೆ.

ತಳಿಗಳು	ನಾಟಿ ಕಾಲ	ಕಾಲಾವಧಿ (ತಿಂಗಳು)	ಬಿತ್ತನೆ ತುಂಡುಗಳು (ಟನ್/ಎ)	ಅಂತರ (ಅಡಿ)	ಸಾ. (ಟನ್/ಎ.)	ಜೈವಿಕ ಗೊಬ್ಬರ (ಕಿ.ಗ್ರಾಂ/ಎ)	ರಾಸಾಯನಿಕ ಗೊಬ್ಬರಗಳು (ಕಿ.ಗ್ರಾಂ/ಎಕರೆಗೆ)			
							ಪ್ರದೇಶಗಳು	ಸಾ.	ರಂ.	ಪೊ.
ಸಿ.ಓ.- 62175	ಜೂನ್- ಆಗಸ್ಟ್ ಅಕ್ಟೋಬರ್- ನವೆಂಬರ್	12 - 14	3 - 3.5 (10000 - 12000) ಮೂರು ಕಣ್ಣಿನ ಬಿತ್ತನೆ ತುಂಡುಗಳು	3 ಅಡಿ ದೋಣಿ ಸಾಲು	10	ಅಜಟೋಬ್ಯಾಕ್ಟರ್- 2 + 1 ಅಝೋಸ್ಪೈರಿಲಂ- 1 ಅಗ್ರೋಬ್ಯಾಕ್ಟೀರಿಯಂ/ ಆಸ್ಪರ್ಜಿಲಸ್ ಅವಮೊರಿ- 4 ಬ್ಯಾಸಿಲಸ್ ಮೆಗತೀರಿಯಂ- 4	ಕಾವೇರಿ ಮತ್ತು ವಾಣಿ ವಿಲಾಸ ನಾಲಾ	100	40	50
							ಭದ್ರಾ ನಾಲಾ	100	30	30
							ಕರಾವಳಿ	75	50	50
ಸಿ.ಓ.- 419	ಜೂನ್- ಆಗಸ್ಟ್ ಅಕ್ಟೋಬರ್- ನವೆಂಬರ್ ಜನವರಿ- ಫೆಬ್ರುವರಿ	12 - 16	3 - 3.5 (10000 - 12000) ಮೂರು ಕಣ್ಣಿನ ಬಿತ್ತನೆ ತುಂಡುಗಳು	3 ಅಡಿ ದೋಣಿ ಸಾಲು	10	ಅಜಟೋಬ್ಯಾಕ್ಟರ್- 2 + 1 ಅಝೋಸ್ಪೈರಿಲಂ- 1 ಅಗ್ರೋಬ್ಯಾಕ್ಟೀರಿಯಂ/ ಆಸ್ಪರ್ಜಿಲಸ್ ಅವಮೊರಿ- 4 ಬ್ಯಾಸಿಲಸ್ ಮೆಗತೀರಿಯಂ- 4	ಕಾವೇರಿ ಮತ್ತು ವಾಣಿ ವಿಲಾಸ ನಾಲಾ	100	40	50
							ಭದ್ರಾ ನಾಲಾ	100	30	30
							ಕರಾವಳಿ	75	50	50
ಸಿ.ಓ.- 7804	ಜೂನ್- ಆಗಸ್ಟ್ ಅಕ್ಟೋಬರ್- ನವೆಂಬರ್ ಜನವರಿ- ಫೆಬ್ರುವರಿ	12 - 14	3 - 3.5 (10000 - 12000) ಮೂರು ಕಣ್ಣಿನ ಬಿತ್ತನೆ ತುಂಡುಗಳು	3 ಅಡಿ ದೋಣಿ ಸಾಲು	10	ಅಜಟೋಬ್ಯಾಕ್ಟರ್- 2 + 1 ಅಝೋಸ್ಪೈರಿಲಂ- 1 ಅಗ್ರೋಬ್ಯಾಕ್ಟೀರಿಯಂ/ ಆಸ್ಪರ್ಜಿಲಸ್ ಅವಮೊರಿ- 4 ಬ್ಯಾಸಿಲಸ್ ಮೆಗತೀರಿಯಂ- 4	ಕಾವೇರಿ ಮತ್ತು ವಾಣಿ ವಿಲಾಸ ನಾಲಾ	100	40	50
							ಭದ್ರಾ ನಾಲಾ	100	30	30
							ಕರಾವಳಿ	75	50	50
ಸಿ.ಓ.ಸಿ- 671	ಜೂನ್- ಆಗಸ್ಟ್ ಅಕ್ಟೋಬರ್- ನವೆಂಬರ್ ಜನವರಿ- ಫೆಬ್ರುವರಿ	10 - 11	3 - 3.5 (10000 - 12000) ಮೂರು ಕಣ್ಣಿನ ಬಿತ್ತನೆ ತುಂಡುಗಳು	3 ಅಡಿ ದೋಣಿ ಸಾಲು	10	ಅಜಟೋಬ್ಯಾಕ್ಟರ್- 2 + 1 ಅಝೋಸ್ಪೈರಿಲಂ- 1 ಅಗ್ರೋಬ್ಯಾಕ್ಟೀರಿಯಂ / ಆಸ್ಪರ್ಜಿಲಸ್ ಅವಮೊರಿ- 4 ಬ್ಯಾಸಿಲಸ್ ಮೆಗತೀರಿಯಂ- 4	ಕಾವೇರಿ ಮತ್ತು ವಾಣಿ ವಿಲಾಸ ನಾಲಾ	100	40	50
							ಭದ್ರಾ ನಾಲಾ	100	30	30
							ಕರಾವಳಿ	75	50	50
ಸಿ.ಓ.- 86032	ಜೂನ್- ಆಗಸ್ಟ್ ಅಕ್ಟೋಬರ್- ನವೆಂಬರ್ ಜನವರಿ-	12 - 13	3 - 3.5 (10000 - 12000) ಮೂರು ಕಣ್ಣಿನ ಬಿತ್ತನೆ ತುಂಡುಗಳು	3 ಅಡಿ ದೋಣಿ ಸಾಲು	10	ಅಜಟೋಬ್ಯಾಕ್ಟರ್- 2 + 1 ಅಝೋಸ್ಪೈರಿಲಂ- 1 ಅಗ್ರೋಬ್ಯಾಕ್ಟೀರಿಯಂ/ ಆಸ್ಪರ್ಜಿಲಸ್	ಕಾವೇರಿ ಮತ್ತು ವಾಣಿ ವಿಲಾಸ ನಾಲಾ	100	40	50
							ಭದ್ರಾ ನಾಲಾ	100	30	30

	ಫೆಬ್ರವರಿ					ಅವಮೊರಿ- 4 ಬ್ಯಾಸಿಲಸ್ ಮೆಗತೀರಿಯಂ- 4	ಕರಾವಳಿ	75	50	50
ಸಿ.ಓ - 8371	ಆಗಸ್ಟ್- ನವೆಂಬರ್- ಜನವರಿ	12 - 13	3 - 3.5 (10000 - 12000) ಮೂರು ಕಣ್ಣಿನ ಬಿತ್ತನೆ ತುಂಡುಗಳು	3 ಅಡಿ ದೋಣಿ ಸಾಲು	10	ಅಜಟೋಬ್ಯಾಕ್ಟರ್- 2 + 1 ಅಝೋಸ್ಪೈರಿಲಂ- 1 ಅಗ್ರೋಬ್ಯಾಕ್ಟೀರಿಯಂ/ ಆಸ್ಪರ್ಜಿಲಸ್ ಅವಮೊರಿ- 4 ಬ್ಯಾಸಿಲಸ್ ಮೆಗತೀರಿಯಂ- 4	ಕಾವೇರಿ ಮತ್ತು ವಾಣಿ ವಿಲಾಸ ನಾಲಾ	100	40	50
							ಭದ್ರಾ ನಾಲಾ	100	30	30
							ಕರಾವಳಿ	75	50	50
ಅಭಿಮನ್ಯು	ಆಗಸ್ಟ್- ನವೆಂಬರ್	12 - 13	3 - 3.5 (10000 - 12000) ಮೂರು ಕಣ್ಣಿನ ಬಿತ್ತನೆ ತುಂಡುಗಳು	3 ಅಡಿ ದೋಣಿ ಸಾಲು	10	ಅಜಟೋಬ್ಯಾಕ್ಟರ್- 2 + 1 ಅಝೋಸ್ಪೈರಿಲಂ-1 ಅಗ್ರೋಬ್ಯಾಕ್ಟೀರಿಯಂ/ ಆಸ್ಪರ್ಜಿಲಸ್ ಅವಮೊರಿ- 4 ಬ್ಯಾಸಿಲಸ್ ಮೆಗತೀರಿಯಂ- 4	ಕಾವೇರಿ ಮತ್ತು ವಾಣಿ ವಿಲಾಸ ನಾಲಾ	100	40	50
							ಭದ್ರಾ ನಾಲಾ	100	30	30
							ಕರಾವಳಿ	75	50	50
ವಿಶಾಲ್	ಜುಲೈ- ನವೆಂಬರ್- ಜನವರಿ	12 - 13	3 - 3.5 (10000 - 12000) ಮೂರು ಕಣ್ಣಿನ ಬಿತ್ತನೆ ತುಂಡುಗಳು	3 ಅಡಿ ದೋಣಿ ಸಾಲು	10	ಅಜಟೋಬ್ಯಾಕ್ಟರ್- 2 + 1 ಅಝೋಸ್ಪೈರಿಲಂ- 1 ಅಗ್ರೋಬ್ಯಾಕ್ಟೀರಿಯಂ/ ಆಸ್ಪರ್ಜಿಲಸ್ ಅವಮೊರಿ- 4 ಬ್ಯಾಸಿಲಸ್ ಮೆಗತೀರಿಯಂ- 4	ಕಾವೇರಿ ಮತ್ತು ವಾಣಿ ವಿಲಾಸ ನಾಲಾ	100	40	50
							ಭದ್ರಾ ನಾಲಾ	100	30	30
							ಕರಾವಳಿ	75	50	50

ವಿಶೇಷ ಸೂಚನೆಗಳು:

- ಸಿ.ಓ.- 86032 (ನಯನ) ತಳಿ ಸಮಸ್ಯಾತ್ಮಕ ಮತ್ತು ಜೌಗು ಮಣ್ಣಿಗೆ ಸೂಕ್ತವಲ್ಲ.
- ಸಿ.ಓ.ಸಿ.- 671 ಭದ್ರಾ ನಾಲಾ ಪ್ರದೇಶಕ್ಕೆ ಮಾತ್ರ.
- ಸಿ.ಓ.ವಿ.ಸಿ.- 2003 - 165 (ಅಭಿಮನ್ಯು) ಬಿಳಿ ಉಣ್ಣೆ ಹೇನು ನಿರೋಧಕ ತಳಿ, ಕಾಡಿಗೆ ರೋಗಕ್ಕೆ ತುತ್ತಾಗುತ್ತದೆ.
- ಕರಾವಳಿ ಪ್ರದೇಶದಲ್ಲಿ ನವೆಂಬರ್-ಫೆಬ್ರವರಿ ನಾಟಿಗೆ ಸೂಕ್ತ ಸಮಯ
- 8 - 10 ತಿಂಗಳಿನ ನಾಟಿ ಬೆಳೆಯಿಂದ ಆರಿಸಿದ ರೋಗರಹಿತ ಕಬ್ಬಿನ ತುಂಡುಗಳನ್ನೇ ಬಿತ್ತನೆಗೆ ಬಳಸಿ.
- ಶಾಖೋಪಚಾರ ಮಾಡಿ ಬೆಳೆದ ಕಬ್ಬಿನ ಬೆಳೆಯಿಂದಲೇ ಬಿತ್ತನೆ ತುಂಡುಗಳನ್ನು ಆರಿಸಿ.
- ಬಿತ್ತನೆ ತುಂಡುಗಳನ್ನು ಪ್ರತಿ ಲೀಟರ್‌ಗೆ ಒಂದು ಗ್ರಾಂ ಕಾರ್ಬೆಂಡಜಿಂ ಬೆರೆಸಿದ ದ್ರಾವಣದಲ್ಲಿ 15 ನಿಮಿಷ ಅದ್ದಿ ಬಿತ್ತನೆ ಮಾಡಿ.
- ಮಣ್ಣು ಪರೀಕ್ಷೆ ಆಧಾರದ ಮೇಲೆ ರಸಗೊಬ್ಬರಗಳನ್ನು ಬಳಸಿ.

ಮಣ್ಣು: ಕಬ್ಬಿಗೆ ನೀರು ಬಸಿದು ಹೋಗುವ 6.5 ರಿಂದ 7.0 ರಸಸಾರವಿರುವ ಕೆಂಪು ಮತ್ತು ಕಪ್ಪು ಮಣ್ಣು ಸೂಕ್ತ.

ಭೂಮಿ ಸಿದ್ಧತೆ ಹಾಗೂ ಬಿತ್ತನೆ: ಕಬ್ಬು ಬೆಳೆಗೆ ಪೂರ್ವಭಾವಿಯಾಗಿ ಹಸಿರೆಲೆ ಗೊಬ್ಬರಗಳಾದ ಚಂಬೆ, ಅಪ್ಸೆಣಬು ಇತ್ಯಾದಿಗಳನ್ನು ಬೆಳೆದು ಹೂ ಬಿಡುವ ಹಂತದಲ್ಲಿ ಭೂಮಿಗೆ ಸೇರಿಸುವುದು. ಭೂಮಿಯನ್ನು 2 - 3 ಬಾರಿ ಚೆನ್ನಾಗಿ ಉಳುಮೆಮಾಡಿ ಎಕರೆಗೆ 10 ಟನ್ ಕೊಟ್ಟಿಗೆ ಗೊಬ್ಬರ ಅಥವಾ ಕಾಂಪೋಸ್ಟನ್ನು ಮಣ್ಣಿಗೆ ಸೇರಿಸಿ ಅಥವಾ ಎಕರೆಗೆ 2 ಟನ್ ಸಕ್ಕರೆ ಕಾರ್ಖಾನೆ ಮಡ್ಡಿ ಕಾಂಪೋಸ್ಟನ್ನು 2 ಕಿ.ಗ್ರಾಂ. ಅಜಟೋಬ್ಯಾಕ್ಟರ್ ಜೈವಿಕ ಗೊಬ್ಬರದ ಜೊತೆ ಮಿಶ್ರ ಮಾಡಿ ಭೂಮಿಗೆ ಸೇರಿಸಿ ಗದ್ದೆಯನ್ನು ಬಿತ್ತನೆಗೆ ಸಿದ್ಧಪಡಿಸಿ. ರಿಡ್ಜರ್/ಕೂಪರ್‌ನಿಂದ 3 ಅಡಿ ಅಂತರದಲ್ಲಿ ಒಂದು ಅಡಿ ಆಳಕ್ಕೆ ಸಾಲು ತೆಗೆಯುವುದು. ಸಿ.ಓ.ಸಿ.- 671 ತಳಿಯಾದಲ್ಲಿ 2.5 ಅಡಿ ಅಂತರದ ಸಾಲು ಮಾಡಿ. ಮೂಲಗೊಬ್ಬರವಾಗಿ ಶಿಫಾರಸ್ಸಿನ ಶೇ.10ರಷ್ಟು ಸಾರಜನಕ, ಪೂರ್ತಿ ಪ್ರಮಾಣದ ರಂಜಕ ಮತ್ತು ಪೋಟ್ಯಾಷ್ ಒದಗಿಸುವ ರಸಗೊಬ್ಬರಗಳನ್ನು ಮಣ್ಣಿನಲ್ಲಿ ಬೆರೆಸಿ. ಸಾಲುಗಳಲ್ಲಿ ನೀರು ಹಾಯಿಸಿ ಬೋದಿನ ಮಧ್ಯ ಭಾಗದಲ್ಲಿ ಕಬ್ಬಿನ ತುಂಡುಗಳನ್ನು ಕಣ್ಣು ಒಂದು ಪಕ್ಕದಲ್ಲಿ ಬರುವಂತೆ ನೆಡಿ. ಒಣ ಹವೆಯ ವಾತಾವರಣವಿರುವಾಗ ನೆಡುವುದು ಸೂಕ್ತ.

ಹೆಚ್ಚು ಅಂತರದ ನಾಟಿ ಪದ್ಧತಿ: ಹೆಚ್ಚು ತೆಂಡೆಯೊಡೆಯುವ ಸಿ.ಓ.- 62175, ನಯನ ಮತ್ತು ವಿಶಾಲ್ ತಳಿಗಳನ್ನು 5 ಅಡಿ ಅಂತರದ ಸಾಲುಗಳ ಎರಡು ಬದಿಯಲ್ಲಿ ಜಿಗ್ ಜ್ಯಾಗ್ ಆಕಾರದಲ್ಲಿ ನಾಟಿ ಮಾಡುವುದು. ಈ ಪದ್ಧತಿಯಿಂದ ಶೇ.20ರಷ್ಟು ನಾಟಿ ಉಳಿತಾಯ, ಅಂತರ ಬೇಸಾಯಕ್ಕೆ ಅನುಕೂಲ ಮತ್ತು ತರಗು ನಿರ್ವಹಣೆ ಸುಲಭವಾಗುವುದಲ್ಲದೆ ಭೂಮಿಯ ಫಲವತ್ತತೆಯನ್ನೂ ಕಾಪಾಡಬಹುದು.

ಜೈವಿಕ ಗೊಬ್ಬರಗಳು: ಎಕರೆಗೆ ಒಂದು ಕಿ.ಗ್ರಾಂ ಸಾರಜನಕ ಸ್ಥಿರೀಕರಿಸುವ ಅಜಟೋಬ್ಯಾಕ್ಟರ್ ಜೈವಿಕ ಗೊಬ್ಬರವನ್ನು ನಾಟಿ ಮಾಡಿದ 30 ಮತ್ತು 60 ದಿನಗಳಲ್ಲಿ ಎರಡು ಸಮ ಭಾಗಗಳಲ್ಲಿ ಹಾಗೂ ರಂಜಕ ಕರಗಿಸುವ ಅಗ್ರೋಬ್ಯಾಕ್ಟೀರಿಯಂ ರೇಡಿಯೋಬ್ಯಾಕ್ಟರ್/ ಆಸ್ಪರ್ಜಿಲಸ್ ಅವಮೋರಿಯನ್ನು ಎಕರೆಗೆ 4 ಕಿ.ಗ್ರಾಂ ಪ್ರಮಾಣದಲ್ಲಿ ಬಿತ್ತನೆಯಾದ 30 ದಿನಗಳಲ್ಲಿ 200 ಕಿ.ಗ್ರಾಂ ಕೊಟ್ಟಿಗೆ ಗೊಬ್ಬರದೊಡನೆ ಮಿಶ್ರ ಮಾಡಿ ಮಣ್ಣಿನಲ್ಲಿ ಸೇರಿಸಿ.

ಮೇಲುಗೊಬ್ಬರ ಮತ್ತು ಅಂತರ ಬೇಸಾಯ: ಮೇಲುಗೊಬ್ಬರವನ್ನು ಮೂರು ಸಲ ಕೊಡಬೇಕಾಗುತ್ತದೆ. ನಾಟಿಯಾದ 45ನೇ ದಿನದಲ್ಲಿ ಶಿಫಾರಸ್ಸು ಮಾಡಿದ ಶೇ. 20, 75ನೇ ದಿನದಲ್ಲಿ ಶೇ. 30 ಮತ್ತು 105 ನೇ ದಿನದಲ್ಲಿ ಉಳಿದ ಶೇ. 40 ರಷ್ಟು ಸಾರಜನಕ ಒದಗಿಸುವ ರಸಗೊಬ್ಬರಗಳನ್ನು ಕೊಡಿ. ತೀರ ಪ್ರದೇಶಗಳಲ್ಲಿ ರಂಜಕ ಗೊಬ್ಬರಗಳನ್ನು ಎರಡು ಬಾರಿ ಅಂದರೆ ನೆಡುವಾಗ ಶೇ. 50ರಷ್ಟು ಮತ್ತು ನಾಟಿಯಾದ 105 ದಿನದಲ್ಲಿ ಉಳಿದ ಶೇ. 50ರಷ್ಟು ಕೊಡುವುದು. ಅಂತರ ಬೇಸಾಯ ಮಾಡುವ ಸಮಯದಲ್ಲಿ ರಸ ಗೊಬ್ಬರವನ್ನು ನೇಗಿಲ ಸಾಲಿನಲ್ಲಿ ಪೈರಿನ ಎರಡೂ ಬದಿಯಲ್ಲಿ ಕೊಡುವುದರಿಂದ ರಸಗೊಬ್ಬರಗಳ ಸಮರ್ಥ ಬಳಕೆ ಸಾಧ್ಯ. ಇದು ಸಾಧ್ಯವಾಗದಿದ್ದಲ್ಲಿ ಪೈರಿನ ಸುತ್ತಲೂ 4 – 5 ಅಂಗುಲ ಆಳದ ಗುಳಿಗಳನ್ನು ಮಾಡಿ ಅದರಲ್ಲಿ ರಸ ಗೊಬ್ಬರಗಳನ್ನು ಕೊಡಬಹುದು.

ನೀರಾವರಿ: ಹವಾಮಾನಕ್ಕನುಗುಣವಾಗಿ ಮರಳು ಮಿಶ್ರಿತ ಭೂಮಿಯಾದಲ್ಲಿ 8 ದಿನಗಳಿಗೊಮ್ಮೆ ಮತ್ತು ಕಪ್ಪು ಮಣ್ಣಿನ ಭೂಮಿಯಾದಲ್ಲಿ 15 ದಿನಗಳಿಗೊಮ್ಮೆ ನೀರು ಹಾಯಿಸಿ. ಬೇಸಿಗೆಯಲ್ಲಿ ನೀರಿನ ಕೊರತೆ ಕಂಡುಬಂದಲ್ಲಿ ಕೊನೆಯ ಸಾರಿ ಮಣ್ಣು ಏರು ಹಾಕಿದ ಮೇಲೆ ಎಕರೆಗೆ 3 ಟನ್ ಕಬ್ಬಿನ ತರಗನ್ನು ಭೂಮಿಗೆ ಹೊದಿಸಿ. ಶೇ. 25 ರಷ್ಟು ಹೆಚ್ಚುವರಿ ಪೊಟ್ಯಾಷ್ ಕೊಡುವುದರಿಂದ ನೀರಿನ ಅಭಾವದಿಂದಾಗುವ ದುಷ್ಪರಿಣಾಮವನ್ನು ತಡೆಗಟ್ಟಬಹುದು. ಜೊತೆಗೆ ಕಬ್ಬಿನ ರಸದ ಗುಣಮಟ್ಟ ಕೂಡ ಉತ್ತಮಗೊಳಿಸಬಹುದು.

ಕಳೆಗಳ ನಿರ್ವಹಣೆ: ಕಬ್ಬು ಬಿತ್ತನೆಯಾದ 2 ರಿಂದ 3 ದಿನಗಳ ನಂತರ ಎಕರೆಗೆ ಒಂದು ಕಿ.ಗ್ರಾಂ ಅಟ್ರಾಜಿನ್ ಶೇ. 50 ಪುಡಿ ಅಥವಾ ಒಂದು ಕಿ.ಗ್ರಾಂ ಡೈಯುರಾನ್ ಶೇ. 80 ಅಥವಾ 600 ಗ್ರಾಂ ಮೆಟ್ರಿಬ್ಯೂಜಿನ್ ಶೇ. 70 ಪುಡಿಯನ್ನು 300 ಲೀ. ನೀರಿನಲ್ಲಿ ಕರಗಿಸಿ ಭೂಮಿಗೆ ಸಿಂಪಡಿಸಿ. ಇದೇ ಸಿಂಪರಣೆಯನ್ನು 25 ದಿನಗಳ ನಂತರ ಕಳೆಗಳ ಮೇಲೆ ಪುನಃ ಸಿಂಪರಣೆ ಮಾಡಿ. ಈ ಕಳೆನಾಶಕವು ಹೆಚ್ಚು ಅಗಲ ಎಲೆ ಹಾಗೂ ತುಂಗೆ ಕಳೆಗಳು ಇರುವ ಜಮೀನಿಗೆ ಸೂಕ್ತ. ಸಿಂಪರಣೆಯ ಸಮಯದಲ್ಲಿ ಮಣ್ಣಿನಲ್ಲಿ ಸಾಕಷ್ಟು ತೇವಾಂಶವಿರಬೇಕು ಮತ್ತು ಹೆಚ್ಚು ಹೆಂಟೆಗಳಿರದಂತೆ ಎಚ್ಚರವಹಿಸಿ.

ಸಸ್ಯ ಸಂರಕ್ಷಣೆ: ಪ್ರತ್ಯೇಕ ಕೋಷ್ಟಕದಲ್ಲಿ ಒದಗಿಸಲಾಗಿದೆ.

ಇಳುವರಿ: ತಳಿಗನುಗುಣವಾಗಿ ಕಬ್ಬು ನಾಟಿ ಮಾಡಿದ 10 ರಿಂದ 14 ತಿಂಗಳುಗಳಲ್ಲಿ ಕಟಾವಿಗೆ ಸಿದ್ಧವಾಗುತ್ತದೆ. ಕಬ್ಬನ್ನು ಸೂಲಂಗಿ ಬಂದ ಎರಡು ತಿಂಗಳೊಳಗಾಗಿ ಕಟಾವು ಮಾಡಿ. ತಳಿ ಮತ್ತು ಬಿತ್ತನೆಯ ಕಾಲಕ್ಕೆ ಅನುಗುಣವಾಗಿ ಕೆಳಗೆ ಸೂಚಿಸಿರುವಂತೆ ಇಳುವರಿ ಪಡೆಯಬಹುದು.

ವಿವಿಧ ಕಾಲಗಳಲ್ಲಿ ನೆಟ್ಟ ಕಬ್ಬಿನಲ್ಲಿ ಬರುವ ಇಳುವರಿ (ಎಕರೆಗೆ ಟನ್ನಗಳಲ್ಲಿ)

ತಳಿ/ಬಿತ್ತನೆ ಕಾಲ	ವಲಯ- 4, 5 ಮತ್ತು 6			ವಲಯ- 7			ವಲಯ- 10
	ಜೂನ್-ಆಗಸ್ಟ್	ಅಕ್ಟೋಬರ್ -ನವೆಂಬರ್	ಜನವರಿ-ಫೆಬ್ರುವರಿ	ಜೂನ್-ಆಗಸ್ಟ್	ಅಕ್ಟೋಬರ್-ನವೆಂಬರ್	ಜನವರಿ-ಫೆಬ್ರುವರಿ	ನವೆಂಬರ್-ಫೆಬ್ರುವರಿ
ಸಿ.ಓ.- 419	50 - 55	40 - 45	30 - 35	45 - 50	30 - 40	30 - 35	30 - 45
ಸಿ.ಓ.- 62175	60 - 70	55 - 60	-	50 - 55	40 - 45	-	40 - 45
ಸಿ.ಓ.- 7804	55 - 60	45 - 50	35 - 40	45 - 50	35 - 40	30 - 35	35 - 40
ಸಿ.ಓ.- 8371	65 - 70	50 - 55	40 - 50	50 - 55	40 - 50	35 - 40	45 - 50
ಸಿ.ಓ.- 86032	60 - 65	50 - 55	45 - 50	50 - 55	40 - 50	35 - 40	40 - 45
ಸಿ.ಓ.- 671	-	-	-	-	35 - 40	30 - 35	-
ಸಿ.ಓ.ವಿ.ಸಿ – 2003-165	60 - 65	50 - 55	-	-	-	-	-
ಸಿ.ಓ.ವಿ.ಸಿ - 99463	65 - 70	55 - 60	45- 50	-	-	-	-

ಕೂಳೆ ಬೆಳೆ: ಕೂಳೆ ಬಿಡಬೇಕೆಂದಿರುವ ಜಮೀನಿನಲ್ಲಿ, ಬೆಳೆ ಕಟಾವು ಮಾಡಲು ಪ್ರಾರಂಭ ಮಾಡಿದ 8 ರಿಂದ 10 ದಿನಗಳೊಳಗಾಗಿ ಕಟಾವು ಕೆಲಸ ಪೂರ್ತಿ ಮಾಡಿ.ಸಾಮಾನ್ಯವಾಗಿ ರಾಜ್ಯದ ಈ ಪ್ರಾಂತ್ಯಗಳಲ್ಲಿ 2 ರಿಂದ 3 ಕೂಳೆ ಬೆಳೆ ತೆಗೆಯಬಹುದು. ಹೆಚ್ಚು ಉಷ್ಣಾಂಶವಿರುವ ಮಾರ್ಚ್ ನಿಂದ ಮೇ ತಿಂಗಳುಗಳಲ್ಲಿ ಕೂಳೆ ಬಿಡುವುದು ಸೂಕ್ತವಲ್ಲ.

ತರಗು ನಿರ್ವಹಣೆ: ಕಟಾವು ಮುಗಿದ ಮೇಲೆ ಗರಿ ಅಥವಾ ತರಗನ್ನು ಕಾಂಪೋಸ್ಟ್ ಮಾಡಬಹುದು ಅಥವಾ ತರಗನ್ನು ಜಮೀನಿನಲ್ಲೇ ಪರ್ಯಾಯ ಸಾಲುಗಳಲ್ಲಿ ಹರಡಿ ನೀರು ಹಾಯಿಸಿ ಎಕರೆಗೆ 15 ಕಿ.ಗ್ರಾಂ ಯೂರಿಯಾವನ್ನು ಬೆರೆಸಿದ ಶೇ. 5 ರ ಸಗಣಿ ಬಗ್ಗಡವನ್ನು ಚಿಮುಕಿಸುವುದು, ಪ್ಲೋರೋಟಿಸ್ ಸೂಕ್ಷ್ಮಾಣುಜೀವಿಯನ್ನು ಎಕರೆಗೆ 4 ಕಿ.ಗ್ರಾಂ ಪ್ರಮಾಣದಲ್ಲಿ ತರಗಿನ ಮೇಲೆ ಹರಡುವುದು ಅಥವಾ ಎಕರೆಗೆ 1 - 1.5 ಟನ್ ಸಕ್ಕರೆ ಕಾರ್ಖಾನೆ ಮಡ್ಡಿಗೊಬ್ಬರ ಹರಡುವುದರಿಂದ ತರಗನ್ನು ತ್ವರಿತವಾಗಿ ಕೊಳೆಯಿಸಬಹುದು.

ಕೂಳೆ ಸವರುವುದು ಹಾಗೂ ಇತರೆ ವ್ಯವಸಾಯ ಕ್ರಮಗಳು: ಕಬ್ಬು ಕಟಾವಾದ ಕೂಡಲೇ ಭೂಮಿಯ ಮಟ್ಟಕ್ಕೆ ಕೂಳೆಯನ್ನು ಸವರಬೇಕು. ಇದರಿಂದ ಒಂದೇ ಸಮನಾಗಿ ಮೊಳಕೆಬರಲು ಸಹಾಯವಾಗುತ್ತದೆ. ಕಬ್ಬಿನ ಸಾಲಿನ ಎರಡು ಪಕ್ಕಗಳನ್ನು ಕಬ್ಬಿಣ ನೇಗಿಲಿನಿಂದ ಸವರಬೇಕು. ಇದಾದ ನಂತರ ಎಕರೆಗೆ 10 ಟನ್ ಕೊಟ್ಟಿಗೆ ಗೊಬ್ಬರವನ್ನು ನೇಗಿಲ ಸಾಲುಗಳಲ್ಲಿ ಹಾಕಿ ಮುಚ್ಚಬೇಕು. ಸಸಿಗಳು ವಿರಳವಿರುವಲ್ಲಿ ಕೂಳೆ ಸಸಿಗಳಿಂದ ಪಿಗ್ಗುಳಿ ಭರ್ತಿ ಮಾಡಿ.

ಕಳೆ ನಿರ್ವಹಣೆ: ಇದಾದ ನಂತರ ನೀರು ಕೊಟ್ಟು, 3 - 5 ದಿವಸಗಳಲ್ಲಿ ಮೊದಲ ಬೆಳೆಗೆ ಶಿಫಾರಸ್ಸು ಮಾಡಿದ ಕಳೆನಾಶಕಗಳನ್ನು ಬಳಸಿ. ತರಗು ನಿರ್ವಹಣೆ ಕೈಗೊಂಡಲ್ಲಿ ಕಳೆನಾಶಕದ ಅವಶ್ಯಕತೆ ಇರುವುದಿಲ್ಲ.

ರೋಗಪೀಡಿತ ಕೂಳೆಗಳನ್ನು ತೆಗೆಯುವುದು: ಹಳದಿ ಗರಿ ರೋಗದ ಲಕ್ಷಣವಿರುವ ಕೂಳೆಗಳನ್ನು ಅಗೆದು ತೆಗೆಯಿರಿ. ಆ ಜಾಗದಲ್ಲಿ ಆರೋಗ್ಯಕರ ಸಸಿಗಳಿಂದ ಪಿಗ್ಗುಳಿ ತುಂಬಿ.

ರಸಗೊಬ್ಬರ ನಿರ್ವಹಣೆ: ಕೂಳೆ ಬೆಳೆಗೂ ಮೊದಲಿನ ಬೆಳೆಗೆ ಒದಗಿಸಿದ ಪ್ರಮಾಣದಲ್ಲೇ ರಸಗೊಬ್ಬರಗಳನ್ನು ಕೊಡಬೇಕಾಗುತ್ತದೆ. ಕೂಳೆ ಸವರಿದ 30 ದಿನಗಳ ನಂತರ ಶಿಫಾರಸ್ಸು ಪ್ರಮಾಣದ ಶೇ. 30 ಸಾರಜನಕ, ಪೂರ್ತಿ ರಂಜಕ ಮತ್ತು ಪೊಟ್ಯಾಷ್ ಒದಗಿಸುವ ರಸಗೊಬ್ಬರ ಕೊಡಿ. ಕೂಳೆ ಬಿಟ್ಟ 60 ದಿನಗಳ ನಂತರ ಶೇ. 35 ಮತ್ತು 90 ದಿನಗಳ ನಂತರ ಶೇ. 35ರಷ್ಟು ಸಾರಜನಕ ಒದಗಿಸುವ ರಸಗೊಬ್ಬರ ಕೊಡಿ. ಗೊಬ್ಬರವನ್ನು ನೇಗಿಲ ಸಾಲುಗಳಲ್ಲಿ ಕೂಳೆಯ ಎರಡು ಪಕ್ಕಗಳಲ್ಲೂ ಕೊಟ್ಟು ಮಣ್ಣು ಮುಚ್ಚುವುದು ಉತ್ತಮ ಕ್ರಮ. ಇಲ್ಲದಿದ್ದಲ್ಲಿ ಕೂಳೆಯ ಪಕ್ಕದಲ್ಲಿ 4 ರಿಂದ 5 ಅಂಗುಲ ಆಳದ ಗುಳಿಗಳಲ್ಲಿ ಗೊಬ್ಬರ ಕೊಟ್ಟು ಮುಚ್ಚುವುದು.

ಸಸ್ಯ ಸಂರಕ್ಷಣೆ: ಮೊದಲ ಬೆಳೆಗೆ ಸೂಚಿಸಿದ ಸಸ್ಯ ಸಂರಕ್ಷಣಾ ಕ್ರಮಗಳನ್ನೇ ಕೂಳೆ ಬೆಳೆಗೂ ಅನುಸರಿಸಿ.

ಇಳುವರಿ: ಉತ್ತಮ ಬೆಳೆ ನಿರ್ವಹಣೆ ಕ್ರಮ ಪಾಲಿಸಿದರೆ ಮೊದಲ ಕೂಳೆಯಿಂದ ಎಕರೆಗೆ 35 ರಿಂದ 40 ಟನ್, ಎರಡು ಮತ್ತು ಮೂರನೆ ಕೂಳೆಯಿಂದ ಎಕರೆಗೆ 30 ರಿಂದ 35 ಟನ್ ಇಳುವರಿ ಪಡೆಯಬಹುದು.

ಕಬ್ಬಿನಲ್ಲಿ ಅಂತರಬೆಳೆ ಪದ್ಧತಿಗಳು

ಅಂತರ ಬೆಳೆಯಾಗಿ ತಿಂಗಳ ಹುರುಳಿ

ಕಬ್ಬಿನ ಸಾಲಿನ ನಡುವೆ ತಿಂಗಳ ಹುರುಳಿಯನ್ನು ಸಾಲಿನಿಂದ ಸಾಲಿಗೆ ಒಂದು ಅಡಿ ಅಂತರ ಹಾಗೂ ಬೀಜದಿಂದ ಬೀಜಕ್ಕೆ 6 ಅಂಗುಲ ಅಂತರದಲ್ಲಿ ಕಬ್ಬು ನಾಟಿ ಮಾಡಿದ ದಿನ ಅಥವಾ ಮಾರನೆ ದಿನ ಬಿತ್ತಬೇಕು. ಎಕರೆಗೆ 20 ರಿಂದ 25 ಕಿ.ಗ್ರಾಂ ಬಿತ್ತನೆ ಬೀಜ ಬೇಕಾಗುತ್ತದೆ. 3 ಅಡಿ ಕಬ್ಬಿನ ಸಾಲಿನಲ್ಲಿ 2 ಸಾಲು ಹಾಗೂ 5 ಅಡಿ ಅಂತರದ ಸಾಲಿನಲ್ಲಿ 3 ಸಾಲು ತಿಂಗಳ ಹುರುಳಿ ಬಿತ್ತಬಹುದು. ಸುಮಾರು 55 ರಿಂದ 60 ದಿನಗಳಲ್ಲಿ ಕಾಯಿ ಕಟಾವಿಗೆ ಬರುತ್ತದೆ. ಎಕರೆಗೆ ಸರಾಸರಿ 12 ಕ್ವಿಂಟಾಲ್ ನಷ್ಟು ಕಾಯಿ ಹಾಗೂ ಶೇ. 6 ರಷ್ಟು ಅಧಿಕ ಕಬ್ಬಿನ ಇಳುವರಿ ಪಡೆಯಬಹುದು. ಕಾಯಿ ಕಟಾವಿನ ನಂತರ ಗಿಡದ ಉಳಿದ ಭಾಗವನ್ನು ಮಣ್ಣಿನಲ್ಲಿ ಸೇರಿಸಿ ಉಳುಮೆ ಮಾಡುವುದು. ಈ ಪದ್ಧತಿಯಿಂದ ಹೆಚ್ಚುವರಿ ಆದಾಯದ ಜೊತೆ ಭೂಫಲವತ್ತತೆ ಉತ್ತಮಗೊಳ್ಳುತ್ತದೆ.

ಅಂತರ ಬೆಳೆಯಾಗಿ ಸೋಯಾಅವರೆ

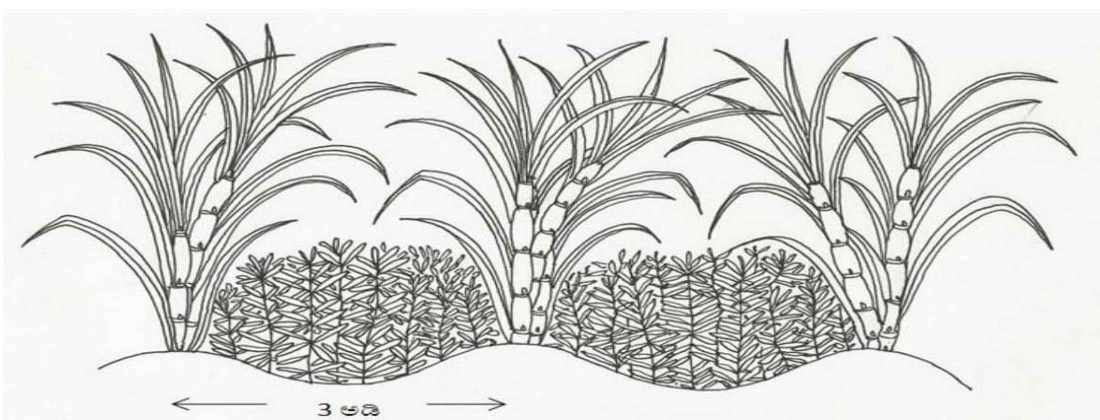
ಕಬ್ಬಿನ ಸಾಲುಗಳ ನಡುವೆ 3 ಅಡಿ ಅಂತರದ ನಾಟಿಯಾದಲ್ಲಿ ಒಂದು ಸಾಲು ಹಾಗೂ 5 ಅಡಿಯಾದಲ್ಲಿ 2 ಸಾಲು ಸೋಯಾಅವರೆಯನ್ನು ಬೀಜದಿಂದ ಬೀಜಕ್ಕೆ 4 ಅಂಗುಲ ಅಂತರದಲ್ಲಿ ಬಿತ್ತಬೇಕು. ಬಿತ್ತನೆಗೆ ಮುಂಚೆ ಸೋಯಾಅವರೆಗಾಗಿಯೇ ನಿಗದಿಪಡಿಸಿದ ರೈಜೋಬಿಯಂ ಜೀವಾಣುವಿನಿಂದ ಬೀಜೋಪಚಾರ ಮಾಡಬೇಕು. ಕಬ್ಬು ನಾಟಿ ಮಾಡಿದ ದಿನ ಅಥವಾ ಮಾರನೆ ದಿನ ಸೋಯಾಅವರೆ ಬಿತ್ತನೆ ಮಾಡಬಹದು. ಚಿತ್ರ (12)ರಲ್ಲಿ ತೋರಿಸಿರುವಂತೆ ಎರಡು ಕಬ್ಬಿನ ಸಾಲಿನ ನಡುವೆ ಬೋದಿನ ಇಳಿಜಾರಿನಲ್ಲಿ ಸೋಯಾಅವರೆ ಬಿತ್ತಬಹುದು. ಎಕರೆಗೆ 10 ರಿಂದ 15 ಕಿ.ಗ್ರಾಂ ಬಿತ್ತನೆ ಬೀಜ ಬೇಕಾಗುವುದು. ಸುಮಾರು 80 - 90 ದಿನಗಳಲ್ಲಿ ಕಟಾವಿಗೆ ಬರುವ ಅಲ್ಪಾವಧಿ ತಳಿಗಳಾದ ಕೆಬಿ- 79 ಮತ್ತು ಮೊನೆಟ್ಟಾ ತಳಿಗಳು ಸೂಕ್ತ. ಕಬ್ಬಿಗೆ ಶಿಫಾರಸ್ಸು ಮಾಡಿದ ರಸಗೊಬ್ಬರಗಳ ಪ್ರಮಾಣದ ಜೊತೆಗೆ ಎಕರೆಗೆ 4 ಕಿ.ಗ್ರಾಂ. ಸಾರಜನಕ, 10 ಕಿ.ಗ್ರಾಂ ರಂಜಕ ಮತ್ತು 5 ಕಿ.ಗ್ರಾಂ ಪೊಟ್ಯಾಷ್ ಒದಗಿಸುವ ರಸಗೊಬ್ಬರಗಳನ್ನು ಬಿತ್ತನೆ ಸಮಯದಲ್ಲಿ ಕೊಡುವುದು. ಕಬ್ಬಿನಲ್ಲಿ ಅಂತರ ಬೆಳೆಗಳನ್ನು ಬೆಳೆದಾಗ ಕಬ್ಬಿಗೆ ಶಿಫಾರಸ್ಸು ಮಾಡಿದ ಕಳೆನಾಶಕಗಳನ್ನು ಸಿಂಪಡಿಸಬಾರದು.

ಬಿತ್ತನೆ ಮಾಡಿದ 2 ರಿಂದ 3 ದಿನಗಳಲ್ಲಿ ಎಕರೆಗೆ ಒಂದು ಲೀಟರ್ ಅಲಾಕ್ಲೋರ್ 50 ಇ.ಸಿ. ಕಳೆನಾಶಕವನ್ನು 300 ಲೀಟರ್ ನೀರಿನಲ್ಲಿ ಬೆರೆಸಿ ಮಣ್ಣಿನ ಮೇಲೆ ಸಿಂಪಡಿಸುವುದು. ಸೋಯಾ ಅವರೆಯನ್ನು ಕಟಾವು ಮಾಡಿದ ನಂತರ ಉಳಿದ ಸಸ್ಯಭಾಗವನ್ನು ಭೂಮಿಗೆ ಸೇರಿಸಿ ಉಳುಮೆ ಮಾಡುವುದು. ಈ ಪದ್ಧತಿಯಿಂದ ಎಕರೆಗೆ 2.5 ರಿಂದ 3.5 ಕ್ವಿಂಟಾಲ್ ಸೋಯಾಅವರೆ ಪಡೆಯಬಹುದು.

ಚಿತ್ರ–12: ಕಬ್ಬಿನಲ್ಲಿ ಅಂತರ ಬೆಳೆಯಾಗಿ ಸೋಯಾಅವರೆ (1:1)

ಅಂತರ ಬೆಳೆಯಾಗಿ ಹಸಿರೆಲೆ ಬೆಳೆಗಳು

ಹಸಿರೆಲೆ ಗೊಬ್ಬರದ ಬೆಳೆಗಳಾದ ಚಂಬೆ, ಅಪ್ಸೆಣಬು ಇತ್ಯಾದಿಗಳನ್ನು ಅಂತರ ಬೆಳೆಗಳಾಗಿ ಬೆಳೆದು ಹೂ ಬಿಡುವ ಹಂತದಲ್ಲಿ ಭೂಮಿಗೆ ಸೇರಿಸುವುದು. ಇದರಿಂದ ಬೆಳೆಯ ಮೊದಲ ಹಂತದಲ್ಲಿ ಕಳೆ ನಿರ್ವಹಣೆ ಹಾಗೂ ಭೂಫಲವತ್ತತೆಯನ್ನು ಹೆಚ್ಚಿಸಬಹುದು. ಚಿತ್ರ (13)ರಲ್ಲಿ ತೋರಿಸಿರುವಂತೆ



ಚಿತ್ರ–13: ಕಬ್ಬಿನಲ್ಲಿ ಅಂತರ ಬೆಳೆಯಾಗಿ ಹಸಿರೆಲೆ ಬೆಳೆಗಳು– ಅಪ್ಸೆಣಬು/ಚಂಬೆ

ಬೆಲ್ಲ ತಯಾರಿಕೆ

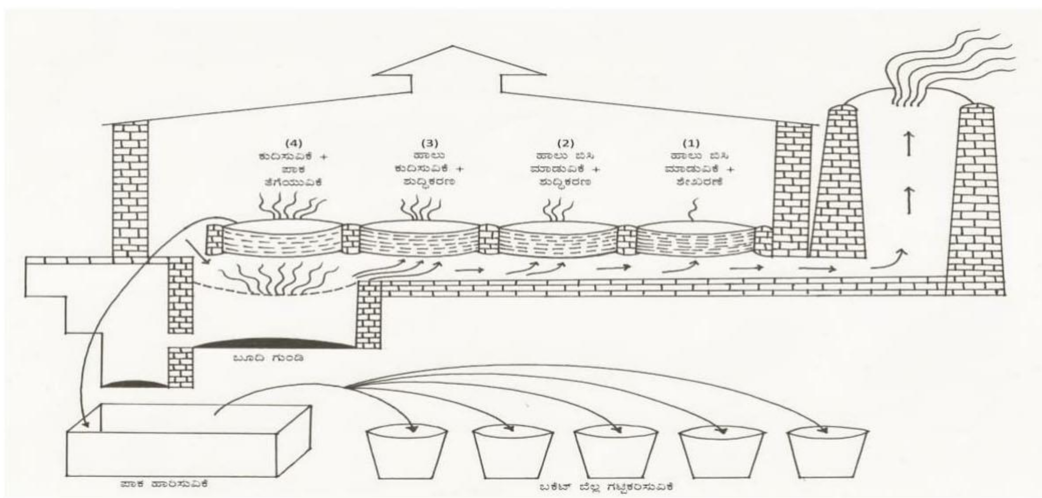
ಬೆಲ್ಲ ತಯಾರಿಸಲು ಬಳಸುವ ಒಲೆಯ ಮಾದರಿ, ಬೆಲ್ಲದ ಗುಣಮಟ್ಟ ಮತ್ತು ಈ ಉದ್ದಿಮೆಯ ಆಕತೆಯನ್ನು ಹೆಚ್ಚಾಗಿ ನಿರ್ಧರಿಸುತ್ತದೆ. ದಕ್ಷಿಣ ಒಣಪ್ರದೇಶದ (ಕೃಷಿ ವಲಯ- 6) ರೈತರು ಬಹಳವಾಗಿ ಎರಡು ಕೊಪ್ಪರಿಗೆ ಒಲೆ ಮಾದರಿಯನ್ನು (ಮಂಡ್ಯ ನಾಡೊಲೆಯನ್ನು) ಉಪಯೋಗಿಸುತ್ತಿದ್ದಾರೆ. ಈ ಮಾದರಿಯಲ್ಲಿ ರಾಸಾಯನಿಕ ಸ್ವಚ್ಛಕಾರಕಗಳಾದ ಅಡಿಗೆಸೋಡ (ಸೋಡಿಯಂ ಬೈಕಾರ್ಬೊನೇಟ್) ಮತ್ತು ಬೆಲ್ಲ ಬೆಳ್ಳಗೆ ಮಾಡುವಂತಹ ಸೋಡಿಯಂ ಹೈಡ್ರೊಸಲ್ಫೇಟನ್ನು ಯಥೇಚ್ಛವಾಗಿ ಬಳಕೆ ಮಾಡುತ್ತಿದ್ದರೂ ಸಹ ಕಬ್ಬಿನ ಹಾಲಿನ ಶುಚೀಕರಣ ಪೂರ್ತಿಯಾಗದಿರುವುದರಿಂದ ಉತ್ತಮ ಗುಣಮಟ್ಟದ ಬೆಲ್ಲವನ್ನು ತಯಾರಿಸಲು ಕಷ್ಟಸಾಧ್ಯವಾಗುತ್ತದೆ. ಜೊತೆಗೆ ಒಂದು ಕ್ವಿಂಟಾಲ್ ಬೆಲ್ಲ ತೆಗೆಯಲು ಹೆಚ್ಚು ಸಮಯ ಅಂದರೆ 2.5 - 3 ಗಂಟೆಗಳು ಬೇಕಾಗಿದ್ದು ಬೆಲ್ಲದ ಉತ್ಪಾದನೆ ದಿನ ಒಂದಕ್ಕೆ ಕೇವಲ 5 ರಿಂದ 6 ಕ್ವಿಂಟಾಲ್ ಮಾತ್ರ ಇರುತ್ತದೆ.

ಬಹು ಕೊಪ್ಪರಿಗೆ ಒಲೆ - ಒಂದು ಸುಧಾರಿತ ಮಾದರಿ

ಈ ಮಾದರಿಯಲ್ಲಿ ಬೆಲ್ಲ ತಯಾರಿಸುವ ಕಾರ್ಯ ರಭಸ ಹಾಗೂ ನಿರಂತರವಾಗಿರುವುದರಿಂದ ಪ್ರತಿ ಗಂಟೆಗೆ ಒಂದು ಕ್ವಿಂಟಾಲ್ ನಂತೆ ದಿನ ಒಂದಕ್ಕೆ ಸುಮಾರು 12 ಕ್ವಿಂಟಾಲ್ ನಷ್ಟು ಬೆಲ್ಲ ತೆಗೆಯಬಹುದು. ಜೊತೆಗೆ ಬಹುಕೊಪ್ಪರಿಗೆ ಒಲೆ ಮಾದರಿಯಲ್ಲಿ ಕಬ್ಬಿನ ಹಾಲನ್ನು ಶುದ್ಧೀಕರಿಸಲು ಸಸ್ಯಜನ್ಯ ಸ್ವಚ್ಛಕಾರಕವಾದ ಬೆಂಡಿರಸವನ್ನು ಹೆಚ್ಚು ಬಳಸಿ ಉತ್ತಮ ಗುಣಮಟ್ಟದ ಹಾಗೂ ಆರೋಗ್ಯಕರವಾದ ಬೆಲ್ಲವನ್ನು ತೆಗೆಯಲು ಸಾಧ್ಯ. ಸುಮಾರು ಒಂದು ಕಿ.ಗ್ರಾಂ ಬೆಂಡಿ ಕಾಂಡವನ್ನು ಅರೆದು 8 ರಿಂದ 10 ಲೀಟರ್ ನೀರಿನಲ್ಲಿ ಕಿವಿಚಿದಾಗ ಲೋಳೆಯಂತಹ ರಸವನ್ನು ಒಂದು ಕ್ವಿಂಟಾಲ್ ಬೆಲ್ಲ ಬರುವಂತಹ ಕಬ್ಬಿನ ಹಾಲಿನಲ್ಲಿ ಬೆರೆಸಿ ಕಾಯಿಸಿದಾಗ ತೇಲಿ ಬರುವ ಮಡ್ಡಿಯನ್ನು ಹೊರತೆಗೆದು ಹಾಲು ಶುದ್ಧೀಕರಿಸಬೇಕು. ಇದೇ ಉತ್ತಮ ಗುಣಮಟ್ಟದ ಬೆಲ್ಲವನ್ನು ಅದೇ ಬೆಂಡಿರಸ ಉಪಯೋಗಿಸಿ ಮಂಡ್ಯ ನಾಡೊಲೆಯಿಂದ ತೆಗೆಯಲು ಕಷ್ಟಸಾಧ್ಯ. ಆದುದರಿಂದಲೇ ಮಂಡ್ಯ ನಾಡೊಲೆಯಲ್ಲಿ ವಿವೇಚನಾರಹಿತವಾಗಿ (ಹೆಚ್ಚಾಗಿ) ಮೇಲೆ ತಿಳಿಸಿರುವ ರಾಸಾಯನಿಕಗಳನ್ನು ಉಪಯೋಗಿಸಲಾಗುತ್ತದೆ. ಇವೆಲ್ಲಕ್ಕಿಂತ ಮಿಗಿಲಾಗಿ ಮಂಡ್ಯ ನಾಡೊಲೆಗಿಂತ ಬಹು ಕೊಪ್ಪರಿಗೆ ಒಲೆ ಮಾದರಿಯ ಬೆಲ್ಲ ತಯಾರಿಕೆ ಸುಮಾರು ಎರಡು ಪಟ್ಟು ಲಾಭದಾಯಕವಾಗಿರುತ್ತದೆ.

ಉತ್ತಮ ಗುಣಮಟ್ಟದ ಬೆಲ್ಲದ ಗುಣಗಳಾದ ಬಂಗಾರದಂತಹ ಬಣ್ಣ, ಗಟ್ಟಿತನ ಮತ್ತು ಶೇಖರಣೆಯನ್ನು ಹೆಚ್ಚಿಸಲು ಸುಣ್ಣ ತಿಳಿ ನೀರನ್ನು ಹಸಿ ಹಾಲಿಗೆ ಬೆರೆಸಬೇಕು. ಆದರೆ ಸುಣ್ಣದ ತಿಳಿ ನೀರಿನ ಪ್ರಮಾಣವನ್ನು ನಿರ್ಧರಿಸಲು ಕಬ್ಬಿನ ಹಾಲಿನ ರಸಸಾರ (ಪಿಹೆಚ್)ಕ್ಕನುಗುಣವಾಗಿ ಬಣ್ಣ ಬದಲಾಯಿಸುವ ಕಾಗದ (ಪಿಹೆಚ್.ಕಾಗದ) ವನ್ನು ಉಪಯೋಗಿಸಿ ಹಾಲಿನ ಆಮ್ಲೀಯ ರಸಸಾರವನ್ನು ತಟಸ್ಥ ರಸಸಾರಕ್ಕೆ (6.5 ಪಿಹೆಚ್) ತರಬೇಕಾಗುತ್ತದೆ. ಸುಣ್ಣದ ತಿಳಿ ನೀರಿನ ಪ್ರಮಾಣ ಹೆಚ್ಚಾದರೆ ಹಾಲಿನ ರಸಸಾರ ಕ್ಷಾರಕ್ಕೆ ಹೋಗಿ (7.5 ಪಿಹೆಚ್.ಗಿಂತ ಹೆಚ್ಚು), ತಯಾರಿಸಿದಂತಹ ಬೆಲ್ಲ ಕಪ್ಪಾಗಿರುತ್ತದೆ. ರೇಖಾ ಚಿತ್ರ (14) ದಲ್ಲಿ ತೋರಿಸಿರುವಂತೆ ಬಹು ಕೊಪ್ಪರಿಗೆ ಮಾದರಿ ಒಲೆಯನ್ನು ನಿರ್ಮಿಸಿ ಬೆಲ್ಲ ತಯಾರಿಸುವುದು. ಆಕತೆ, ಬೆಲ್ಲದ ಉತ್ಪಾದನೆಯ ಪ್ರಮಾಣ, ಗುಣಮಟ್ಟ ಮತ್ತು ಆರೋಗ್ಯ. ಇಲ್ಲವುಗಳ ದೃಷ್ಟಿಯಿಂದ ಸೂಕ್ತ.

ಶುದ್ಧೀಕರಣ



ಪಾಕ ಆರಿಸುವಿಕೆ

14: ಬಹುಕೊಪ್ಪರಿಕೆಯ (ಉತ್ತರ ಪ್ರದೇಶ) ಒಲೆ ಮಾದರಿ

ಸಸ್ಯ ಸಂರಕ್ಷಣೆ: ಕಬ್ಬು

ಕೀಟಗಳು

ಕೀಟಗಳು	ಹಾನಿಯ ಲಕ್ಷಣಗಳು	ಪರಿಣಾಮಕಾರಿ ಕೀಟನಾಶಕಗಳು (ಯಾವುದಾದರೊಂದು ಕೀಟನಾಶಕವನ್ನು ಬಳಸಿ)	ಪ್ರಮಾಣ ಮಿ.ಲೀ./ಗ್ರಾಂ ಲೀಟರ್ ನೀರಿಗೆ	ಎಕರೆಗೆ ಮಿ.ಲೀ./ ಕಿ.ಗ್ರಾಂ	ಬಳಸಬೇಕಾದ ಅವಧಿ/ವಿಧಾನ
ಆದಿ ಸುಳಿ ಕೊರೆಯುವ ಹುಳು	ಮರಿಹುಳು ಬುಡಭಾಗದಲ್ಲಿ ಕೊರೆದು ಸುಳಿಯಲ್ಲಿ ಸೇರಿ ತಿನ್ನುವುದರಿಂದ ಸುಳಿ ಒಣಗುತ್ತದೆ. ಕೈಯಿಂದ ಎಳೆದರೆ ಸುಲಭವಾಗಿ ಹೊರಬರುತ್ತದೆ. ಹುಳು ಬಿದ್ದ ಪೈರಿನಲ್ಲಿ ಅನೇಕ ಕುಡಿ ಸಸಿಗಳು ಬರುತ್ತವೆ.	ಕ್ಲೋರ್ ಪೈರಿಫಾಸ್ 20 ಇ.ಸಿ ಜೈವಿಕ ನಿಯಂತ್ರಣ *ಟ್ರೈಕೋಗ್ರಾಮ ಪರತಂತ್ರ ಜೀವಿಗಳ ಬಳಕೆ.*	2 ಮಿ.ಲೀ.	600 ಮಿ.ಲೀ.	ಬಾಧೆ ಕಂಡಾಗ ಎಕರೆಗೆ 300 ಲೀಟರ್ ಸಿಂಪರಣಾ ದ್ರಾವಣವನ್ನು ಸಿಂಪಡಿಸುವುದು ಅಥವಾ ಟ್ರೈಕೋಗ್ರಾಮ ಪರತಂತ್ರ ಜೀವಿಗಳನ್ನು ಕಬ್ಬು ನೆಟ್ಟ 4ನೇ ವಾರದಿಂದ ಪ್ರತಿ ಎಕರೆಗೆ 6000 ಪರತಂತ್ರ ಜೀವಿಗಳನ್ನು ಪ್ರತಿ ವಾರಕ್ಕೊಮ್ಮೆ 5 ವಾರ ಬಿಡುಗಡೆ ಮಾಡುವುದು. ಕಬ್ಬು ನೆಟ್ಟ ಒಂದೂವರೆ ತಿಂಗಳಿನಲ್ಲಿ ಬುಡಕ್ಕೆ ಮಣ್ಣು ಏರು ಹಾಕಿ ನೀರು ಹಾಯಿಸುವುದು
ನೆತ್ತಿ ಸುಳಿ ಕೊರಕ	ಸುಳಿಯ ಗರಿಯಲ್ಲಿ ಗುಂಡು ಸೂಜಿಯಾಕಾರದ ರಂಧ್ರಗಳು ಕಾಣುತ್ತವೆ. ಜೊಲ್ಲೆಯ ಮೇಲ್ಭಾಗದ ಕಣ್ಣುಗಳು ಮೊಳೆತು ಕವಲುಗಳು ಬರುತ್ತವೆ. ಇದನ್ನೇ ಗೊಂಚಲು ತುದಿ ಎಂದು ಕರೆಯುವುದು.				ಜೈವಿಕ ಹತೋಟಿ: ಪರಿಸರದಲ್ಲಿ ಐಸೋಟೀಮ ಎಂಬ ಪರೋಪಜೀವಿ ಸುಳಿಕೊರಕವನ್ನು ನಿಯಂತ್ರಿಸುವುದರಲ್ಲಿ ಪರಿಣಾಮಕಾರಿಯಾಗಿರುತ್ತದೆ ಈ ಪರೋಪಜೀವಿಗೆ ಪ್ರೋತ್ಸಾಹ ಕೊಡುವುದು.
ಶಲ್ಕ ಕೀಟಗಳು ಮತ್ತು ಹಿಟ್ಟು ತಿಗಣೆ	ಶಲ್ಕ ಕೀಟಗಳು ಗರಿ ಮತ್ತು ಕಾಂಡದಿಂದ ರಸ ಹೀರುವುದರಿಂದ ಗರಿಗಳು ಹಳದಿ ಬಣ್ಣಕ್ಕೆ ತಿರುಗುತ್ತವೆ ಇವುಗಳು ಗೆಣ್ಣಿನ ಸುತ್ತ ಇರುತ್ತವೆ. ಹಿಟ್ಟು ತಿಗಣೆಗಳು ಗರಿಯ ಸೋಗೆಯಲ್ಲಿ ಮತ್ತು ಗಿಣ್ಣಿನ ಸುತ್ತ ಇದ್ದು ರಸ ಹೀರುತ್ತವೆ. ಇದರಿಂದ ಕಬ್ಬಿನ ಬೆಳವಣಿಗೆ ಹಾಗೂ ಸಕ್ಕರೆ/ ಬೆಲ್ಲದ ಇಳುವರಿಯಲ್ಲಿ ಕುಂಠಿತಗೊಳ್ಳುತ್ತದೆ.	ಕ್ಲೋರ್ ಪೈರಿಫಾಸ್ - 20 ಇ.ಸಿ. ಡೈಮಿಥೋಯೇಟ್ - 30 ಇ.ಸಿ	2 ಮಿ.ಲೀ. 1.7 ಮಿ.ಲೀ.	600-800 ಮಿ.ಲೀ. 510 - 680 ಮಿ.ಲೀ.	ಕೀಟಗಳ ಹಾವಳಿ ಕಂಡುಬಂದಾಗ ಕಬ್ಬಿನ ಸೋಗೆಯನ್ನು ಬಿಡಿಸಿ ಸಿಂಪಡಿಸುವುದು ಎಕರೆಗೆ 300-400 ಲೀಟರ್ ದ್ರಾವಣ ಬೇಕಾಗುತ್ತದೆ.
ಬಿಳಿ ಉಣ್ಣೆ ಹೇನು (ತಾತ್ಕಾಲಿಕ ಶಿಫಾರಸ್ಸು)	ಬಿಳಿ ಉಣ್ಣೆ ಹೇನುಗಳು ಗುಂಪಾಗಿ ಗರಿಗಳ ತಳಭಾಗದಲ್ಲಿದ್ದು ರಸ ಹೀರುತ್ತಿರುತ್ತವೆ. ತಳ ಗರಿಗಳಲ್ಲಿ ಕಪ್ಪು ಬೂಷ್ಟು ಬೆಳೆದುಕೊಂಡಿರುತ್ತದೆ. ಕಬ್ಬಿನ ಬೆಳವಣಿಗೆಯಲ್ಲಿ ಕುಂಠಿತ	ಕ್ಲೋರ್ ಪೈರಿಫಾಸ್ - 20 ಇ.ಸಿ. ಡೈಮಿಥೋಯೇಟ್ - 30 ಇ.ಸಿ.	2 ಮಿ.ಲೀ. 1.7 ಮಿ.ಲೀ.	600 ಮಿ.ಲೀ. 510 ಮಿ.ಲೀ.	ಕೀಟ ಬಾಧೆ ಮೊದಲು ಬೆಳೆಯ ಒಂದೆರಡು ಪ್ರದೇಶದಲ್ಲಿರುವುದು ಕಂಡುಬರುವುದರಿಂದ ಆ ಪ್ರದೇಶಕ್ಕೆ ಮಾತ್ರ ಸಿಂಪರಣೆ ಮಾಡುವುದು. ಬೆಳೆಯ ಎಲ್ಲಾ ಭಾಗದಲ್ಲಿ ಕಂಡುಬಂದಲ್ಲಿ ಎಕರೆಗೆ 300 ಲೀಟರ್ ಸಿಂಪರಣಾ ದ್ರಾವಣ ಬೇಕಾಗುತ್ತದೆ. ಜೈವಿಕ ಹತೋಟಿ: ಎಕರೆಗೆ 500-1000 ಮೈಕ್ರೋಮಾಸ್ ಹೇನು ಸಿಂಹ ಪರಭಕ್ಷಕಗಳನ್ನು ಬಿಳಿ ಉಣ್ಣೆ ಹೇನು

					ಕಂಡ ತಕ್ಷಣ ಬಿಡುಗಡೆ ಮಾಡುವುದು ಬಿಳಿ ಉಣ್ಣೆ ಹೇನು ಪೀಡಿತ ಪ್ರದೇಶದಲ್ಲಿ ನಿರೋಧಕ ಕಬ್ಬಿನ ತಳಿ ಅಭಿಮನ್ಯುವನ್ನು ಬೆಳೆಯುವುದು ಸೂಕ್ತ. ಇತರೆ ತಳಿಗಳನ್ನು ಹೆಚ್ಚು ಅಂತರ (5 ಅಡಿ) ಸಾಲುಗಳಲ್ಲಿ ನೆಡುವುದು.
ಗೊಣ್ಣೆಹುಳು	ಹುಳುಗಳು ಬೇರನ್ನು ತಿನ್ನುವುದರಿಂದ ಕಬ್ಬಿನ ಬುಡ ಒಣಗುವುದು. ಅಂತಹ ಬುಡಗಳು ಗಾಳಿ ಬೀಸಿದಾಗ ಮಲಗುತ್ತವೆ.	ಪುಸ್ತಕದ ಕೊನೆಯಲ್ಲಿ ಕೊಟ್ಟಿರುವ ಪ್ರತ್ಯೇಕ ಅಧ್ಯಾಯವನ್ನು ನೋಡಿ.			
ಗೆದ್ದಲು	ಕೆಲಸಗಾರ್ತಿ ಗೆದ್ದಲು ಹುಳು ಬೆಳೆಯ ಯಾವುದೇ ಹಂತದಲ್ಲಾದರೂ ಹಾನಿ ಮಾಬಹುದು. ಬಿತ್ತನೆ ತುಂಡುಗಳನ್ನು ಕತ್ತರಿಸಿದ ಭಾಗದಿಂದ ತಿನ್ನುವುದರಿಂದ ಮೊಳಕೆ ಪ್ರಮಾಣ ಕಡಿಮೆಯಾಗುತ್ತದೆ. ಬೆಳೆಯುತ್ತಿರುವ/ ಬೆಳೆದ ಬೆಳೆಯ ಬೇರನ್ನು ತಿನ್ನುವುದರಿಂದ ಬೆಳೆಯ ಬುಡ ಒಣಗಿ ಗಾಳಿಯ ಒತ್ತಡಕ್ಕೆ ಬೀಳುತ್ತದೆ.	ಪುಸ್ತಕದ ಕೊನೆಯಲ್ಲಿ ಕೊಟ್ಟಿರುವ ಪ್ರತ್ಯೇಕ ಅಧ್ಯಾಯವನ್ನು ನೋಡಿ.			

ರೋಗಗಳು

ರೋಗಗಳು	ಮುಖ್ಯವಾದ ಚಿಹ್ನೆಗಳು	ರೋಗನಾಶಕಗಳು	1 ಲೀ. ನೀರಿಗೆ ಬೇಕಾಗುವ ಪ್ರಮಾಣ	ಎಕರೆಗೆ ಬೇಕಾಗುವ ಪ್ರಮಾಣ	ಉಪಯೋಗಿಸಬೇಕಾದ ಕಾಲ ಮತ್ತು ವಿಧಾನ
ಅನಾನಸ್ ರೋಗ	ಬಿತ್ತನೆ ತುಂಡುಗಳು ಕೊಳೆತು ಮಾಗಿದ ಅನಾನಸ್ ಹಣ್ಣಿನ ರೀತಿಯ ವಾಸನೆ ಸೂಸುತ್ತದೆ ಹಾಗೂ ಮೊಳಕೆಯೊಡೆಯುವ ಪ್ರಮಾಣ ಕಡಿಮೆಯಾಗುತ್ತದೆ.	ಪಾದರಸ ಸಂಯುಕ್ತ ವಸ್ತು ಅಥವಾ ಕಾರ್ಬೆಂಡಜಿಂ	2 ಗ್ರಾಂ 1 ಗ್ರಾಂ	1.0 ಕಿ.ಗ್ರಾಂ 0.5 ಕಿ.ಗ್ರಾಂ	ಬಿತ್ತನೆ ತುಂಡುಗಳನ್ನು 5 ನಿಮಿಷ ದ್ರಾವಣದಲ್ಲಿ ಅದ್ದಿ ನೆಡುವುದು
ಎಲೆ ಚುಕ್ಕೆ ರೋಗ	ರೋಗಪೀಡಿತ ಗಿಡದ ಎಲೆಗಳ ಮೇಲೆ ನೀಳವಾದ ಕಂದು ಅಥವಾ ಕೆಂಪಾದ ಚುಕ್ಕೆಗಳು ಕಾಣಿಸಿಕೊಂಡು ಎಲೆಗಳು ಸಂಪೂರ್ಣ ಒಣಗುತ್ತವೆ.	ತಾಮ್ರದ ಆಕ್ಸಿಕ್ಲೋರೈಡ್ ಅಥವಾ ಮ್ಯಾಂಕೋಜೆಬ್	2.5 ಗ್ರಾಂ 2 ಗ್ರಾಂ	750 ಗ್ರಾಂ 600 ಗ್ರಾಂ	8, 12, 16 ಮತ್ತು 20ನೇ ವಾರಗಳಲ್ಲಿ ಎಕರೆಗೆ ಪ್ರತಿ ಬಾರಿ 300 ಲೀ. ದ್ರಾವಣ ಸಿಂಪಡಿಸಿ.
ಹಳದಿ ನಂಜು ರೋಗ	ರೋಗ ಬಂದ ಗಿಡಗಳು ಹಳದಿಯಾಗಿ ಬೆಳವಣಿಗೆ ತುಂಬಾ ಕುಂಠಿತವಾಗುತ್ತದೆ				ರೋಗ ಬಂದ ಗಿಡಗಳನ್ನು ಕಿತ್ತು ಸುಟ್ಟು ಹಾಕಿ
ಕಾಡಿಗೆ ರೋಗ	ರೋಗ ಬಂದ ಗಿಡಗಳ ಬೆಳವಣಿಗೆಯು ಕುಂಠಿತಗೊಂಡು ಸುಳಿ ಬರುವ ಬದಲು 3 ರಿಂದ 4 ಅಡಿಯಷ್ಟು ಕಾಡಿಗೆ ಕಡ್ಡಿ ಹೊರಬರುತ್ತದೆ.				ರೋಗ ಕಾಣಿಸಿಕೊಂಡ ಗದ್ದೆಗಳಿಂದ ಕಬ್ಬಿನ ತುಂಡನ್ನು ಬಿತ್ತನೆಗೆ ಉಪಯೋಗಿಸಬಾರದು

ANNEXURE - 4

Table 1: Vegetable additives used in manufacture of Jaggery

Common& Botanicalname	**Plant part to be used**	**Methodology**	**Qnt / qut / juice g**	**Functions, Contributors / Discovered by**	**Demerits**
Deola (*Hibiscus ficulneus*)	Stem and root of green plant	Pound and rubbed in water. Use mucilaginous extract Removal of slurry / colour impart.	40-50	**(Roy, 1951, Khanna and Chakravarthy, 1954).(Anon., 1995).**	Non availability
Bhindi *(Hibiscus esculentus)*	Stem and root of green plant	Pound and extract in water. Use mucilaginous extract Solidification, hardness of jaggery & keeping quality. Colour import.	45-50	**(Mungare *et al*, 1999).(Mungare *et al*, 2001)**	Insufficient supply during crushing season needs consistent cultivation.
Phalsa (Grewia asistica)	Green bark of the tree	Pound and extract in water. Use mucilaginous extract	50-55	**Vaidya *et al*,. (1984)**	
Semul (Bombax malabaricum)	Green bark of the tree	Pound and extract in water. Use mucilaginous extract	55-60		Non availability
Sukhlai (Kydia calycine)	Dry bark of the plant	Soak in water. Pound and rubbed in water. Use mucilaginous extract	45-60	**Singh and Singh (1954) Chakrawarty *et al*,.(1954)**	Non availability
Castor (Ricinus communis)	Seed	Soaked in water, Ground decorticated seed with water. Use milky liquid after straining. For removal of scum & for good colour	70-75	**(Roy, 1951 & Anon., 1958-59)**	Non availability Precaution to recommended dose.
Groundnut (Arachis hypogaea)	Seed		70-75		
Soybean (Glycine max)	Seed		30-40		
Castor oil		Proved to better jaggery recovery than liming to pH 6.4	20-25 ml	If used more leads to Rancidity	use is Harmful to humans

Annexure 4 continued....... Table 2: Chemical additives used in manufacture of jaggery

Chemical	**Qnt required / qtl. Jaggery**	**Action**	**Immediate effect on product**	**Functions, Contributors / Discovered by**	**Demerits**
Hydrose (sodium hydrosulphite)	3.5 g	Colour bleaching	Brightens colour temporarily	**(Aruna *et al*, 1997; Pawar and Dongare, 2001).(Mungare *et al*, 2001)**	Hastens process of spoilage liberally use of this is harmful to Human health.
Super phosphate	50 g	Increases natural acidity and improves colour.	Reduces crystallization.	**(Javalekar et al, 1985 and Mungare *et al*, 2001).(Roy, 1951 and Anon, 1998).**	Poor storability. Weight gain
Flocculent muddy powder	-	Remove unwanted material in juice. Brightens colour temporarily.	Improves color of jaggery	Less keeping quality.	Poor storability.
Lime 1 shell lime 2 lime stone	100 to 125 ml of 10% lime.	Juice acidity and clarification	Liming to pH 6.3-6.6 results in good quality. Useful in solidification and gives hard jaggery and stores better.	**(Anon., 1957-58).**	Liming >6.7 pH gives dark good color jaggery. Induces hardness to jaggery and better texture, good storability
Alum	-	Improves clarification. Needs neutralization with lime / soda	Brightens colour temporarily and leads to poor storability	**Roy, 1951 and Singh, (1998).**	Temporary retention of colour & poor storability.
Sodium carbonate (washing Soda)	2.5 to 4.0 g	Clarification of juice, reduces acidity (it is used for inferior quality canes). Brightness color & attractive color.	Helps in setting and improving Jaggery.	**Roy, 1951 and Mungare *et al*, (2001).**	liberal Use, directly effects Human health. Used for inferior quality cane.
Sodium bicarbonate (Added in cooling pan)	5 to 8 g	Clarification of juice, colour bleaching.	Brightens colour temporarily	**Roy, 1951 and Anon., (1998).**	Hastens process of spoilage liberal use of this is harmful to human health.

Annexure 4 Continued........

Sajji (50% sodium carbonate + 6.4% sodium sulphate + 4.5% sodium chloride)	400 ml of 5% solution	Partial neutralization of juice acidity and colour bleaching	Brightens colour temporarily. Reduces the taste.	**(Roy, 1951; Anon., 1999)**. **(Mungare *et al*,, 2001)**	Poor Storability. For unripe cane of inferior quality.
Trisodium Phosphate (TSP)	-	Solidification Hard Jaggery	Hardness of Jaggery	Poor storability	Hastens process of spoilage.
Phosphoric acid(Food grade)	-	Brightness colour Gives hard jaggery Store better Keeping quality	Hardness		Hastens process of spoilage liberally use of them is harmful to human health. Storability and keeping quality
Sodium formaldehyde sulphoxylate safolite / Decolite		Brightens colour and gives hard jaggery and store better	Temporary retention of colour and storability	Not recommended but being used Mandya area	It is a textile bleaching agent Harmful to Human Health.

Annexure -5

Cost of Processing Jaggery

Cost of Jaggery Processing at Jaggery Park, V.C. Farm, Mandya during 2017

	Types of Jaggery			
Particulars	**Lump (Solid)**	**Powder**	**Liquid**	**Jaggery by Outsourcing Agency**
Cane procurement/ton	2300	2300	2300	2300
Lime @ 400 g/juice from one ton	7	7	7	7
Bhandi 1 kg/ juice from one ton	15	15	15	15
Coconut oil- 80 ml/batch	20	20	20	20
Labour /quintal of Jaggery	525	800	525	525
University lease charges/ton	-	-	-	567
Electricity charges Rs. /quintal	50	50	50	50
Diesel, oil, grease & maintenance of machineries and equipments Rs. /quintal	25	25	25	25
Packing charges @ Rs.2.5/kg	250	250	-	250
Bottling charges @ Rs.50/kg	-	-	6500	-
Preservatives	-	-	200	-
Bagasse fuel charge Rs. 150/kg	225	225	225	225
Depreciation cost Rs./ton	5	5	5	5
Technology charge Rs./ton	50	50	50	50
Total cost	3472	3747	9922	4039
Total Returns @10% recovery for solid & powder Jaggery and 13% recovery for liquid Jaggery	6000	7000	19500	6000
Bagasse 150 kg/ ton @ Rs 2/kg	225	225	225	225
Scum @ 3 % @ Rs 1/kg	30	30	30	30
Ash @1 % = 2 kg/ ton	5	5	5	5
Total Returns	**6260**	**7260**	**19760**	**6260**
Net Returns	**2026**	**2826**	**9356**	**1459**

Price of Lump jaggery @ Rs. 60/kg, Price of Powder jaggery @ Rs. 70/kg, Price of Liquid jaggery @ Rs. 150/kg, Cost of sugarcane @ Rs. 2300/ ton, coconut coil @ Rs. 300/kg, Bhendi @ Rs. 5/kg, Bagasse @ Rs. 1.50/kg, labour @ 400/ man day

Note: These rates are as per the UAS (B) norms. The returns of outsourcing agency depends on selling price of jaggery by the agency

Annexure - 6

Terms of Reference for Evaluation of RKVY project on "Establishment of Jaggery Park in Southern Karnataka" by the Department of Agriculture (Period -2008-09 to 2012-13).

1. Title of the Evaluation Study:

The title of the Evaluation study is **"***Establishment of Jaggery park inSouthern Karnataka"*established with the funding from RKVY financed throughthe Department of Agriculture in Karnataka from 2008-2009 to 2012-13.

2. Department/Agency implementing the Scheme:

The Department of Agriculture in Karnataka through the University of Agricultural sciences, Bangalore, Zonal Agricultural Research Station, V.C. Farm, Mandya.

3. Background Information:

Sugarcane is one of the important commercial crops cultivated in the command areas of Karnataka state. In the State it is cultivated in an area of 4.25 lakh hectares annually giving a production of 357.3 lakh tonnes of sugarcane with a productivity of 84 tonnes / hectare (Ministry of Agriculture, 2014-15). Karnataka ranks 3rdamongst all the States of the countryin respect of area of under Sugarcane cultivation. In the southern districts of Karnataka,on an average across the years, out of the total sugarcane produced, around 60 per cent has been utilized for sugar extraction in the sugar mills and 30-35 per cent in Jaggery making. On an average, 25 per centof the total sugarcane produced in the country is utilized for Jaggery preparation. As such, Jaggery preparation is an important cottage industry of Karnataka. In simple terms Jaggery is the solidified mass of sugarcane juice. Sugarcane juice is boiled and condensed in open pans removing impurities to obtain the solidified mass called Jaggery.

Jaggery is an important natural sweetener widely used in confectionaries, culinary preparations and Ayurvedic medicines. Jaggery has got nutritive as well as medicinal values unlike white sugar and is much more sweetening than white sugar, by virtue of its higher content of reducing sugars. Cauvery command area in southern Karnataka is an important sugarcane growing belt, with over 5000 Jaggery boiling units under operation during 1999-2000. However, the number of Jaggery boiling units has been reducing gradually because of market price fluctuations over the years. APMC market in Mandya is the major Jaggery market in the Cauvery command area.

Utilization of sugarcane for different purpose

Period Years	Sugar cane production ('000' tons)	Sugarcane utilized for production of ('000' tons)			% of Sugarcane utilized for production of		
		White sugar	Seed, feed, chewing etc.	Jaggery & Khandsari	White sugar	Seed, feed, chewing etc.	Jaggery & Khandsari
1970 to 1980	1,30,096	45,713	16,675	77,708	35.29	11.90	55.81
1980 to 1990	1,85,659	78,527,	22,005	85,125	41.85	11.85	46.31
1990 to 2000	2,65,452	1,37,557	30,408	97,487	51.57	11.59	37.07
2000 to 2010	2,91,370	1,85,706	34,313	70,589	62.92	11.79	25.29

* **Source**: Lucknow Jaggery Manual 2014.

The National Commission Agriculture (1976) estimated that per capita consumption of sweeteners would increase to about 40 kg/head/annum from current consumption of approximately 25 kg/head/annum.

Table-1: Projections of Sweetener Requirement vis-a-vis sugarcane production in India by 2020

Year	Sweetener Requirement (MT)			Sugarcane Requirement (MT)	Sugar Production (MT)
	Sugar	Jaggery	Total		

1990-91	12.40	9.00	21.40	241.00	12.05
2000	18.00	13.70	31.70	300.00	18.90
2010	22.17	16.81	38.98	348.50	22.48
2020	27.29	20.69	47.98	415.00	27.39

Nutritional and Medicinal value of Jaggery

The acceptable taste and nutritive value of Jaggery has attracted human population since ancient times. Jaggery is also called "*Non Centrifugal Sugar*" or Artisan Sugar. White sugar contains only sucrose (99.70%).Jaggery has sucrose (51.00%), protein (0.25%), glucose (21.20%) and minerals (3.40%) in addition to trace amount of fats (0.02 to 0.03%), calcium (0.39%), vitamin A, vitamin B, Phosphate (0.025%) and provides 383 K cal/100g.

Dietary sucrose (sugar) is a mixed blessing which makes food more attractive and appetizing, but excessive consumption often leads to various kinds of pathological conditions like., dental caries, coronary thrombosis, ischemic heart disease, diabetes, hyperacidity, depression, obesity etc., Some studies have also shown that high sugar intake leads to increased cancer risk.

Jaggery is an alternative sweetener to sugarcane and eco-friendly too. In Ayurveda**,**Jaggery is considered to be the best of all the preparations made from sugarcane**.**

Jaggery contains the following nutritive elements which has made it a better sweetener than white crystal Sugar:

- Sucrose 60-85%
- Glucose and fructose 5-15%.
- Moisture 5-6%
- Protein 0.4%,
- Fat 0.1%
- Minerals 0.6 to 1.0%

(8 mg of Calcium, 4 mg of Phosphorus and 11.4 mg of Iron per 100 g along with traces of vitamins and amino acids).

- It serves as a cardiac tonic.

- It is used in Ayurvedic medicines
- Jaggery has a cooling and diuretic effect.
- 100 g of Jaggeryprovides 383 kcal of energy.

Constraints in Jaggery Industry:

a) Non-availability of technology & existing research gap, low price for Jaggery due to poor quality are causing the closure of Jaggery units.

b) Cauvery command area is the only area in India where Jaggery is manufactured in the off-season (June-Sep.), apart from the regular crushing season (Oct-March). But the farmers in this area do not get appreciable price for Jaggery because of poor quality. Hence, there is a need to utilize the off-season crushing in a profitable manner through advanced research.

c) In the command area, usually farmers grow excess sugarcane without knowing the demand from the sugar industries. Under such circumstances, it is an extra burden on the sugar factory for crushing and theyrefuse to purchase excess sugarcane. Thus farmers incur loss both in terms of cane yield and quality. Under this situation, the best way to rescue the farmers and build confidence in them is by diverting excess sugarcane toJaggery industries.

d) Many farmers are preparing Jaggery by age-old methods under highly Unhygienic conditions. It is considered that the process is scientifically inefficient to produce quality Jaggery.

e) There is no specific research Centre working exclusively on Jaggery production in Karnataka but for some research being carried out at ZARS, V.C. Farm, Mandya and ARS, Sankeshwar, to solve the problems faced by the farmers in Karnataka.

f) Jaggery making is a cottage industry operated at a decentralized level in unorganized rural sectors and needs institutional support for quality.Jaggery production, handling, storage, management which can accrue higher returns at lower cost.

g) Farmers in Karnataka are preparing Jaggery by using several chemicals (clarificants) like hydros (Sodium hydrosulphite), Sodium formaldehyde sulphoxylate (*Chakke*), and Sodium bicarbonate (Baking soda), Sodium carbonate (washing soda), Super phosphate, Phosphoric acid, alum and lime at higher concentrations and dose. Hydros (Sodium hydrosulphite) and Sodium carbonate (washing soda) are liberally used to get attractive bleached white colorofJaggery but causing deleterious effects on health of the consumers. Jaggery which is prepared by using higher quantity of hydros and Sodium formaldehyde sulphoxylate (*Chakke*) contains more than 500 ppm of Sulphur dioxide, which is well above the prescribed norms of 50 ppm by Indian standards (IS 12923):1990. This amount of Sulphur dioxide is detrimental to the beneficial intestinal microflora leading to digestive disorders and gastrointestinal problems. It can also cause breathing problems in asthmatic patients, colon/rectal cancer and destroy the formation of vitamin A and vitamin B1. Hence, extensive research has to be carried out on use of clarificants of plant origin and safe chemical clarificants.

h) The crushers that are being presently used are old, unsafe and highly inefficient to crush more quantity of cane and have less extraction efficiency (50%). Hence, there is a need for modification of existing crushers for effective juice extraction (65-70% efficiency). A 10 per cent increase in crushing efficiency will yield more than 10-15 kg extra Jaggeryper tonne of cane to the farmers just by adopting improved crushers.

i) The furnaces and boiling pans presently used have many disadvantages in gettinghigher Jaggery yield with good quality. The type of furnace for Jaggery making plays an important role in deciding the efficiency and quickness of juice boiling besides other factors. The overall heat utilization efficiency of these furnaces is merely 20 per cent which is too low. Hence, it is very much essential to improve combustion and heat utilization efficiency of existing furnaces and development of furnaces working on forced draft system in order to reduce the boiling time is the need of the hour.

j) Fuel use efficiency in traditional methods is very poor. In some cases farmers are using old vehicle tyres and tubes as fuel source which emit toxic gases which are directly absorbed in the process of Jaggery making and ultimately affect its quality. Development of bagasse gassifier to generate producer gas for concentrating juice over burners appears to be promising.

k) Jaggery manufacturing units that are presently working harbour many harmful microorganisms due to unhygienic conditions where the whole

Jaggery making process is carried out in one shed. There is a need to design scientific state of the art Jaggery manufacturing unit at low cost to produce quality Jaggery.

Considering the above constraints a detailed project report was prepared after thorough discussions, deliberations with experts in the fields and visiting various research stations and plants which are involved in Jaggery preparation. As a result, specific objectives were formulated to tackle many of the issues concerning Jaggery industry. To fulfill the objectives so designed, infrastructure was created looking into the requirements including a modern open boiling Jaggery pilot plant.

4. Objectives:

The specific objectives of the project are as under-

1. Identification of sugarcane genotypes suitable for Jaggery production and to develop viable agro-techniques for improving juice content, quality and Jaggery yield.
2. Identification and modification of different types of crushers suitable for efficient juice extraction and safety.
3. Improvement of furnaces for heating the juice and sophisticated equipment for fuel use economy and reduced drudgery.
4. Mechanization in Jaggery processing to reduce manpower at different stages of Jaggery production.
5. Identification of different herbal and safe chemical clarificants for obtaining better texture, color, fragrance and quality of Jaggery.
6. To develop value added products of Jaggery suitable for local and export quality.
7. To develop packing and storage techniques for longer shelf life of Jaggery.
8. To provide trainings and conduct demonstrations on quality cane and Jaggery production.
9. To establish marketing network cell to cater the needs of Jaggery farmers.

5. <u>Present Status of the Scheme:</u>

The scheme was initiated in 2008-09 and the Jaggery Park was officially commissioned during April 2011. The pilot plant of the open boiling system of Jaggery preparation started during June 2011. The plant has the installed capacity of crushing 25 tonnes of Sugarcane that produces 2.5 tonnes of hygienic organic/chemical free Jaggery.

The laboratory for analysis of Sugarcane juice and Jaggery quality parameters has been established. HRD activities included training of Jaggery unit farmers on organic/chemical free Jaggery preparation and creating awareness among the visitors to Jaggery park on ill effects of chemicals used in Jaggery processing. Storage facilities have been created to stock 5 tonnes of Jaggery till it is marketed. Demonstration on Sugarcane varieties and agronomic practices for production of quality Sugarcane for higher quality chemical free Jaggery production. Posters, folders/handouts have been prepared on various technologies of Sugarcane varieties, Sugarcane cultivation and Jaggery preparation.

A plant with a novel idea of indirect boiling of Sugarcane juice in the evaporators through the Steam generated from the boiler has been established for hygienic quality Jaggery production.

Three varieties viz. Co 86032, Co 92005 and VCF 0517 have been identified for better yield and quality Jaggery production. Nutrient management, particularly nitrogen management, for quality Jaggery production was evolved. Ratio of organic and inorganic nutrients for quality Jaggery was emphasized.

Creating awareness among farmers, farm women, house wives, students, delegates, officers of development departments and large number of visitors during *Krishimela* and other occasions is being done regarding chemical free/organicJaggery preparation and ill effects of chemicals used in famers Jaggery units for Jaggery preparation on human health.

Outsourcing of Jaggery Preparation Facilities in PPP Mode

From 2015-16 the facilities for Jaggery preparation at Jaggery park Mandya were outsourced involving an organic group of farmers – Mandya Organic Farmers Co-Operative Society for organic/Chemical free Jaggery preparation in public – in the Private Participatory (PPP) mode. Since then they have been involved in commercial Jaggery production by scouting and procuring quality Sugarcane from the farmers' fields as well as the cane produced at V.C. Farm, Mandya.

6. Assets created and work under taken under Jaggery park:

Abstract of expenditure for establishment of Jaggery Park

Sl.no	Particulars	Expenditure in (Rs)
1	Contractual man power	2619300
2	Travelling expenses	214200
3	Other recurring contingency (Experiments, contractual labour Jaggery processing cost chemicals, fertilizers & maintenance of Equipment)	8983356
4	HRD activities (Training, field visits, demonstrations etc.)	605000
5	Purchase of Equipments (Laboratory Equipments, computer etc.)	15157000
6	Purchase of Equipment for mechanized sugarcane cultivation (Tractor, mini tractor, Dozer, ploughing equipments etc.)	1842000
7	Strengthening of infrastructure (Civil works)	50570000
	Total	**79990856**

Expenditure details for building and infrastructure

Sl. No	Particulars	Expenditure (Rs. In lakh)	Remarks
1	Jaggery Park Building	290.00	Building includes Jaggery production unit office facilities for the Scientists, Laboratory, Training hall and Jaggery store
2	Jaggery preparation Equipment	40.00	Equipment have been fabricated with food grade SS 304 for quality Jaggery

3	Steam based Jaggery boiling unit including Jaggery preparation equipment	71.06	Steam produced from the bagasse using boiler will be used for Jaggery preparation
4	Asphalting of roads in the Jaggery park premises	40.81	Roads in the Jaggery park premises have been asphalted
5	Construction of compound and watch cabin	25.00	Security to Jaggery park
6	Bagasse storage shed	20.00	To store dried bagasse
7	Box drain	17.50	To drain out excess rain water and canal water
8	Bagasse drying yard	10.00	To dry bagasse to increase the fuel efficiency
9	Riveting of open well, construction of pump house and provision of irrigation pipes.	6.25	To provide irrigation to Sugarcane blocks for Jaggery preparation.
	Total	**520.62**	

The following are the details of the infrastructure created at Jaggery Park, ZARS, V.C. Farm, Mandya.

a) Civil work

1. Construction of Jaggery Park building.
2. Asphalting of roads in the premises of Jaggery Park building.
3. Construction of compound and watchman shed in front of Jaggery Park.
4. Construction of box drains.
5. Riveting of open well and construction of pump house.
6. Barbed wire fencing.
7. Bagasse drying yard (735.20 m^2).
8. Bagasse storage shed (457.25 m^2).
9. Building to house Steam boiling unit.

b) **Jaggery preparation pilot plant**

1. Sugarcane crusher (15 HP).
2. Bagasse conveyor belt.

3. Stainless steel (SS 304) sunken tank (3000 L capacity).
4. Stainless steel (SS 304) screen mesh for juice filtering (2 Stage).
5. Stainless steel (SS 304) pump (1 HP).
6. Stainless steel (SS 304) sugarcane juice conveyance pipes.
7. Stainless steel (SS 304) over head juice collection tank (3000 L capacity).
8. Stainless steel (SS 304) rectangular pre heating pans (2000 L capacity) – 2 Nos.
9. Stainless steel (SS 304) main boiling pans (3000 L capacity) – 2 Nos.
10. Hydraulic system.
11. Furnaces (IISc designed) – 2 Nos.
12. Stainless steel (SS 304) scum collection tank – 2 Nos. 13. Jaggery cooling pit (granite) – 2 Nos.
14. Chimneys – 2 Nos.
15. Jaggery moulds:

    Wooden – 10 Nos.

    Aluminum – 1 kg – 660 Nos. 5 kg – 30 Nos.
16. Double effect evaporators& accessories and Steam boiler.

c) **Sugarcane juice and Jaggery quality analysis laboratory**

Furnishing of the laboratory with island tables with chemicals and reagents, and instruments relating to sugarcane and Jaggery research has been done and the details of the equipment purchased for establishment of laboratory are given in ***Annexure3*.**

d) **Storage structures** – Structures for storage of Jaggery from the pilot plantand samples prepared in the laboratory. Eight racks have been procured to store approximately 5 tons of Jaggery.

e) **Training hall** – Furnished with false ceiling and AC, audio visual aids,public address system with a seating capacity of 50 trainees.

f) **Office space** – For seating of scientists, research and supporting staffconcerned to sugarcane and Jaggery research.

g) **Irrigation facilities** - Piped irrigation to an area of 8 acres of sugarcane forquality Jaggery preparation.

h) **Mechanization -**Purchase of tractor and tractor drawn implements formechanization of sugarcane cultivation – *Kuboto* mini tractor, Dozer, tractor drawn rotovator, inter cultivation implement and trash shredder.

7. Utilization of the assets of Jaggery Park

a) Jaggery preparation pilot plant

The pilot Jaggery preparation plant has been utilized for commercial production and demonstration of chemical free Jaggery to farmers and farm women, trainee farmers, trainees of water users associations of Bhadra and Cauvery CADA, officials and trainee farmers of the department of agriculture, school children, visitors of *Krishimela* of ZARS, V.C.Farm, Mandya, the delegates from within and outside the country visiting Jaggery park on various occasions, students from different universities and colleges.

In addition, the pilot Jaggery preparation plant has also been utilized for large scale Jaggery preparation. The Jaggery so prepared is sold locally and outside. This is as a result of the awareness created on the chemical free Jaggery in and around the villages of Jaggery Park that most of the Jaggery produced was sold out locally. Further, some Jaggery unit farmers have been influenced by the process of chemical free Jaggery preparation at Jaggery Park to venture into chemical free Jaggery preparation in their own Jaggery units.

b) Utilization of sugarcane juice and Jaggery quality analysis laboratory)

The laboratory equipments have been put to use by the sugarcane and Jaggery scientists working at Jaggery Park for analysis of sugarcane juice, physical, chemical, biological properties and grading of Jaggery. The laboratory is also attracting Jaggery samples for analysis and grading from Jaggery unit farmers. The UG and PG students from the Agriculture College, Mandya have also been utilizing the laboratory facilities at Jaggery Park. The laboratory is also very useful for analysis of soil samples from different experimental blocks of sugarcane and Jaggery.

c) Utilization of Storage structures

The storage structures are used for storage of Jaggery produced from large scale plant and the samples from different sugarcane and Jaggery experiments till their analysis, characterization and grading

d) Utilization of Training hall

A total of 200 Jaggery unit farmers have been trained on production of quality sugarcane for chemical free Jaggery preparation. The training facilities have also been put to use by the development departments, Sir MV Institute of Sugarcane research, Mandya and ZARS, V.C. Farm, Mandya for conducting training programmes, Seminars, conferences, meetings and lectures.

e) Utilization of Bagasse drying yard and bagasse storage shed

Bagasse drying yard and bagasse storage shed are being used for drying and storage of bagasse obtained after crushing sugarcane for better fuel efficiency.

f) Utilization of Piped irrigation and pump house

This is very useful for providing protective irrigation from the open well particularly during summer months when the canal water is off.

g) Utilization of tractor and tractor drawn implements

Availability of labour is a major constraint in sugarcane cultivation. Tractor and tractor drawn implements have been purchased for mechanization of sugarcane cultivation to carry out timely operations.

h) Jaggery production at Jaggery Park

Since inception of Jaggery Park, chemical free Jaggery production has been demonstrated to the Jaggery unit farmers. The Jaggery production details are as under

Year	Cane Crushed (metric tons)	Jaggery production (quintals)
2011-12	72.16	64.57

2012-13	170.89	161.46
2013-14	36.9	32.62
2014-15	85.78	75.33
2015-16 ***** (Till 16Dec 2015)	85.66	80.23

* ***Year in which the facilities of Jaggery preparation were leased out to Mandya Organic Agricultural Co-operative Society, Mandya.***

8. Jaggery Research:

a) Field Research

The following arethe field experiments conducted and results obtained under Jaggery Research:

1. Identification of Sugarcane varieties suitable for Jaggery preparation

The Elite Sugarcane genotypes from the different trials were evaluated for their Jaggery quality and yield. Sugarcane varieties viz.. Co7804, Co86032, Co92005. Co8371, VCF 0517, CoM 0265, CoSNK 07103 & Co9009were found to be suitable for Jaggery preparation.

2. Integrated nutrient Management for quality Jaggery

Integration of organic and inorganic sources of nutrients was ideal for obtaining higher yield and quality of Jaggery. 75 per cent of nutrients through chemical fertilizers and 25 per cent through organic sources was better compared to either organic or inorganic source alone.

3. Nitrogen management for quality Jaggery:

Excessive use of nitrogen and late application of it results in inferior quality Jaggery. Balanced application of NPK was found to improve the quality of Jaggery.

b) Laboratory Research

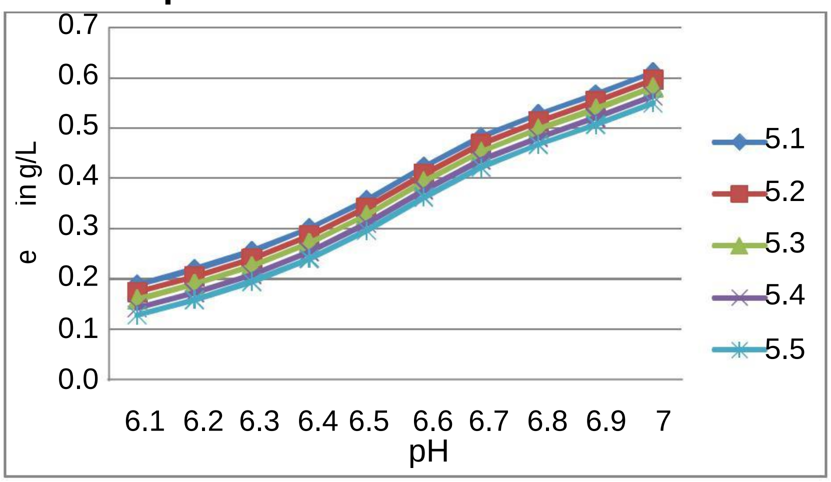
1. Standardization of lime requirement for adjusting of pH in Jaggery preparation

The lime requirement depends on the initial pH of the sugarcane juice which ranges from 5.1 to 5.5 and lime requirement was determined to raise the pH level from 6.1 to 7.0. On an average, to raise the pH from 5.1 to 6.4, 0.301 g of lime was required per liter of juice. Likewise for various pH levels, a ready reckoner was prepared and also a graph was plotted. Calcium hydroxide was the source of liming material used.

Ready reckoner for sugarcane juice pH adjustment (Lime requirement (g/lit juice)

Initial	**Final pH**									
pH	**6.1**	**6.2**	**6.3**	**6.4**	**6.5**	**6.6**	**6.7**	**6.8**	**6.9**	**7**
5.1	0.189	0.219	0.255	0.301	0.357	0.424	0.483	0.528	0.568	0.611
5.2	0.174	0.205	0.240	0.286	0.342	0.409	0.468	0.513	0.553	0.596
5.3	0.159	0.190	0.225	0.271	0.327	0.394	0.453	0.498	0.538	0.581
5.4	0.142	0.172	0.208	0.254	0.310	0.377	0.436	0.481	0.521	0.564
5.5	0.128	0.158	0.194	0.240	0.296	0.363	0.422	0.467	0.507	0.550

Lime Requirement



2. **Standardization of sources of liming material for adjustment of pH in Jaggery preparation(*are in Annexure-1*and pH test using different liming materials for varieties of sugarcane are in *Annexure-2).***

Different sources of liming materials like calcium oxide, calcium hydroxide and calcium carbonate were used to find out the best source of liming material during Jaggery preparation. Different varieties of sugarcane viz., Co 92005, Co 62175, Co 86032 were used in the experiment. The Jaggery so prepared was analyzed for its physical and chemical parameters and grading was done.

With respect of quality of Jaggery from different sources of liming material, A1 and A2 grades were obtained with calcium oxide and calcium hydroxide. Calcium hydroxide is available in powder form and easy to use for neutralizing the pH of juice as its dissolution is faster.

However,, with respect to price of liming material, calcium oxide is cheaper as given below:

Sl. No	Liming material	Cost per Kg (Rs.)
01.	Calcium hydroxide	35.00
02.	Calcium oxide	17.50
03.	Calcium carbonate	25.00

Among the different adjusted pH values of sugarcane juice at which Jaggery was prepared, Jaggery prepared with juice adjusted to 6.4 pH recorded sweet taste but had amorphous texture. At 6.6 and 6.8 pH, Jaggery was crystalline in texture. However, at 6.8 pH, Jaggery was saltish in taste and dark in color.

3. Estimation of quantity of scum in different sugarcane varieties during Jaggery preparation

Seven released varieties were used for estimation of scum in different sugarcane varieties during Jaggery preparation. Jaggery was prepared with and without addition of *bhendi*(Lady Finger or Okra) mucilage to find out the quantity of scum removed in the process.

The scum per centage ranged from 0.694% (Co 86032) to 1.36% (Co 92005) with addition of bhendi and 0.65% (Co VC 99463) to 1.3% (Co 92005) without bhendi. Addition of bhendi was effective in the removal of scum, as the per centage of removal of scum was higher.

Estimation of scum in different varieties of sugarcane

Sl. No.	Variety	Juice weight (kg)	With *bhendi* mucilage		Scum % Fresh weight	Scum % Dry weight	Without *bhendi*mucilage		Scum % Fresh weight	Scum % Dry weight
			Scum fresh weight (g)	Scum dry weight (g)			Scum fresh weight (g)	Scum dry weight (g)		
1	Co 92005	4.5	154.66	61.27	3.43	1.36	151.60	58.23	3.36	1.30
2	Co 62175	4.48	76.32	41.20	1.7	0.92	128.94	24.33	2.82	0.54
3	Co 7804	4.5	99.88	37.71	2.21	0.84	94.64	36.38	2.10	0.81
4	VCF 517	4.49	124.05	43.20	2.76	0.96	120.26	41.90	2.67	0.93
5	Co 99463	4.7	124.12	32.01	2.64	0.68	125.29	30.61	2.66	0.65
6	Co 419	4.38	100.12	44.31	2.28	1.01	115.68	43.46	2.64	0.99
7	Co 86032	4.49	125.27	31.20	2.78	0.69	113.90	32.69	2.53	0.73

4. Studies on use of herbal clarificants for sugarcane juice clarification in Jaggery preparation

Different herbal clarificants were used for their efficacy in clarification of sugarcane juice during Jaggery preparation.

Among the clarificants used, the Jaggery was of A1 grade irrespective of clarificants. However,, color was golden yellow with castor and soybean seed extract.

Jaggery with groundnut and hibiscus as clarificants recorded very sweet taste compared to other clarificants.

Studies on the use of herbal clarificants for sugarcane juice clarification in Jaggery processing.

A. Physical parameters

Treatments	Color	Taste	Hardness(kg/c
Hibiscus leaves	Light brown	Very sweet	2
Hibiscus flower	Light brown	Very sweet	2
Ground nut powder	Light brown	Very sweet	2
Ground nut extract	Light brown	Very sweet	2
Aloe Vera	Light brown	Sour	1.5
Badam powder	Pale yellow	Very sweet	1.5
Castor	Golden yellow	Sweet	2
Soybean extract	Golden yellow	sweet	2

B. Chemical parameters

Treatments	Moisture (%)	Porosity (ml/g)	Ash (%)	RS	Pol reading	Sucrose (%)	NR Value	Grade
Hibiscus leaves	5.61%	0.1	4.15	5.4	41	67.92	77.045	A1
Hibiscus flower	6.37%	0.15	4.28	4.9	41	75.61	85.69	A1
Ground nut powder	6.78%	0.15	3.86	5.8	40	77.46	85.17	A1

Ground nut Extract	4.7%	0.15	3.12	5.2	39	67.23	65.51	A1
Aloe vera	3.99%	0.1	3.46	6.2	35	59.6	72.95	A1
Badam Powder	6.66%	0.1	4.04	4.7	39	74.84	84.28	A1
Castor	6.25%	0.15	4.35	5.2	35	68.15	77.95	A1
Soybean extract	6.95%	0.15	4.31	4.3	40	77.04	87.82	A1

5. **Studies on preheating of sugarcane juice and its effect on clarification**.

Pre heating of sugarcane juice in clarification of juice was studied by heating sugarcane juice upto 60°, 65° and 70°C. One liter of juice was taken for the study and observations were made on floating and settled particles in the juice in preheated as well as cold juice. It is clear that heating of juice up to 70° yields more of scum (5.26 g of fresh weight) with higher floating particle (20ml) and settled particles (10ml) there by extraction of scum is made easier. When cold juice (raw) was observed for its floating and settled particles, only floating particles were observed (5ml) which was the lowest among all.

Sl. No	Juice pH	Temp (°c)	Total volume of juice	Volume of floating particles	Volume of suspended particles	Fresh weight of scum (g)
1	6.4	60	1L	10ml	15ml	2.58
2	6.4	65	1L	20ml	5ml	4.09
3	6.4	70	1L	20ml	10ml	5.26
4	6.4	cold	1L	5ml	-	2.05

c) Survey of farmers' Jaggery units

A Survey was conducted to study the status of Jaggery units run by the farmers in Mandya district. Jaggery units are either functional or non-functionaldepending on the Jaggery price in the market, unhygienic Jaggery production, injudicious use of very high dose of industrial chemicals in Jaggery preparation, inefficient crushers (45-50% juice extraction), inefficient furnaces, labour constraint and poor quality cane used for Jaggery making resulting in poor quality Jaggery were the main technical points that emerged during the survey.

This is evidenced by large scale dwindling of Jaggery units from 5000 in 1990's to less than 1000 at present.

9. Objective wise Achievements:

Sl. No.	Objectives	Achievement
1	Identification of sugarcane genotypes suitable for Jaggery production and to develop viable agro-techniques for improving juice content, quality and Jaggery yield.	Sugarcane varieties suitable for Jaggery making viz., Co 86032, Co 92005, Co 8371, CoVC 99463 and VCF 0517 have been identified. Nutrient management especially nitrogen management for quality Jaggery production, Integrated nutrient management for better quality Jaggery have been evolved. 75 per cent nutrients through fertilizers and 25 per cent through organic manure was ideal for getting higher Sugarcane yield and quality. It is better to nourish the Sugarcane crop in an integrated way than depending on organic sources alone. The same has been imparted to farmers through training programmes.
2	Identification and modification of different types of crushers suitable for efficient juice extraction and safety.	Crusher with three rollers with food grade stainless steel 304 of 15 HP and planetary gear box has been installed. It has the crushing capacity of 1.4-1.6 tons/hour with safe and hygienic extraction of juice
3	Improvement of furnaces for heating the juice and sophisticated equipment for fuel use economy and reduced drudgery.	Furnace has been designed in collaboration with IISc, Bangalore. The furnace is fuel efficient and as a result saving of bagasse is observed.
4	Mechanization in Jaggery processing to reduce	Bagasse conveyor belt has been provided to convey bagasse to the drying yard.

	manpower at different stages of Jaggery production.	Hydraulic system has been provided to lift and tip the Jaggery syrup from the pan on furnace to the cooling pit
5	Identification of different herbal and safe chemical clarificants for obtaining better texture, color, fragrance and quality of Jaggery.	Ladies finger stem mucilage is identified as the herbal clarificant. In addition, seed extracts of castor, groundnut, soya bean were experimented with hibiscus and *aloe vera*as herbal clarificants. Castor and soybean were found to be good clarificants with better color and quality of the Jaggery.
6	To develop value added products of Jaggery suitable for local and export quality.	Experiments were conducted on preparation of liquid and powder Jaggery
7	To develop packing and storage techniques for longer shelf life of Jaggery.	Studies have been conducted on different packing material and duration of storage of Jaggery. Aluminum foil followed by paper box and sugarcane trash was better among the 10 packing materials tried. Jaggery can be stored for four months without spoilage
8	To provide trainings and conduct demonstrations on quality cane and Jaggery production.	Four training and awareness programmes have been conducted involving 300 Jaggeryunit farmers on chemical free Jaggery preparation. Field demonstrations were conducted on farmers' field to give wide publicity for sugarcane varieties (Co92005, VCF0517) suitable for Jaggery preparation and agronomic practices to obtain quality Jaggery. These demonstrations were conducted in Mandya in an area of 80 acres
9	To establish marketing network cell to cater the needs of Jaggery farmers.	A network has been created among the Jaggery unit farmers who are in the field of chemical free Jaggery preparation.

10. Training/awareness Programme to Jaggery and Sugarcane farmers

Sugarcane Farmers and Jaggery unit owners of Mandya district were imparted training on Sugarcane cultivation for quality Jaggery production and chemical free Jaggery preparation by conducting demonstration at Jaggery Park. The details are as under

Sl. No	Date	No of Trainees
1	15.03.2013	40
2	06.12.2013	61
3	11.03.2014	40

Some of the Jaggery unit farmers so trained have started Jaggery units of their own for preparation of chemical free Jaggery.

In addition, the Farmers, Delegates, Students and other visitors who had visited the Jaggery Park on various occasions (which run up to 1000 numbers) were provided information on chemical free Jaggery preparation.

Extension folders on Improved Sugarcane varieties, Improved Sugarcane cultivation practices and chemical free Jaggery preparation have been prepared and distributed to farmers, department officers, students and other visitors.

11. Field Demonstrations in Farmers fields to popularize Sugarcane Production technologiesand varieties suitable for Jaggery preparation:

A total of 54 farmers in area of 53 acres were selected for demonstration of Sugarcane production technologies and varieties in different villages of Mandya District. Improved Sugarcane varieties suitable for Jaggery preparation, Nutrient management particularly nitrogen management, Harvest management for quality Jaggery preparation were demonstrated in the farmers' fields. Sugarcane yields recorded were 20-25 per cent higher compared to farmers practice in addition to 15-20 per cent increased Jaggery yield and better quality as a result of these demonstrations.

12. Establishment of Steam Based Jaggery boiling unit

The conventional system of Jaggery preparation is open boiling. Jaggery park has ventured into an innovative novel system of Jaggery preparation using steam boilers and evaporators.

The principle involved is that steam is generated with the help of a suitable boiler. The juice extracted is heated at 2-3 stages in the pans facilitated with steam jacket. In this system, the heat is totally under control which facilitates easy and efficient removal of scum. Caramelization and discoloration of juice and Jaggeryare totally avoided andheat, fuel and labour efficiency are enhanced. Overall, there is an improvement in the quality of Jaggery.

Following are some of the advantages that could be achieved in steam boiling.

1. Effective Scum removal: In the production of organically processed Jaggery removal of scum is important and for clarification only organic clarificants and flocculants are used. Gradual heating of juice will allow ample time to remove the scum and other suspended materials in the juice.
2. Evaporator in the system under closed boiling enhances fuel efficiency and steam from evaporators is recycled for preheating and heating of juice. This also improves the fuel efficiency.
3. The down time of the plant, auxiliary power consumption of the equipment etc., are greatly reduced.
4. The hygiene and safety of the workmen are ensured.

Evaporators:

Sugarcane juice after initial clarification is let in to the evaporators for further evaporation of moisture in the juice till it is taken to the final pan before moulding.

Time span: Rate of evaporation of water is more in evaporators with steamcompared to open pan boiling. This is because of the fact that the surface area exposed is more when juice is passed through the tubes containing steam. This results in faster evaporation of water from the juice. The surface area exposed in open pans is lesser which results in more time for evaporation of same quantity of water. In the evaporators the vapour can be collected and recycled where as in open pan it is not possible.

Fuel efficiency: The package boilers have the fuel efficiency up to 72 percent whereas in the open pan boiling it is merely 35 per cent. In addition, the steam boiling has got other advantages like hygienic conditions, good working environment, thermal efficiency and recovery of vapour which can be condensed for refeeding into the boiler. The comparison and contrast of important parameters of steam boiling and open pan boiling are as follows-

Advantages of Evaporator:

1. Heat transfer isquick because of condensation of steam
2. Since surface area provided is more, rate of heat transfer is higher, as a consequence the efficiency is also high
3. Since the juice is divided into thin vertical columns, the surface contact for heat transfer naturally increases
4. Heat transfer by convection is very fast
5. Time required in evaporator to attain required temperature, brix, viscosity etc., is very less

The Jaggery prepared from the steam boiling would result in higher quality Jaggery under most hygienic conditions. The plant set up at Jaggery park has installed capacity of producing one quintal of Jaggery per boiling.

13. Collaboration with other Institutes:

The Jaggery park has close association with Indian institute of Sugarcane research, Lucknow, Sugarcane Breeding Institute, Coimbatore, Regional Sugarcane and Jaggery research Institute, Kolhapur and Anakapalli and CFTRI, Mysuru for Jaggery related research and extension activities.

14. Deployment of staff at Jaggery park:

Jaggery Parkdoes not have staff of its own. The university has given the additional responsibilities of JaggeryPark to existing Scientists working in Sugarcane crop. They have engaged the personnel on contractual basis for conducting research in Jaggery.

15. Commercial Jaggery production:

The Jaggery Park is engaged in preparation of Jaggery on commercial scale. In the initial years, Jaggery preparation was on a pilot basis and now it has reached commercial scale. Mandya organic Agricultural co-operative Society, a farmers group, has been entrusted with the responsibility of preparation and marketing of chemical free/Organic Jaggery by utilizing the facilities for Jaggery preparation at Jaggery Park on lease basis with the monitoring by the University Scientists.

16. Value addition :

Jaggery Parkis also engaged in production of value added Jaggery products like powder Jaggery, liquid Jaggery and Jaggery in different size and shape though in a small scale in addition to regular production of lump Jaggery. The shelf life of powder Jaggery is substantially higher than other forms of Jaggery.

17. Utilization of the facilities by the farming community

- Sugarcane varieties (Co 86032, Co92005 and VCF0517) suitable for Jaggery preparation have been identified and these varieties were demonstrated in the farmers' field to convince the farmers that Sugarcane varieties are exclusively for Jaggery preparation and not all varieties are suitable for Jaggery making.
- The demonstrations were also utilized for demonstrating agronomic practices for quality Jaggery production by emphasizing the nutrient management particularly nitrogen.
- The chemical free Jaggery produced at Jaggery Park has attracted quite a good number of villagers in around V.C.Farm. They have given a very good feedback as far as the quality of Jaggery produced at V.C.Farm is concerned.
- Training programmes and demonstrations were conducted to Jaggery unit farmers on chemical free Jaggery preparation. This has convinced the farmers on the ill effects of chemicals used in Jaggery preparation by farmers. Some Jaggery unit farmers who were imparted training have started Jaggery units for chemical free/Organic Jaggery on their own.

- Many dignitaries, farmers of Cauvery and Bhadra command area and students have been benefited by visiting Jaggery Park and witnessing chemical free Jaggery preparation.
- Handouts on chemical free Jaggery preparation and sugarcane cultivation have been prepared for wide circulation among the farmers and Jaggery unit owners to propagate sugarcane production and Jaggery preparation on scientific lines.
- Sugarcane from the farmers’ field is being drawn for preparation of chemical free/Organic Jaggery. This has helped the Sugarcane farmers of the district particularly when the Sugar mills were off during the Sugarcane crisis period.

18. Evaluation Questions and minimum expectations (Inclusive notexhaustive):

1. Has the chemical free Jaggery preparation unit, the Jaggery Park V.C. Farm, Mandya, and the trainings provided by it in making chemical free Jaggery made any impact on Jaggery unit owners, APMC Merchants and consumers with regards to going in for only chemical free Jaggery production, marketing and consumption?
2. Are the Jaggery sellers and its consumers aware about the fact that chemicals are used in making Jaggery? Are they aware of the chemicals used and/or its ill effects on human health?
3. Does chemical free Jaggery have a different taste or appearance than usual Jaggery prepared with the usage of chemicals? (perception of Jaggery users may be used to answer this)
4. Are the Jaggery sellers and its consumers paying or willing to pay a higher price for chemical free Jaggery? If no, why not? If yes, what per centage more than the price of usual Jaggery are they paying, and what is the scope further in willingness to pay, for chemical free Jaggery?
5. What are the issues in hygiene in the Jaggery making units existing in the surroundings?

6. Is hygiene in the Jaggery Park certainly and surely better than the Jaggery making units existing in the surroundings?
7. What are the views of Jaggery making unit owners on usingchemical clarificants viz a viz herbal clarificants in Jaggery processing?
8. What are the opinion of Jaggery sellers and consumers of Jaggery about using herbal clarificants in Jaggery processing?
9. Does chemical free Jaggery have a longer shelf life than usual Jaggery prepared with the usage of chemicals? If yes, how much longer or shorter and why?(perception of Jaggery users may be used to answer this)
10. What has been the production, sale and utilization pattern of powdered Jaggery, Liquid Jaggery and Jaggery made into unique shapes and sizes?
11. Which States and districts (outside Karnataka and in Karnataka) are the main purchasers of chemical free Jaggery produced in the Jaggery Park?
12. Which Sugarcane varieties are better for Jaggery making from the point of view of Jaggery yield and quality as per Jaggery making unit owners of Mandya?
13. Is there a control mechanism (legal and procedural) for checking the usage of harmful chemicals in the making of Jaggery and the hygiene aspect in the process of making Jaggery? If not, what mechanism can be suggested? Please elaborate.
14. Please detail a few tests that can be done at home to check whether the Jaggery one is using is chemical free or not.
15. Has the present Jaggery farm fulfilled its objectives? Is a good case made out for having a few more Jaggery Parks in Karnataka? If no, why not? If yes, what further inputs need to be provided?

19. Time Schedule for the Study:

On the basis of the proposed time schedule outline in these Terms of Reference, the consultant organization shall prepare a brief work plan. The work plan should set out the Consultant Organization's approach for conducting research activities. The period for the consultancy should not exceed 3months starting with day of signing theagreement.They are expected to adhere to the following timelines and deliverables or be quicker than the follows-

a. Work plan submission : 15 days after signing the agreement.
b. Field info Collection : Onemonths from date of Work Plan Approval.
c. Draft report Submission : One month after field data collection.
d. Final Report Submission : 15 days from draft report approval.
e. Total duration : 3months.

20 .Qualification of Consultant Evaluation Organization

Consultant Evaluation Organizations should have evaluation team members having minimum technical qualifications/capabilities as below-

i. One Post Graduate in Agriculture/Sugar Technology having at least 10 years' experience in the academic field. (Principal Investigator)

ii. One with masters in Health and Nutrition, Public health, Chemistry, Zoology, Medicine (only MBBS is enough, masters not needed), Bio-Chemistry, or Pathology (plant pathology excluded)only who will be a team member.

iii. One Social Scientist with masters in Sociology, Social Work, Psychology or Environmental Science only who will be a team member.

Consultant Evaluation Organizations without teams of these minimum qualifications will not be considered.

20. <u>Research Methodology:</u>

The following methodology and research tools will be employed (but not limited to) during the assessment.

- *Literature Review*

The Consultant Evaluation Organization will have to review the existing literature that deals with the history and production of Jaggery in Mysore/Karnataka. Further literature review should be done on the process followed in making Jaggery and how the constituents have changed over time. The chemicals used and its possible ill effects on human health too must be documented.

Interviews with key persons

The Consultant Evaluation Organization will have to interview the following types of persons-

- At least 50those who own or run Jaggery making units in and around the Jaggery Park (25 who are continuously manufacturing and 25 who manufacture seasonally). These should include at least 5 who have been trained in the field of chemical free Jaggery making.
- The Jaggery manufactured in at least 15 units who are continuously manufacturing and at least 15 units who are manufacturing seasonally should be sample tested for the presence of chemicals and other impurities.

  For this they have to declare as to in which laboratory and/or how the samples will be tested in the proposal to take up studies. A proposal lacking these or insufficiently or wrongly covering this will be rejected as for want of minimum capabilities/knowledge.
- At least 50 consumers of Jaggery, including at least 20 who have used or are using Jaggery prepared in the Jaggery Park.
- At least 10 sellers of Jaggery, including at least 5 who have sold or are selling Jaggery prepared in the Jaggery Park.
- At least 5 persons working in the Jaggery Park.

Focus Group Discussions(FGD)

The Consultant Evaluation Organization should conduct FGD of groups each consisting of 10 to 15 persons comprising of Jaggery Park Jaggery sellers and consumers.

Besides, at least 15 Jaggery making units in the vicinity of the Jaggery Park needs to be inspected.

21. The Final Report

The Consultant Evaluation Organization shall document the assignment in a final report; which should be in English and Kannada. The report shall include:

- Executive Summary (say about 1500 words).
- Details of the Assignment methodology and analysis.
- Findings and Recommendations.
- Lessons learned from the study.
- Annexure including questionnaire.

22. Contact persons for further details:

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2. Dr. Chandrasekhar Vaster, Professor, DR's Office and I/c, RKVY projects under UAS, Bengaluru, UAS, GKVK, Bengaluru 560065.

   Phone No. 9945201306.
3. S.N. Swamygowda, Project Leader, Jaggery Park, ZARS, V.C. Farm, Mandya, Phone No. 9341156455.
4. Dr. K.V. Keshavaiah, Associate Professor (Agronomy-Jaggery) ZARS, V.C. Farm, Mandya, Phone No: 9900192322.

Annexure – 7

Primary Inception Report

EVALUATION OF RKVY PROJECT ON ESTABLISHMENT OF JAGGERY PARK IN SOUTHERN KARNATAKA

(by the Department of Agriculture 2008-09 to 2012-13)

Hyderabad Karnataka Centre for Advanced Learning.

November 2016

I. EVALUATION TITLE AND BACKGROUND INFORMATION

a) Title of the evaluation study:

Establishment of Jaggery Park in southern Karnataka

(RKVY of Ministry of agriculture government of India, funding through department of Agriculture GOK from 2008-09 to 2012-13)

b) **Implementing Agency :** University of Agricultural Sciences, Bangalore
Location: Zonal Agricultural Research station, VC Farm, Mandya.

c) Background Information;

Sugarcane is one of the important commercial crops cultivated in the command areas of Karnataka state. It is cultivated in an area of 4.25 lakh hectares annually with a production of 357.3 lakh tons of sugarcane with a productivity of 84 tons/hectare (Ministry of Agriculture, 2014-15). Karnataka ranks 3rd amongst all the State in the country with respect to area of Sugarcane cultivation. Indeed, sugarcane is a predominant crop in the southern districts of the state with an area of 1.3 lakh hectares and an average productivity of 100 tones/ha across Mandya, Mysore, Chamarajanagara, Hassan, Shimoga and Davanagere districts which happens to be the domain of Jaggery Park. In Southern Karnataka, out of the total sugarcane produced, around 60 per cent is being utilized for sugar extraction in the sugar mills while 30-35 percent goes for Jaggery Making. At national level, 25 per cent of the total sugarcane produced is utilized for Jaggery Preparation indicating the importance of Jaggery industry in the region. As such, Jaggery preparation is an important cottage based industry of Karnataka.

In simple terms, Jaggery is the solidified mass after boiling and condensing sugarcane Juice in an open pan by removing water and impurities. Jaggery is an important natural sweetener widely used in confectionaries, culinary preparations and Ayurvedic medicines. Jaggery has got nutritive as well as medicinal values unlike white sugar and is much sweeter than white sugar, by virtue of its higher reducing sugars. Cauvery command areas in southern Karnataka are important sugarcane growing areas, with over 5000 Jaggery boiling units under operation during 1999-2000.

2 *Log Frame/Theory of Change / Program Theory:*

The research and developmental program undertaken by UAS Bangalore has adopted the path line mentioned below:

I. Crop Production

a) Initiation of sugarcane varietal screening for suitability for Jaggery Preparation
b) Standardization of Agronomic package of practices for maximizing productivity of sugarcane.
c) Capacity building of farmers.

II. Processing Unit

a. Establishment of sugarcane crushing mills, boiling unit, modified furnace and Jaggery Storage Structures.
b. Establishment of Jaggery production pilot plant in addition to office infra structure.
c. Procurement of different Jaggery moulds.
d. Establishment of sugarcane and Jaggery testing laboratory.
e. Establishment of steam based jaggery preparation Unit including steam boiler double effect evaporator and open jacketed pans.
f. Construction of bagasse drying unit.
g. Capacity building of the Jaggery Processors.

III. Values addition and Marketing :

a) Initiation of work on different types of Jaggery.
b) Initiation of research work on storability, packaging and quality parameters.
c) Branding and Marketing of Jaggery.
d) Implementation of PPP Model.

2 A. Expected Outputs/Outcomes:

The outcome of the project can be grouped into 3 headings namely

a. Crop Production:

i) Development of Agro technologies for enhancement of yield and quality of sugarcane.
ii) Capacity building of the farmers for quality sugarcane production and tonnage.

b. Processing (Chemical free Jaggery making) :

i) Technological intervention for enhancing sugarcane juice recovery and quality.
ii) Development of pre heating treatment of sugarcane juice.
iii) Development and Standardization of sugarcane juice clarification technique using plant products.
iv) Standardization of furnace heat for getting the quality jaggery.
v) Finding out constraints in Jaggery processing.
vi) Capacity building of the jaggery processors.

c. Value Addition and Marketing:

i) Development of different forms of Jaggery (solid, liquid, Powder)
ii) Enhancement of jaggery shelf life.
iii) Market potential- Local, National and International.
iv) Economic viability of the Project.

(The sustainability of the above project can be assessed only after detailed study and the same will be submitted along with the final report)

3. Evaluation Frame work:

b. What is the purpose of the evaluation? Why it is done now?

iv) To know the relevance and the potentiality of established jaggery park in meeting the objectives of the project proposal funded through RKVY.
v) The evaluation process of the project has been envisaged in order to assess the strength and weaknesses of the ongoing Jaggery Park and to up scaling and replicating in other parts of the state.

c. What is the scope of Evaluation? What reference time period it covers?

vii) To study the impact of Jaggery Park and training provided in making chemical free Jaggery on Jaggery units, AMPC's merchants and consumers.
viii) To assess the consumer perception on use of chemical free Jaggery.
ix) To study the impact of partial mechanization of Jaggery units including Juice extraction, processing, moulding, Storing and packaging in relation to chemical free jaggery
x) To examine the potential of up scaling chemical free jaggery.
xi) To study the awareness level among the farmers, consumers, traders on use of chemical free jaggery.
xii) To assess the potentiality of chemical free solid and liquid jaggery for its export potential. The Evaluation Period covers from inception time that is 2008-09 to 2012-13.

d. Who are the stakeholders? Who are the key audience for the study?

ii) The stakeholders are:

6. The scientists of university of agricultural sciences
7. Officials of the state Agricultural University, Agriculture and Allied Department.
8. Farmers in and around command area growing sugarcane.
9. Jaggery Manufacturers.
10. Jaggery traders.

Key Audience:

5. Farmers and Farming Family
6. Research Scholars.
7. Traders.
8. Consumers.

e. What will the study evaluate basically? Program effectiveness, efficiency, economy? Administrative Processes? Program / scheme out puts? Outcomes and from whose prospective?

ii) The study envisages the relevance of implementation of the jaggery Park for its technical services rendered in processing chemical free jaggery in terms of its efficiency, economical feasibility, sustainability and health prospective of Consumers, Farmers and traders.

In addition, the study also encompasses administrative hurdles/bottle necks for corrective measures needed in achieving the scheme output/outcomes in relation to Jaggery Park rendering the services to the farming community, scientist and consumers.

f. What are the specific objectives for this evaluation study? Are any refinements to the objectives listed in the ToR necessary?

Objectives of the Evaluation Study:

viii) To assess the relevance of crop production, processing and value addition technologies in attaining the objectives of the jaggery project for getting chemical free jaggery.

ix) To know the impact of knowledge of chemical free jaggery technology dissemination to the farmers, consumers and traders.

x) To assess the potentiality of chemical free jaggery solid and liquid form for its export potentials.

xi) To assess the strength and weakness of technologies involved in chemical free jaggery production and its refinements.

xii) To document the overall progress of the objectives of the jaggery park envisaged in the final report.

xiii) To study feasibility of e-market initiatives and PPP models under taken by the implementation agencies.

xiv) To assess the economic viability of the project.

The refinements to the objectives listed in ToR will be looked into after making a detailed analysis of the study

g. **What is the baseline or benchmark against which evaluation will be done? Does it involves control group or a counterfactual? How will the attribution issue be addressed?**

The newly established Jaggery Park at VC farm, Mandya will be compared with other existing similar Jaggery units located in northern parts of Karnataka and Maharashtra in order to assess the feasibility and efficacy.

Detailed comparative information on crop production, processing, value addition technologies will be collected and compared for to know the strength and weaknesses.

h. **What is the precision required in the study? What is the confidence limit and statistical power?**

The chemical free Jaggery prepared by the Jaggery park as well as its ancillary units of Jaggery Manufacturers will be assessed for its quality in tune with the food grades and hygiene as suggested by FASSI / CFTRI for consumer. (Tested in accredited laboratory of Government of India/State)

The data generated based on the evaluation questions will be statistically analyzed and interpreted accordingly

i. **What are the risks and limitations that may undermine the reliability and validity evaluation results?**

Nil. However efforts will be made to document the strength and weaknesses of the existing project for its feasibility and up scaling.

4 *Evaluation questions and sub questions:*

SI	***Evaluation questions (Inclusive and not exhaustive):***	*Approach*	*Indicators*
1.	Has the chemical free Jaggery preparation unit, the Jaggery Park V.C. Farm, Mandya and the trainings provided by it in making chemical free Jaggery made any impact on Jaggery unit owners, APMC Merchants and consumers with regards to going in for only chemical free Jaggery production, Marketing and consumption?	Through primary data collection from farmers, Traders and consumers.	Growth of chemical Free jaggery Processing units, chemical free jaggery production, marketing and consumption Farmer (Q, V), processor VI & and consume r(QII)
2	Are the Jaggery sellers and its consumers aware about the fact that chemicals are used in making Jaggery? Are they aware of the chemicals used and/or its ill effects on human health?	By primary data collection from jaggery traders and consumers	Awareness on use of chemical free jaggery Farmer (Q, V), processor VI & and consume r(QII)
3	Does chemical free Jaggery have a different taste or appearance than usual Jaggery prepared with the usage of chemicals? (perception of Jaggery users may be used to answer this)	Through quality Analysis, Testing by consumer taste personal.	Sensory evaluation Data Processor Q. V, consumer Q II,
4	Are the Jaggery sellers and its consumers paying or willing to pay a higher price for chemical free Jaggery? If no, why not? If yes, what percentage more than the price of usual Jaggery are they paying, and what is the scope further in willingness to pay, for chemical free Jaggery?	Survey	Awareness and Willingness Consumer QIV & V processor Q III,
5	What are the hygiene issues in the Jaggery making units existing in the surroundings?	Discussion with consumer / Scientist /Processors, Dealers (survey) and personal visit by Team	Sanitation / cleanliness Farmer XII. Traders VII, consumer vii
6	Is hygiene in the Jaggery Park certainly and surely better than the Jaggery making units existing in the surroundings?	Survey & personal visit by Team	Sanitation / cleanliness Do
7	What are the views of Jaggery making unit owners on using chemical	Discussion with Scientist as well as	Knowledge dissemination / technical knowhow

	clarificants vis a vis herbal clarificants in Jaggery processing?	Processors	Farmer QVI and Scientist Q VIII
8	What are the opinion of Jaggery sellers and consumers of Jaggery about using herbal clarificants in Jaggery processing?	Survey & collection of data, Discussion with Scientist Ayurvedha Doctors.	Awareness on quality Scientist VIII. And consult local herbal expert
9	Does chemical free Jaggery have a longer shelf life than usual Jaggery prepared with the usage of chemicals? If yes, how much longer or shorter and why?(perception of Jaggery users may be used to answer this)	Survey & Discussion with Scientist on the shelf life	Enhancement of shelf life / keeping quality Scientist QIII, Trader VII, Processor VIII
10	What has been the production, sale and utilization pattern of powdered Jaggery, Liquid Jaggery and Jaggery made into unique shapes and sizes?	A market survey	Consumer preference Marketer discussion QIX
11	Which States and districts (outside Karnataka and in Karnataka) are the main purchasers of chemical free Jaggery produced in the Jaggery Park?	Secondary Data Through APMC, etc	Marketing preference and issues Processor IX Marketer II
12	Which Sugarcane varieties are better for Jaggery making from the point of view of Jaggery yield and quality as per Jaggery making unit owners ofMandya?	Discussion with Scientists, farmers, Processors.	Scientific innovations Trained farmer Q IV & scientist Q
13	Is there a control mechanism (legal and procedural) for checking the usage of harmful chemicals in the making of Jaggery and the hygiene aspect in the process of making Jaggery? If not, what mechanism can be suggested? Please elaborate.	Discussion with Scientist & Food civil supply dept.	Quality standards enforcement by food and civil supply department Processor discussion
14	Please detail a few tests that can be done at home to check whether the Jaggery one is using is chemical free or not.	Discussion with scientists, consumers and Food civil supply dept.	Scientific methodology and indigenous knowledge Processor QIX, trader and scientist

15	Has the present Jaggery Park fulfilled its objectives? Is a good case made out for having a few more Jaggery Parks in Karnataka? If no, Why not? If yes, what further inputs need to be provided?	Thoroughly discussion With farmers, Scientist & Distributors and comparison with other similar parks	Impact assessments Summary of questions administered from farmer, processor, trader and scientist will provide information

9. Indicators:

The Indicators to measure the expected results of the project will be indicated in the sub question asked for the scientist/ trader/ consumer independently.

10. Evaluation methods and techniques:

The following methods are going to adopted in evaluating the existing Jaggery Park work. They are:

i) Through inspection of Jaggery Park for collection of primary, secondary and tertiary data.
ii) Through inspection of Jaggery manufacturers.
iii) The primary data collected through visit to farmers sugarcane field.
iv) Discussions with jaggery consumers.
v) The Focus Group Discussion of progressive farmers in the field of jaggery manufacturers, consumers and traders.

Based on the primary data collected appropriate statistical tools will be used to analyze the data and to draw conclusion, however the techniques like randomization designs, and minimum sample size will be addressed suitable in tune with the statistical method.

11. Data and Information source:

For authentic data the evaluators have designed systematic questionnaire to elucidate the real time data for the benefit of systematic evaluation of project. The different instruments have been developed. Such as the material for focus Group Discussion and Questionnaire for scientist, farmers, Jaggery producers, traders and consumer.

The information obtained from the instruments will be co related across different variables collected information from the stakeholders. Further the inference will be drawn based on relevant indicators chosen from each questionnaire.

12. *Evaluation Matrix:*

I. A. **Crop Production**

Main Evaluation issue	Sugarcane variety for Jaggery.	
Key evaluation question	Spread of the variety	
Sub-question	Sugar content	
Indicator(s)	Tonnage / yield	
Normative/baseline value	N.A.(Not Applicable)	
Success threshold	N.A.	
Data sources	Scientist/ farmers	
Data collection method	Question one to one	
Data collection instrument	Questionnaire	
Method of data analysis	Two way table	
Expected results	Suitability and adoptability	

I **B.Crop production**

Main Evaluation issue	Agro techniques developed	
Key evaluation question	Use of Nitrogen & irrigation	
Sub-question	Excess use of Nitrogen, irrigation water, saline alkaline soil cane, lodged cane, over mature & immature cane.	
Indicator(s)	Yield and quality of Jaggery	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Farmers/Scientists.	
Data collection method	Survey	
Data collection instrument	Questionnaire	
Method of data analysis	Opinion and data interpretation	
Expected results	Correlation of yield and quality of jaggery with the above parameters and feasibility of technologies and there extent of adoption.	

C. **Crop Production**

Main Evaluation issue	Capacity building of the farmers on quality cane cultivation.	
Key evaluation question	Farmers knowledge on quality cane production and chemical free jaggery production	
Sub-question	Agro-techniques awareness and implementation	
Indicator(s)	Level of knowledge and their interest in adoption	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Farmers	
Data collection method	Survey	
Data collection instrument	Questionnaire	
Method of data analysis	Averages & Two way analysis	
Expected results	Awareness of farmers on agro-techniques for quality cane production	

II. A. Processing

Main Evaluation issue	Extraction of juice	
Key evaluation question	Extraction percentage, crusher used and quality of juice	
Sub-question	Juice extraction efficiency	
Indicator(s)	Crushing and extraction efficiency, quality of juice	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Processors, jaggery producers	
Data collection method	Survey and observation in jaggery units	
Data collection instrument	Team of experts and Questionnaire	
Method of data analysis	Averages and Two way Analysis	
Expected results	Awareness and adoption of quality juice extraction and its efficiency	

II B. Processing

Main Evaluation issue	Boiling of juice	
Key evaluation question	Chemicals used, herbal clarificants used,	
Sub-question	Dose of chemicals, type of herbal clarificants	
Indicator(s)	List of chemicals, food grade / industrial best herbal clarificant	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Processors and labours/ employees of jaggery unit, CFTRI/Govt. agencies of quality testing	
Data collection method	Physical inspection and Questionnaire, jaggery quality testing	
Data collection instrument	Team of experts and Questionnaires	
Method of data analysis	Two way analysis	
Expected results	Quality of jaggery	

II C. Processing

Main Evaluation issue	Moulding jaggery	
Key evaluation question	Type and shape of moulds	
Sub-question	Wooden/aluminum moulds	
Indicator(s)	Which wood for moulds	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Opinion, observation	
Data collection method	Survey, observation	
Data collection instrument	Questionnaire	
Method of data analysis	Measures of central tendency	
Expected results	Wooden moulds yield better quality jaggery	

II D. Processing

Main Evaluation issue	Furnace	
Key evaluation question	Source of fuel, furnace type, loss of energy in chimney	
Sub-question	Cleanliness -ash (Fuel whether sufficient, do you purchase additional fuel)	
Indicator(s)	List of fuels used, cost of additional fuel (fuel use efficiency and cleanliness)	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Processing units, owners / labourers	
Data collection method	Physical inspection and interviews	
Data collection instrument	Experts and Questionnaire	
Method of data analysis	Measures of central tendency (Two way Analysis)	
Expected results	Hygiene and fuel use efficiency	

II E. Processing

Main Evaluation issue	Steam jaggery	
Key evaluation question	Processing time, hygiene Labour requirement, and time for jaggery preparation	
Sub-question	Quality of jaggery compared with open boiling system	
Indicator(s)	Hygiene, cost effectiveness and shorter processing time	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Processing unit	
Data collection method	Personal visit and interview	
Data collection instrument	empirical	
Method of data analysis	Observations	
Expected results	Efficiency in time and fuel, economic viability, Better quality jaggery at reduced cost	

II F Processing

Main Evaluation issue	Capacity building of the farmers and jaggery manufacturers on chemical free jaggery	
Key evaluation question	Health hazards of chemicals	
Sub-question	Impact of training – effect on the above (knowledge level)	
Indicator(s)	Awareness and usage	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Jaggery producers and consumers	
Data collection method	Survey	
Data collection instrument	Interviewer.	
Method of data analysis	Two way analysis	
Expected results	Health and hygiene	

III A Value Addition and Marketing

Main Evaluation issue	Value Addition	
Key evaluation question	Marketability of chemical free jaggery, shelf life and type of value addition	
Sub-question	Powder, liquid, moulds	
Indicator(s)	Quality of jaggery, consumer preference	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Producers, consumers, food testing laboratory	
Data collection method	Personnel interview and quality analysis	
Data collection instrument	Expert team, food laboratories	
Method of data analysis	Two way analysis	
Expected results	importance of value addition in marketing chemical free jaggery	

III B. Value Addition and Marketing

Main Evaluation issue	Marketing	
Key evaluation question	Price of chemical free jaggery and chemical jaggery (Market)	
Sub-question	Price, preference taste, quality and shelf life	
Indicator(s)	Price per kg comparison / cost of acceptance	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Consumers and traders	
Data collection method	Survey (personnel Interview)	
Data collection instrument	Questionnaire	
Method of data analysis	Comparative / Two way analysis	
Expected results	Marketability for chemical free jaggery (niche) market for chemical free jaggery	

III C. Value Addition and Marketing

Main Evaluation issue	Capacity building of the traders	
Key evaluation question	Knowledge of traders, Differentiate two jaggery types	
Sub-question	Create market for each of the type, traders preference to buy chemical free jaggery	
Indicator(s)	Procurement of chemical free jaggery and Profit from different jaggery types	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Traders and Statistics	
Data collection method	Interview, data set	
Data collection instrument	Interviewer , data analyst and Questionnaire	
Method of data analysis	Two way analysis, Measures of central tendency	
Expected results	Awareness among traders and Create niche market for chemical free jaggery	

III D Value Addition and Marketing

Main Evaluation issue	Quality analysis of jaggery	
Key evaluation question	Quality parameters / standards	
Sub-question	Physical, chemical and biological parameters (health benefits)	
Indicator(s)	Test, moisture, sucrose, reducing sugars, inert matter, ash content	
Normative/baseline value	N.A.	
Success threshold	N.A.	
Data sources	Actual jaggery sample analysis	
Data collection method	Sampling of jaggery	
Data collection instrument	Sampling and survey	
Method of data analysis	Observations/comparisons	
Expected results	Standards for Chemical free jaggery (Better quality and shelf life with chemical free jaggery)	

III E Value Addition and Marketing

Main Evaluation issue	Feasibility and economic viability of jaggery park	
Key evaluation question	Economic analysis of production unit	
Sub-question	Long term technological benefits	
Indicator(s)	Economical viability	
Normative/baseline value	N.A.	
Success threshold	N. A.	
Data sources	Jaggery park Scientist, traders, PPP Partners	
Data collection method	Interview and waited analysis	
Data collection instrument	Technicians	
Method of data analysis	Two way analysis / observation	
Expected results	Feasibility for up scaling	

09. Sample and Sampling Design:

i) Two types of Jaggery units 1. Regular production units followed by seasonal production units

ii) Inspection of 10-15. Jaggery production units in and around the Jaggery park (10-15 who are continuously producing and 10-15 who produce seasonally).

iii) Of these at least 5 who have been trained in the field of chemical free jaggery production.

vi) Sample testing of chemicals and other impurities in 10 units who are continuously producing and at least 10 units who produce seasonally.

Simple random method will be adopted for sample collection

10. Data Collection Tools:

Questionnaires will be administered to each stakeholder in different formats. FGD will be conducted assembling the farmers and traders at a different locations. All the relevant data available in the form of publication at jaggery park and department of Agriculture information bureau, South Indian Sugar Technologies Association (SISTA) and Government of India Statistic.

11 method of data Analysis :

Based on the primary data collected and sample size appropriate analytical tool will be applied to draw valuable scientific conclusion

12. Lay out of the Final Report:

After a detailed study of the ongoing project the final layout of the final report will consist of following information listed below

i) Title and opening page

ii) Index.

iii) Review of literature and post evaluation reports.

iv) Project implementation / execution history.

v) The objectives and performance of the programs being evaluated.

vi) Evaluation methodology.

vii) Findings of the evaluation study.

viii) Limitations / constraints in evaluation study

ix) Recommendation from the study

x) Annexure

1. Sanction terms and reference of the study.
2. Survey tools and questionnaires.
3. Primary and secondary data sets on quality standards of jaggery area, production, demand and supply etc.
4. List of Acronyms and
5. Abbreviations and references.

1. Working Schedule :

a.	work plan submission	:	15days after signing the agreement.
b.	field data collection	:	one month from date of work plan approval
c.	Draft report submission	:	two month after field data collection.
d.	final report submission	:	30 days from draft report approval.

Total duration : 5 months.

Questionnaire I. Questionnaire for the Processor at Jaggery Park

Name of the head of centre		**Since functioning …..**
Qualification		**Specialization……..**
No of years experience		**Years of exp. at Mandya ……**
Total staff strength: ……	**Professionals:**	**Field staff…….**

Establishment of following items					
Items		**Date of installation**	**function**	**utilization**	**remarks**
Crushing mills (Steel/Iron)					
Filtering Units					
Boiling units	Pre – Boiling				
	Boiling				
Methods jaggery preparatio	Conventional Type				
	Steam Boiling				
Modified furnace	Traditional				
	Modified				
Source of Energy	Bagasse only				
	Any other				
Clarificants quantify Gram/kg per ton used	Chemicals used				
	Organics used				
	Organics +Chemicals				
Jaggery End Point	striking Point				
Moulds	Steel				
	wooden				
	Any other				
Packing	Plastic				
	Any other				
Testing laboratory unit for cane & jaggery					
1. Cost of testing.					
Construction bagasse drying unit					
Facilities for storage of jaggery					
Automation					

Relavance of Jaggery Park in Mandya **Demand for processing technology in the district,** **If yes,** **What is the process for allocating time for incubates/farmer** **1. Farmers do they contact in advance?** **2. Do you find rush of the farmer at a time.** 3. **Do you provide training to farmer to upgrade in use of unit** 4. **any other form.**	**Yes/No** **Yes/No**
II. Extraction Processes **1.Does you weigh the cane before crushing** **2. will you able to identify quality of cane]** **3.extraction how long it will continue** **(in a year, how many months)** **4.How much time will take extraction of juice for one ton of sugar cane.** **5. Have you trained up in this activity** **If yes, how many days training is provided** **Is this training enhances the processing activity** **If so, list it out**	
III. Quality of Jaggery (bet. Chemical and without chemical processed jaggery) which is better in sugar content.	
IV. Packing – Research if any it's transfer **1.Have introduced any new package system**	
V. Is there any Value addition due to new package system **If yes. Please explain in details**	**Yes/No**

Any other Information on Sugarcane and Jaggery -

Questionnaire II: Questionnaire for the Processor at Farmers jaggery units

Name of the head of centre		**Since functioning…..**
Qualification		
No of years experience		
Total staff strength…..		

Establishment of following items					
Items		**Date of installation**	**function**	**utilization**	**remarks**
Crushing mills (Steel/Iron)					
Filtering Units					
Boiling units	Pre – Boiling				
	Boiling				
Methods jaggery preparati	Conventional Type				
	Others				
Modified furnace	Traditional				
	Modified				
Source of Energy	Fuel wood				
	Bagasse only				
	Tires Tubes, Agriculture waste etc.				
	Solar Power only				
	Bio Fuel				
	Mixture of all				
	Any other				
Clarificants quantify Gram/kg per ton used	Chemicals used (List)		-		
	Organics used (List)				
	Organics +Chemicals				
Jaggery End Point	striking Point				
	boiling point				
Moulds	Steel				
	wooden				
	Any other				
Packing	Plastic				
	Tin				
	Organic, sugarcane leaves				

	Gunny bag, date leaves				
	Others				
Testing laboratory unit for cane & jaggery					
1. Type of testing. 2. Cost of testing.					
Construction bagasse drying unit					
Others					

I. Jaggery Park in Mandya **1.do you need jaggery Park in Mandya** **If yes/No, give justification** 5. **Do you provide training to farmer to upgrade in use of unit** 6. **Any other form.**	**Remarks**
II. Extraction Processes **1. Do you weigh the cane before crushing** **2. Criteria for quality cane?** **3. Methods of extraction, Metal used for the extraction. Steel /Iron/ Steel grade (in a year, how many months)** **4. Time taken for the crushing of one ton cane.** **5. Define Keeping quality. Furnishing details the test, that needs to be for quality jaggery.** **6. What is cost quality of jaggery per quintal?** **7. The parameters to differentiate chemical free/chemical jaggery** **8. Keeping quality:** **9. Have you conducted any research on keeping quality on jaggery?** **10. Type of packing of jaggery?** **11. Type of jaggery provided (Solid/ liquid / powder)** **12. Amount of energy required for processing one ton sugarcane Juice.** **13. Type of juice heating pan.** **14. Type of pans available around mandya for preparing jaggery**	
III. Quality of Jaggery (bet. Chemical and without chemical processed jaggery) which is better in the cont	

IV. Packing – Research if any its transfer **1.Have introduced any new package system**	
V. Is there any Value addition due to new package system **If yes. Please explain in details**	**Yes/No**

VI. Cost-effectiveness
What will be cost and labour per tonjaggery production

Type of jaggery	Fixed cost		Variable cost		Manpower (no. of men/day)	
	Chemical	Non-chemical	Chemical	Non-chemical	Chemical	Non-chemical
Solid						
Liquid						
powder						

List out fixed cost (items)
List out variable cost(items)

VII. Traders and consumer willing to pay higher price for chemical free Jaggery? If yes, how much more to normal price they ready to pay?	Higher price ready to pay by trader & consumer **Higher price paid in per centage**		
	10 to 15	**15>**	**20>**
VIII. Jaggery Park surrounding hygienic, certainly and surely better than the Jaggery making units existing in the surrounding area			
IX. Which States and districts (outside Karnataka and in Karnataka			
X. Please detail a few tests that can be done at home to check whether the Jaggery one is using is chemical free or not.			

Any other Information on Sugarcane and Jaggery -

Questionnaire III:Questionnaire for the Jaggery Consumers

Name & contact no		
Location	Taluk:	
Religion and caste:		
What is your occupation		
Age and education:		
Do you hold land (Acres)	Dry	irrigated
What is annual income (RS)		
Number of family members		
Since how long you know this product (yrs)		
Do you know the Jaggery Park		
If yes, how		
I. The park is ideally located		

II. Quality of Jaggery consumption (Difference between Chemical and Non Chemical Jaggery)

Jaggery type	Color		taste		healthy	
	CJ	NCJ	CJ	NCJ	CJ	NCJ
Solid						
Liquid						
Powder						

CJ: Chemical Jaggery NCJ: Non Chemical Jaggery

Answer: A. Good B.OK C. Not good

III. What is annual consumption of jaggery: kgs

Quantity(kgs)	Amt(Rs)
Sources of Purchasing: Type of jaggery: 1. 2. 3.	Local m APMC
IV. How much extra you are willing to pay higher price for chemical free Jaggery?	Higher price ready to pay by trader & consumer Higher price paid in per centage 10 to 15 | 15> | 20>
V. Why are you willing to pay more price for chemical free jaggery	1.Health 2. Good color
VI. Jaggery Park surrounding hygienic, certainly and surely better than the Jaggery making units existing in the surrounding area	1.Hygenically maintained 2. Hygiene is not observed

Any other Information on Sugarcane and Jaggery -

Questionnaire IV: Questionnaire for Scientist of Jaggery Park

I. General information		
Name of Scientist & contact no		
Sex & Age		
Professional degree	Expertisation :	
Years of Experience	Experience in Jaggery park	
Places of work experience		

I. Relevance of Jaggery Park in Mandya A. Large Area under sugarcane growing B. Farmer is experienced with professional cultivation C. Availability of required type of sugarcane	
II. Crop-Production Suitability of Resources A. Is the soil suitable for cultivation of SC B. Farmers have enough financial sources C. Better visit and extension of Agri. dept. D. Availability of established market linkage	
III. Training to farmers: a. Where the soil to be get tested and what are the parameter to be tested b. Selection of variety, fertilizers and pesticides c. New technology for scientific cultivation (variety, spacing, irrigation etc.)	
IV. Extraction Processes a. Process of crushing /pattern b. How maximum juice to be extracted c. Jaggery preparation/visit of any demo stations	
V. Processing A. How many days training is provided B. Training provided at jaggery park C. Will you provide any instruments	
a. Training — No. of trainings to farmers No. of trainings to processors	
VI. Quality of Jaggery (Difference between Chemically processed and Chemical free Jaggery) A. what tests are adopted in testing of Jaggery quality? 1.By using chemicals 2.through taste one can make it our	

3.Similar to milk testing any instrument is there to test the quality.	
VII. Quality & Packaging – Research if any its transfer	Type of packing | Material | Cost Rs
VIII. Value addition- Research & its transfer	
IX. Cost of Jaggery Production 1. Cost of cane and jaggery production of non-chemical jaggery per quintal 2. Chemical jaggery	*Sugar cane* | *Chemicals* | *labour*
X. Using chemical clarificants viz herbal clarificants in Jaggery processing?	
XI. Please detail a few tests that can be done at home to check whether the Jaggery one isusing is chemical free or not.	
XII. Patents developed	
XIII. Scientific jaggery quality Parameters according to IMA	
XIV. Publications	
XV. Comments on viability of the park	

Any other Information on Sugarcane and Jaggery -

Questionnaire V: Questionnaire for sugarcane growers Farmer

1. General Information

Name of Beneficiary & contact number			
Respondents name			
Sex: & age			
Village:	Grama panchayat:		
When were you introduced to the programme:	Date:		

II. Members in family

Male		Female		Total	
Below 18	Above 18	Below 18	Above 18	Below 18	Above 18

III. Land holding details (Acres)

Dry	Irrigated	Garden	Total

Earlier to Training/in the programme

Area under sugar cane(Acre)	Production (Tons)	Cane Used for jaggery (Tons)	Cane Sold for the factory(Tons)

After training & part of the programme

Area under sugar cane(Acre)	Production (Tons)	Cane Used for jaggery (Tons)	Cane Sold for the factory(Tons)

III. Basic Amenities at household level

1. Type of House:

1. Katcha House
2. Pucca House (Concrete)
3. 1. Own house 2. Provided by the government (Scheme)
4. Household toilet is available Yes/No

Do you know the following points on sugarcane cultivation	Remarks
2. Crop-variety Suitability for jaggery preparation	
3. The soil is suitable for cultivation of quality cane	
4. Farmer have enough financial source	
5. Have you undergone a training programme by park scientists? If yes, list the technological interventions that you have adopted after training for growing quality canes(impacts)	
6. Do you know the cost of cane production per ton per hectare?	
7. Training on Cultivation Practices, Pkg of harvesting and post-harvest mgt	
8. Have provided soil testing technology in Jaggery park & what are the	
9. parameter to be tested	
10. Selection of seeds, fertilizers and pesticides	
11. The process of scientific cultivation	
12. Method of transport of cane and impact on quality (time taken to transport and quality parameters) 1. Tractor 2. Bullock cart 3. lorry	

Any other Information on Sugarcane and Jaggery -

Questionnaire VI: Questionnaire for the Jaggery traders

Name & contact no	
Location	**Name of organization**
Annual turnover	**Rs**
Trading places (name)	
Since how long in this trade	
How you know Jaggery Park	
Do you know the type of Jaggery prepared in the park: list	
Do you know meaning chemical free Jaggery.	
Have you undergone training in Jaggery park	
1.Relevance of Jaggery Park in Mandya **2.Are you member of the jaggery park technical committee?** **3. Number of meetings attended in a year** **4. Do you know the market potential of jaggery ? (State, National and International)** **5. Are we Importing jaggery/ if so from where** **6. Is there any differential price for chemical free jaggery v/s chemical jaggery** **7. If so give reasons**	

II. Quality of Jaggery(Differences between CJ and NCJ Jaggery)

Jaggery type	Color		taste		healthy	
	CJ	NCJ	CJ	NCJ	CJ	NCJ
Solid						
Liquid						
powder						

CJ: Chemical JaggeryNCJ: Non Chemical Jaggery

Answer: A. Good B.OK C.Not good

III. Have you observed any quality parameter change which jaggary as suggested by park.

Activity	Impact	No impact	Remark
Storability			
Packing 1.Gunny bag 2.Sugar cane trash 3.Data palm leaves 4.Plastic cover 5.without cover.			
Quality parameters			
Branding			
PPP model			

IV. Marketing 1.Incentive are provided to trader 2.Does there is progressive commission 3.what strategies adopted in creating demand for CFJ	

IV. consumer perception in buying the jaggery

Reasons	Type of jaggery				Remarks
	Chemical		Chemical free		
	seasonal	Un seasonal	seasonal	Un seasonal	
Price					
Color					
Tasty					
Storability					

VI. Preference of traders & AMPC's merchants

incentives	Chemical	Non-chemical	
Credit facility			
Timely Delivery			
Adequate supply			
Demand from consumer			

VII. Jaggery Park surrounding hygienic, certainly and surely better than the Jaggery making units existing in the surrounding area	**1.Hygenically maintained** **2. Hygiene is not observed**
VIII. What has been the production, saleand utilization pattern of powderedJaggery, Liquid Jaggery and Jaggerymade into unique shapes	**discussion**
XII. Please detail a few tests that can bedone at home to check whether theJaggery one is using is chemical freeor not.	

Any other Information on Sugarcane and Jaggery -

Questionnaire –VII : Score card for sensory evaluation of products

Name of the judge: Date:

Name of the product:

Instructions:

- Rinse your mouth in between evaluating each sample.
- Please evaluate each of the following samples using scoring system given below.
- Write the preferred numerical score in the space provided.
- Comments should justify the numerical score and must be brief.

Quality characters	Products				
	A	B	C	D	E
Appearance					
Color					
Texture					
Flavor					
Taste					
Overall acceptability					

Scoring system:

9-like extremely: 6-like slightly: 3-dislike moderately: 8-like very much:

5-neither like nor dislike : 2-dislike very much:

7-like moderately: 4- dislike slightly; 1-dislike extremely:

Comments: **Signature**

Annexure -8: Reply to Independent Assessor, KEA Comments

Evaluation Report on study of “Evaluation of RKVY project on Establishment of jaggery park in Southern Karnataka”

The draft report on study of “Evaluation of RKVY project on Establishment of jaggery park in Southern Karnataka” submitted by the Karnataka Evaluation Authority to me for assessment. I have gone through the draft evaluation report and have the following to submit on the same;

Sl. No.	Assessor’s observations	Remarks
I	page numbers may be mentioned in list of tables	Incorporated
Ii	Page numbers may be mentioned in list of graphs.	Incorporated
iii	List out the abbreviations and mention in the report	Incorporated
1	**Executive Summery**	
	It is suggested to mention the recommendations and the findings as per the ToR evolutions questions in the executive summary chapter	Incorporated
2.	**Introduction, objectives and methodology**	
	Adequately covered.	
3.	**Area of study**	
	Adequately covered.	
	In page 66, the objectives of the jaggery park may be mentioned.	Incorporated
4.	**Hypothesis**	
	Need to be mentioned	Attended
5	**limitations**	
	Mentioned in the report	
6.	**Review of literature**	
	Adequately covered	
7	**Analysis and Discussions**	
	In pages 104, 105, 110, 116 percentage errors were noticed –check and correct the same	attended

	In page 127, the table and fig nod. May be mentioned	Attended
	In page 143, the annexure mentioned and enclosed do not tally check correct the same	Attended
8.	**Conclusions and Recommendations**	
	The conclusions and recommendations ere covered in the chapter however thte consultant organization is suggested to bring out the findings of the study as per the tor evaluation questions separately. The findings of the same may be brought in the executive summery chapter also	incorporated
9	**Importance of the study and limitations**	
	Adequately covered	
10	**Overall presentation**	
	Document well presented	
11	**Policy brief**	
	Adequately covered	
12	**Other suggestions**	
	Few corectins are marked in pencil in the report- these needs to be corrected and incorporated in the report	Atteneded

Reply to 35th Technical committee meeting of KEA proceedings Comments

Sl. No.	Suggestions	Remarks
1	**Recommendation of banning all the chemicals needs tobe revisited as there may not to be aneed to ban harmless and permitted chemicals**	**Incorporated in page No. 194**
2	**To give a concept map as related to size of the park, no. of farmers and market.**	**Furnished in page no. 201**
3	**Note on feasibility of organic faring to be added.**	**Furnished in page no. 211**

List of Individuals of groups interviewed/ consulted and sites visited

District level: Joint Director of Agriculture and APMC Market officials at Mandya

Taluk Level: Sugarcane growers and jaggery processors

Scientists at VC Farm Mandya, Agriculture research Station, Mudhol andSankeshwar and Scientist at jaggery Research station, Kolhapur

Farmers of Maharastra and North Karnataka

Beneficiaries / stakeholder/ consumers

A Short Biography of the Principal investigator.

1.	Name of the applicant	*Dr. M.A. Shankar*
2.	Your PAN number (please attach a self-attestedcopy of your PAN card)	*PAN No.: ABIPS2305K*
3.	Age in completed years	*63 Years*
4.	Gender	*Male*
5.	Address and contact details (please include mobile number and email id)	*No.14, Rangashree, 1st Main Road, Ganganagar, Bangalore – 560 032, Karnataka* *Mobile No: +91 8197992346* *Tel No.: +91 80 23331539* *Email:* drmashankar191212@gmail.com
6.	Educational qualifications (attach proof with page number)	*Photo copy enclosed*

Level	Degree	Institute/ University	Year	Subject	Division/ Grade
➢ *Graduation*	*B.Sc.(Agri)*	*University of Agricultural Sciences, Bangalore*	*1976*	*Agriculture & Allied*	*First*
➢ *Masters*	*M.Sc.(Agri.)*		*1979*	*Agronomy*	*First*
➢ *Ph.D*	*Ph.D*		*1990*	*Agronomy*	*First*

7.	Details of present employment if any	*Superannuated*
8.	Details of employment	*Experience certificate enclosed in* ***ANNEXURE-III***

Designation	Nature of work	Organization	Period
➢ *Instructor*	*Teaching*	*University of Agricultural Sciences, Bangalore*	*28/05/1978 to 26/06/1982*
➢ *Assistant Professor*	*Teaching / Research / Extension*		*26/06/1982 to 22/08/1990*
➢ *Associate Professor*			*23/08/1990 to 24/11/1998*
➢ *Professor & Chief Scientist,*	*Administration Research/ Teaching/ Extension*		*25/11/1998 to 20/08/2008*
➢ *Dean (Agri).*			*20/08/2008 to 19/12/2012*
➢ *Director of Research*			*19/12/2012 to 30/09/2015*

9.	Details of 10 years or more work experiencein the field as mentioned (attach proof with page number)	*Organization Name: University of Agricultural Sciences, Bengaluru* *Position held: Director of Research, Dean (Agri) and Chief Scientist* *Nature of job: Administration and monitoring of the Research Activities*
10.	Furnish details of publications made/Bookswritten/Papers published etc., if nay	*Research paper: 173* *Papers presented in Seminars /Conference: 125* *International conferences: 23* *Popular Articles and Leaf lets: 26* *Books & Chapters in books: 21* *Technical Bulletins: 49* *Lab. Manuals: 20* *Radio Talks : >50* *T.V. Programme: >15*
11.	Awards and rewards received, if any	

A. International

1997: Certificate of Appreciation for the scientific work on Potassium Sulphate in Mulberry

2010: Best Photography award by International Plant Nutrition Institute, Washington

B. National

1997: Best Teacher Award

1998: FAI Award

2003-09: Certificate of Merit along with cash incentive -9 times

2008: Best poster presentation award– 2 times.

2009: Nagamma Dattatreya Rao Desai Prize

2009: Ground water Augmentation Award

2010: Fellow, Indian Society of Oilseeds Research

2012: S.N. Ranade Memorial award for Micro-nutrient research

2014: Best Scientist Award

2014: Dr. J. Venkateswarlu Award for Outstanding research contributions in the field of dry farming

2014: Indian Society of Agronomy Gold Medal

2015: Vasanth Rao Naik Award for Application of dryland agriculture from ICAR, New Delhi

C. State

1994: Best Scientist Award - Silver Medal

1998: Letter of Appreciation and cash incentive, Govt. of Karnataka

2008-09: First Prize for Dryland Technology Demonstration. DLAP, UAS(B)-2 times.

2009: Rotary club, Bangalore (South) award

2010: Best Scientific Book on Sericulture Technology Award fom DST & DBT, Govt. of India

2013: Late Sri Giriyappa Gowda Memorial Best Research Award (2012-13) by the Alumni Association, UAS, Bangalore, in recognition of outstanding research contribution

12.	Do you have development programme research/evaluation experience? If yes, please list the details.	*Yes* ❖ *Implemented 53 Research Projects* ❖ *Evaluated 33 All India Coordinated Research Projects*
13.	Have you ever assessed any research paper or evaluation reports? If yes, please give details.	*Yes* ❖ *Editor for Mysore Journal of Agricultural Sciences*
14.	Whether fitness certificate is enclosed issued by Taluk/District level health officers	*Enclosed*
15.	List of other documents attached as enclosures	Distinguished achievements in my Career

A. TEACHING

- Offered 45 courses for Under-Graduates and Post-Graduates
- Guided 6 Ph.D. students and 15 M.Sc. Students
- Academic excellence in agricultural education
- Academy for developing students in comprehensive sprit

As Dean, College of Agriculture, Hassan

- Streamlined accounting financial, academic and administrative issues
- Instrumental in putting milestone of Success in ICAR-JRF examination from the campus since its inception
- Successfully implemented Hands on Training and Rural Agricultural Experience Program for the newly established degree programs in the campus
- Developed infrastructure for Agricultural Technology Information Centre (ATIC) through funding from Zilla Panchayath, Hassan (Rs. 22 Lakhs)
- Established a Post Office in the College Campus, liasening with Department of Posts and Telegraphs
- Operationalized Canara Bank branch and ATM in the campus for the benefit of students and staff
- Got Express Power Feeder Line for uninterrupted 24 hr electricity to the Campus

- Instrumental in mobilizing health care and medical facilities by appointing lady doctor seeking support from Deputy Commissioner, Hassan Dist and District Medical Officer, Govt. of Karnataka and appointed one male medical officer on the campus
- Decentralization of accounts and administration through local purchase committees
- Organized Inter-collegiate Sports and Cultural tournament in the campus
- Introduced Biometric attendance to the staff for ensuring punctuality
- Successfully arranged the Combined Annual College and Hostel Day celebrations.
- Established Bus shelter through Zilla Panchayath, Hassan Grants (2.5 lakhs)
- Created Farm pond for efficient rain water harvesting for this water scare condition sponsored (3.0 lakhs) by State Watershed department, Govt. of Karnataka.
- Coordinated the National Horticulture Mission Project on development of Seed Infrastructure facilities worth 18 lakhs at Hassan College
- Organized Sate level workshop on Site Specific Nutrient Management, Annual technical / group meetings of different disciplines
- Construction of compound wall and front gate for the campus

B. RESEARCH

- Operated 51 research projects to the University funded by International organizations, Central & State government, Private firms.
- Developed package of practices in organic farming in rainfed and irrigated intercropping system involving groundnut soybean, green gram, horse gram, cowpea and vegetables. Besides, the research results paved the way for split application of farm yard manure, bio-fertilizers and use of non-edible oilcakes in enhancing the economic returns from dryland as well as in irrigated sericulture.
- Developed a package of practices for enhancing the productivity of groundnut and finger millet through micronutrient (Zinc and boron) and green manure management. The outcome of micronutrient research as led to BOOCHETANA Programme.
- Standardized the use of green manures and weeds as an alternative source to FYM for enhancing the productivity of Groundnut and finger millet, besides studying the impact on seed quality parameters.
- Documented the symptoms of major, secondary and micronutrients disorders (Hand book of mulberry cultivation) and standardized the nutrient management practices with special reference to sources of nitrogen and phosphorus. Emphasis was laid on potassium management in enhancing the yield and quality of commercial crops like mulberry, groundnut, cowpea and soybean.
- Assessed the potentiality of drip irrigation for enhancing the mulberry yield and quality in relations pure and intercropping systems of oil seeds and pulses.
- Standardized a package on mechanization for groundnut-finger millet production system for *Alfisols*.

- Developed technology for high yielding chilly variety Samrudhi released during 2002.
- Carried out resource characterization (Mapping of natural resources) and inventarization of natural and biophysical resource at micro level in a watershed of 500 ha for recommending suitable crop and cropping system based on land use capability. Developed policies for lease of subsidy to farming community.
- Documentation of Indigenous Technology know-how on soil and water conservation, rainwater harvesting and recycling and intercropping system of southern dry zones of Karnataka. Besides, provided technical back supporting to watershed development activities of Government and NGO's.
- Resources Appraisal for Sustainable Land Use Planning of Doddagangawadi Micro Watershed.
- Soil resource characterization of fragile drylands has been done. Deficiency of organic carbon, potassium, zinc and boron was identified and a package was given for corrective measures.
- Intensified the research of farming and cropping systems for providing sustainability to dryland resource constraint farmers and advocated location specific farming system module.
- The contribution of common pool resources (CPR's) to the economics of rural poor in Deccan plateau of India was examined. A declining trend in CPR's was noticed which was mainly due to over exploitation of natural resources resulting in environment degradation, population outburst besides breakdown of traditional systems of NRM.
- QRT team adjudged the Dryland Research Project as the top among AICRP's center in the country

- Developed 1 Patent, 3 varieties and 9 Technologies as detailed below

Category		**Year**	**Additional Details/ Information**
➢ *Patent*	*Honey pan*	*2014*	*Honey powder with natural profiles-process technology*
➢ *Varieties*	*Chilli: Samruddhi* *Cowpea: IT 38956-1* *Sesame: Chandana*	*2002* *2007* *2009*	*Improved varieties for dryland condition*
Technology for Package (9)		*2003*	

1. *Glyricidia as a green manure crop for dryland crops*
2. *Combined application of zinc and borax for finger millet and groundnut*
3. *Eupatorium as green leaf manure for dryland crops*

4. *Package of practices for dry farming and watershed,*
5. *Rain water harvesting*
6. *Application of Micro-nutrients (ZnSO4 and Borax) in sesame*
7. *Periodical / staggered nipping in castor*
8. *Double cropping of Fodder maize - Chilli for dryland*
9. *Horse gram in-situ green manuring followed by finger millet under dryland situation*

As Director of Research, UAS, Bangalore

- Started AICRP on Cotton, Sorghum, Micro-nutrient, Farm Power and Machinery
- Establishment of Water technology center for Cauvery command with an outlay of Rs. 250.00 lakhs
- Starting Fodder research station at Kunigal with an outlay of Rs. 100.00 lakhs
- Developed Nelamakanahalli Seed Farm as new Agricultural Research Station
- Resource was mobilized through research projects and testing trials worth of Rs. 2681.12 and 120.51 Lakhs, respectively
- Establishment of Suvarna Raitha Bhavan at UAS, GKVK, Bengaluru with an budget outlay of Rs. 400.00 Lakhs.
- Co-ordinated the research activities of the University systematically.
- Technical, Administrative and Financial Monitoring of 36 ICAR sponsored All-India Coordinated and 20 Rashtriya Krishi Vikas Yojana (RKVY), 90 DBT / DST, GoI and 146 Projects funded from Other agencies.
- Sensitized the scientists for undertaking research through external funding on priority areas.
- Successfully organized Zonal Research and Extension Program (ZREP) of different zones.
- Initiated modalities for technical auditing of Research Scientists and Farm Superintendents
- Efforts to strengthen the infrastructure of all the centers through RKVY and other funding

Professional affiliations

- **Served as Board of examiner for**

Tamil Nadu Agriculture University	*Annamalai University*
PadmavathiMahilaUniversiy	*Bangalore University*
CSRTI	*Mysore University*
Karnataka University	*UAS, Dharwad*
Agricultural Scientist Recruitment Board	*UAS, Raichur*

- ***Served as Academic council member of*** *Acharya NG Ranga Agricultural*

University, Hyderabad

- ***Served as Member, Board of studies of*** *Bangalore University and UAS, Bangalore.*
- ***Served as Agronomy Club Secretary*** *for a period of two years and organized 9 seminars / symposis*
- ***Served as Secretary to Sericulture club*** *and organized several scientific lectures for a period of 2 years*
- ***Served as Joint Secretary,*** *Indian Society of Oil Seeds, Directorate of Oilseed Research, Hyderabad*

Membership and fellowships of professional bodies

I. At National level

i. *Institution management committee member of CRIDA, ICAR, Hyderabad, Govt of India 23.1.2001 to 22.1.2004 / F.No. 4-23/95-1A-4 dated 2.2.2001*

ii. *Member of panel experts on Dryland Agriculture for Indian National Committee on irrigation and drainage, Ministry of Water Resources, Govt of India, New Delhi from 2000 to 2008*

iii. *Member of Academic Council, ANGRAU (AP), Rajendranagar, Hyderabad*

iv. *Served as a member of peer review team to visit to NATPRRPS Projects in Orissa (D.O.No. NATP/ SAP/ 2003 dt 17.11.2013)*

v. *Served as member of Farmers Advisory Committee to suggest the RRPS in routine research activity on mulberry cultivation (CSB) RSRS/KDT/FAC/2001-02/330 dt 23.6.2001*

vi. *Member of screening committee for Principal Scientist to ASRB, New Delhi*

vii. *Member of Indian Council of Irrigation and Drainage Committee, New Delhi for the past 6 yrs*

viii. *Member of the panel of Experts for Mulberry Agronomy to review the research projects of Central Silk Board, GOI. Bangalore, 1995-98*

ix. *Member of Research Advisory Committee of RSRS,Kodithi and Chamarajanagar, Central Silk Board, GOI. Bangalore (RSRS/KDT/Sub-RAC/97-98/S36, 23.7.1997)*

II. At State level

i. *Served as member of the panel of Scientists from Moriculture in Karnataka State Sericulture and Development Institute*

ii. *Member of Drought Monitoring and evaluation team for Kolar and Tumkur district of Karnataka of State Dept.of Agriculture for two years*

iii. *Member of state level implementation committee for river valley project and reclamation of saline*

iv. *Member of Board of Directors of Environment Association of Bangalore (NGO)*

v. *Member of Board of Studies for Post graduate program in sericulture in Bangalore University*

Certified that the above information is true and correct to the best of my knowledge and belief.

Place:

Date: Signature of applicant

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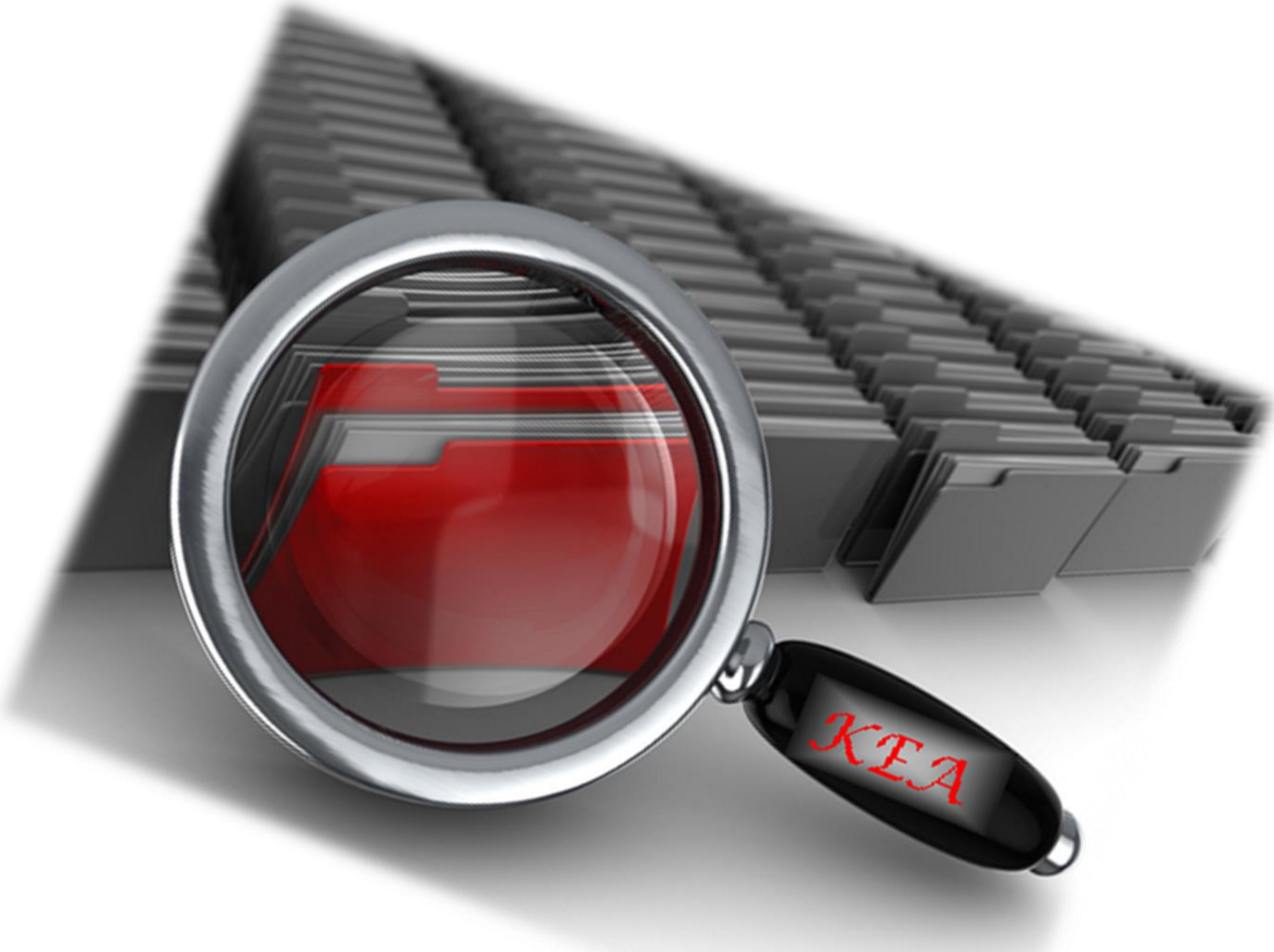

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