POLICY BRIEF

Technological and Policy Options for Modernization of Jaggery Industry in India

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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. It is a low grade non-centrifugal sweetener prepared from sugarcane and certain species of palm, consumed in India, Pakistan, Bangladesh, Africa, Myanmar, China, Indonesia, Brazil and many other countries. Prior to introduction of modern sugar industry in beginning of 20th century, entire sugarcane was utilized for jaggery making in rural areas. This unorganised cottage industry remain neglected due to inadequate cane crushing efficiency, juice clarification technological development, inefficiencies 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 from one in 1902 to 520 in crushing season 2013-14. Jaggery making units has been frightened in historical backdrop during rapid industrialization era. Jaggery is still popular in some sugarcane producing states of U.P., Karnataka, Tamil Nadu, Maharashtra 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 54% to 15%. Hence, jaggery production and its per capita consumption has shown diminishing trend. Its annual production 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 factors 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 issues, lack of technical skill, meagre financial support *etc.* Poor adoption of R&D interventions due to paucity of infrastructure, development fund, improper jaggery market and extension supportive mechanism are the other factors. Therefore, it is vital to modernise the jaggery cottage industry to safeguard economic interest of millions of sugarcane farmers and rural workers for their livelihood security, employment and prosperity.

Establishment of integrated sugar-ethanol-energy complexes could benefit sugarcane farmers through economy of scale in vacuum pan sugar-energy products processing may offer higher cane prices. However, question arises how these integrated complexes would process efficiently entire sugarcane production to fulfill diversified sweetener products demand and safeguard the socio-economic structure, skill, employment and prosperity of rural community. At present, 15 % cane production is utilized for solid jaggery production (Table-1) such as *laddoo, pansera, khurpapad, balti etc.* liquid jaggery (*kakavi)* and powder jaggery *(shakkar*) by small scale agro cottage industries. The review reveals that 8-10 MT jaggery was produced by 8 lakhs operational crushers in rural villages. The jaggery processing sector provided employment to 25 lakh workers engaged in various operations (Alam,1999).

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Table 1: Sugarcane production and utilization

Year	Production (MT)	Sugarcane utilization (%)		Consumption (kg/year)	
		Sugar	Jaggery	Sugar	Jaggery
1970-71	126.4	30.2	57.8	7.4	13.6
1980-81	154.3	33.4	54.8	7.3	12.5
1990-91	241.0	50.7	37.4	12.7	10.7
2000-01	296.0	59.7	29.8	15.7	8.4
2010-11	342.4	70.0	18.1	17.5	5.1
2013-14	350.0	73.9	14.8	18.9	3.7

Medicinal benefits of jaggery

Jaggery has higher nutritional value as compared to sugar (Table 2). It preserves all minerals and vitamins found in cane juice, viz., calcium, iron, phosphorus *etc.* The Ayurvedic medicine advocates that the jaggery consumption purify blood, improves digestion and strengthens lungs, bones and nervous system. The low glycemic index and chain of sucrose make jaggery a slow glucose releasing sweetener as compared to refined sugar. Hence, awareness should be created among the people for the benefits of jaggery consumption through mass media publicity, campaigns and advertisement. In spite of, good source of natural minerals and vitamins, jaggery products have lost the race to sugar sector during rapid industrialization era.

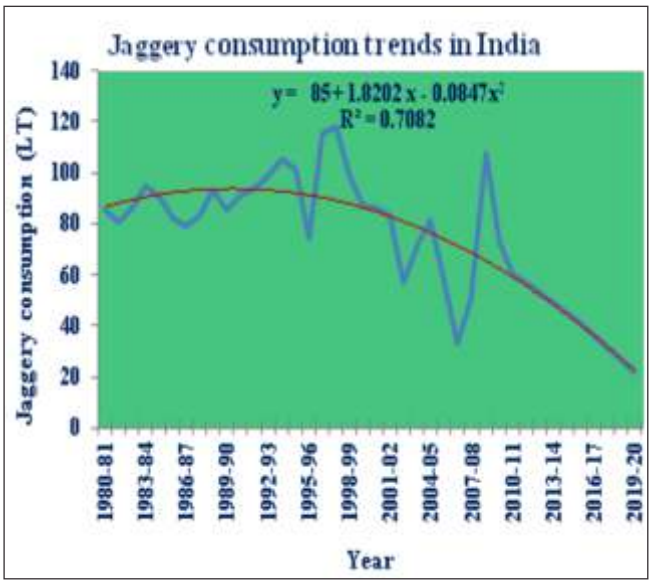
Table 2: Nutritive value of jaggery and sugar

(per 100 gram)

Particulars	Jaggery	Sugar
Sucrose (%)	65-85	99.5
Reducing sugars (%)	10-15	-
Protein (g)	0.4	-
Fats (g)	0.1	-
Total minerals (g)	0.6-1.0	0.05
Calcium (mg)	8	-
Phosphorus (mg)	4	-
Iron (mg)	11	-
Moisture (g)	3-10	0.2-0.4
Energy (kcal)	383	398

The higher juice extraction leads to better sucrose recovery in sugar mills. However, during white sugar processing valuable nutrients, minerals and reducing sugars are also removed that adds to total losses in mills. These minerals and nutrients are very useful dietary ingredients for healthy persons. The jaggery production, due to crushing inefficiencies lead to poor juice recovery, but supplemented by reducing sugar recovery and nutrient retention. It makes jaggery products more nutritive having higher medicinal values as compared to sugar. Hence, its consumption is eco-friendly and does not have sugar related health hazards.

Figure 1: Projections for jaggery consumption



Source: Solomon and Gangwar (2014)

The projection for sweeteners requirement by 2030 and 2050 would be 32 and 42 MT respectively, (Solomon and Gangwar 2014). Therefore, sweeteners demand and supply gaps should be optimized to meet the enduring requirement of food and energy security. It is essential to minimise cane post-harvest losses, improve machine processes and add to diversified products recovery percentage and productivity. There should be integration of strategies for combining the strengths of traditional and cutting-edge processing technologies.

Technological intervention and measures for modernization of jaggery industry are efficient crushers for higher juice recovery, settling and filtration of juice, mechanical juice transport to processing pans and use of effective organic clarificants. The jaggery unit plan layout should be semi-automatic, compact, fuel and labour efficient, along with moulding and product packaging facilities. The furnaces should be improved one to save bagasse used as fuel. The government may offer financial incentives for establishing jaggery units in villages promoting use of horizontal crushers, vacuum pans in combination with open pans, efficient furnaces, moulding accessories and product packaging. It will enhance product quality, hygiene and market access to reap economic benefits of premium jaggery products prices in super markets. This policy brief highlights some production interventions useful for modernization of jaggery units.

Jaggery processing methods

In India, jaggery is produced by traditional methods. The major unit operations involve juice extraction, clarification, heating and concentration, cooling, moulding and packaging. Farmers use three-roller vertical or horizontal crushers and open pan furnaces. These crushers give juice recovery 50-60 % (on cane weight basis) which led 15-20 % juice loss due to poor extraction and need more bagasse for juice concentration. The juice is cleaned during heating and boiling in open pans using vegetative or chemical clarificants. The product quality depends largely on effectiveness of juice clarification. The clarificants makes juice clear and light in colour. Traditionally, mucilage obtained from stem and roots of (deola and bhindi, Phalsa bark and Castor seed *etc.*) are used as organic clarificants. Farmers also use chemical clarificants such as hydros (Sodium hydrosulphite), lime, sodium carbonate *etc*. which give golden light colour jaggery. After juice clarification, they boil it vigorously to evaporate excess water. After certain consistency juice temperature starts rising and when if reaches 105°C, starts frothing. They stir syrup to prevent charring and spilling over pan sides, add 10 -15 ml cooking oil in pans. It prevents excessive frothing and facilitate hot jaggery transfer from pans to settling trays. The critical striking temperature for solid jaggery varies from 116° C to 118° C. Once striking point is achieved, concentrated juice is remove from pan and transferred to wooden or cement trough for settling, stirring and cooling (Baboo and Solomon 1995). This is then moulded in shape of choice and packed for final disposal. To make jaggery, incompliance with quality parameters, jaggery making should revamp at each unit operation from juice extraction till packaging.

Less sugarcane price payment

Jaggery units offered less cane price to farmers during beginning months of crushing season (₹1600-1800 per tonne). Once, sugar mills start crushing and cane price declared by state government, it still offers cane prices below State Advised price (SAP) such as ₹2200-2500/ tonne. However, some studies reveal that jaggery units were competitive as processing cost was ₹ 250-300/ tonne as compare to sugar processing cost ₹700-800/ tonne. Due to existing tax provisions, jaggery units have shifted from U.P to M.P as there was no tax on jaggery units. In U.P., government has imposed lump sum tax @ ₹40000 to establish jaggery unit and mandi tax @ 5 % of product sale price.

Impact of jaggery processing in India

The socio-economic impact of jaggery cottage industry may not be ruled out because of its contribution in rural development. It is a labour intensive cottage industry managed by semi-skilled workers. It provides employment to the village workers and also restricts their urban migration. Farmers may harvest crop as per their convenience and supply cane to jaggery units to get early payment for planting next crops. In contrast, if they are willing to supply cane to sugar mills, they depend on mills requirements, cane supply indent availability and wait for price payment. Due to money hardship, small and marginal farmers may not afford to wait for price payments. Therefore, they prefer early price payment from jaggery units. This cottage industry does not require sophisticated technologies as it uses indigenous processing equipments. They can also make diversified form of jaggery such as solid, liquid and powder jaggery as per market demand by using same machinery. Jaggery and its value added products may help in fulfilling requirement of food and nutritional security in rural areas. Hence, it is vital to develop efficient processes techniques for modernization of jaggery cottage industry to face challenges of sugar sector and safeguard farmers economic interest.

Sugar and jaggery production dynamism

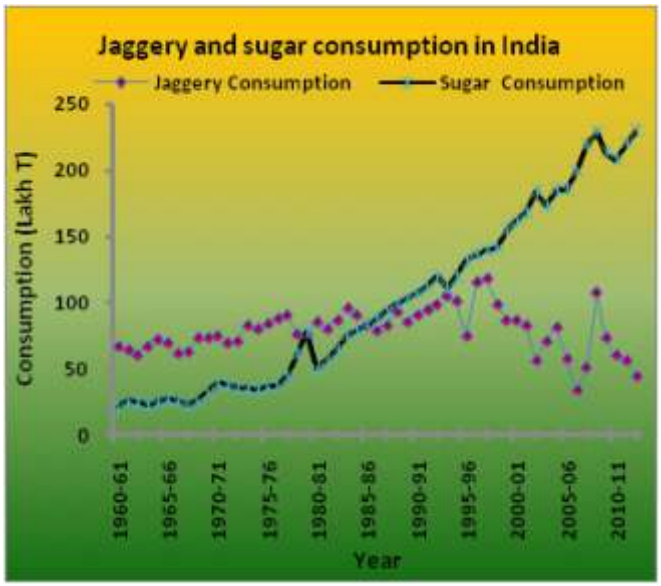
In jaggery processing, open pans juice concentration technology is prevalent. Due to downward trend in sugarcane utilization for jaggery processing and its per capita consumption, future of this cottage industry is questionable. Besides, this diversion of jaggery for elicit distillation of liquor is another challenge. The basic reasons for rapid downfall of jaggery sector are insignificant improvement in juice extraction, open pan evaporation techniques, lack of hygiene and quality products, heat inefficient furnaces, packaging, quality deterioration in storage, marketing inefficiencies and extension support.

Scope of jaggery industry modernization

Jaggery is a product of cottage industry, prone to production inconsistencies and inefficiencies, indiscriminate use of chemicals, poor hygiene and quality. The minimum quality specifications as per BIS are difficult to be assured in jaggery processing at cottage level to obtain Agmark certificate. However Introduction of Food Safety and Standards Authority of India (FSSAI) and ISO 22000:2005 standards for processed food products and HACCP norms under stringent quality assurance has to be ensured. Food safety has emerged as major concern for modernization of jaggery industry. To fulfill quality parameters, jaggery industry has to be overhauled thoroughly. Jaggery sector should overcome product quality challenges to meet demand of health conscious consumers. Printing of composition, calorific value, certification, manufacturing and expiry date *etc.* on packaged product have become essential. Hence, to reap economic benefits and meet jaggery product expected demand; this industry must be upgrade from its current position. The agrarian economy is still dominated by small scale industries for socio-economic welfare.

There is growing awareness amongst the consumers towards nutritious food. It may reverse the current trend of sweetener consumption of refined sugar and declining trend in jaggery and its value added products (Fig.2). Its processing creativity, hygiene, quality, innovative packaging and aggressive marketing strategies may add momentum for gainful income and employment to rural youths.

Figure 2: Sugar and jaggery consumption



Sugarcane varieties for jaggery

It is well known fact that sugarcane varieties are developed and adopted to meet raw material demand of sugar industry. Jaggery has never been a concern for variety development. Although, many varieties meet desired characters for jaggery but none have been developed specifically for its production. Jaggery taste and quality are influenced by juice composition, which in turn depend on cane stalk and environmental factors such as weather, soil health, biotic and abiotic stress *etc.* Several released cane varieties are suitable for jaggery. Some old and rejected varieties such as Co 313, Co 421, Co 475, Co 508, Co 775 and BO 70 were well known for jaggery. The other popular varieties CoJ 64, CoC 671, BO 91, CoS 8432, CoS 8436, CoLk 94184, CoLk 9709 *etc.* are known for quality jaggery. The desirable varietal traits for jaggery are soft and straight cane with low fiber, high sucrose, low reducing sugars, light color juice, low non-protein, ash and high phosphate content.Varieties should be tolerance to insect-pests and diseases. Keeping in view, economic significance of jaggery industry, it is crucial to develop suitable cane varieties for jaggery also.

Cane crushing and high juice recovery

Crop harvesting at peak maturity is first step towards jaggery quality. Juice quality depends on cleaning and quality of harvested cane. The juice extracted by dry crushing using various crushers operated by bullock or mechanical power gives poor juice recovery. Now old system has been replaced by three-roller crushers. However, open pan furnace juice heating is still popular technology for jaggery making. The existing crushing technique leaves 15-20 % juice in bagasse. M/s Kisan Krishi Yantra Udyog, Kanpur in collaboration with KVIC has developed an improved vertical roller crusher. The cane juice extracted with crushers using chromium plated rollers and concentrated in copper jacketed stainless steel boiling pan, with Deola as vegetative clarificants gives quality jaggery with low reducing sugars (3-5%) and high non-reducing sugars (82 -88%) in Kolhapur Maharashtra. The study conducted by NSI, Kanpur on wastages reduction during jaggery making and bagasse consumption as fuel reveals that these units have high wastage during cane crushing. The juice recovery target of 65-70% could be achieved with slight modification in existing crushers. The shredding of cane at feeding time and hydraulic loaded roller may yield higher juice recovery.

Interventions for juice heating and concentration

In jaggery making open pans, designed and fabricated by local artisan are used for boiling and juice concentration. The juice boiling in open pans on simple circular pits made with bricks boundaries support gives very poor fuel heating efficiency. Depending on capital invested, jaggery unit have provision for single, double and three pans. The fuel biomass used after briquetting improves heating efficiency. The heat utilization efficiency in open pans varies from 20 to 40 % with step grates, gutter pans, chimney and air preheating. The juice heating techniques has passed through developmental phase during past decades. Hence, the improved furnaces should be designed and adopted by jaggery entrepreneurs. The double grating furnace consume 37 kg dry bagasse or 45 kg trash to process 100 kg juice for jaggery processing. The electronic device developed at IISR, Lucknow to sound alarm at 118°C striking point to remove open pan from furnace for superior quality jaggery. However, it is well documented that the time to identify striking point for diversified jaggery also depends on sugarcane variety, pan capacity, furnace design and working on natural dry biomass fuel. Triple pans furnace gives better heat efficiency as compare to double pans. The vacuum pan, though not allowed for jaggery making, multiple pans integrated with vacuum and open pan may be tried for improving heating efficiency. The gravity feed system may be adopted for downward flow of concentrated slurry from one pan to another pan.

Cane juice clarification

The presence of foreign material and impurities deteriorate colour and jaggery storage life. The microorganism may also deteriorate juice quality. The juice clarification by physical means minimise use of chemical or vegetable clarificants. Therefore, juice clarification is a crucial process for making light colour and hygienic jaggery. During juice boiling, chemical or vegetable clarificants are added in small quantities in open pan. These clarificants coagulate during boiling, trap impurities and make forth floating at surface which is removed regularly. The lime, hydro, chemi-flocks and alum has been apply for removal of juice impurities in jaggery industry. It show improvement in products colour and quality. However, indiscriminate use of chemicals, makes jaggery unfit for human consumption. The studies reveals that vegetable clarificants such as sukhalai extract was better than caster seed for golden colour, high sucrose jaggery. Deola mucilage is also good for juice colour and jaggery making. It removes maximum scum from juice and produce medium quality jaggery. Amongst vegetable and chemical clarificants viz. deola, hydros lime and alum, deola was most effective for quality jaggery production with high sucrose and low reducing sugars, absorbs less moisture and give long storage life. Hence, it is essential to develop ready to use vegetable clarificants for quality jaggery production to meet consumers demand of niche Metro city Super Mall segments.

Jaggery moulding and packaging

Once concentrated cane juice attains condition of 92^0 Brix, it has to be poured into regular shape moulds. Generally, solid jaggery is moulded in *balls, bricks or bucket.* Innovative jaggery producers to attract urban consumer's starts moulding jaggery in cubes or trapezoidal shapes. Jaggery should be dried up to 5% moisture for long storage whereas permissible moisture is 10%. Its packaging and storage is still a challenge and researchable issue to scientists and jaggery industry.

Value added jaggery products

Jaggery is rich in natural vitamins and minerals present in sugarcane juice. However, its combination with various spices, dry fruits and condiments enhance its market demand and prices. These value added jaggery products sold as sweets at premium prices in Metropolitan City. The IISR and some AICRP centres developed innovative products such as jaggery chocolate, jaggery based ice cream, cakes and pastries. These products have huge market potential for jaggery moulding, packaging, labelling and aggressive marketing strategies for trapping domestic demand of health conscious consumers.

Jaggery marketing system

Jaggery marketing is a key activity of production process which has impact on economic viability and profitability of this cottage industry. It facilitates products movement from its production site to ultimate consumers through various marketing channel. The studies concludes that the Indian farmers are best producer but poor retailer and businessman. Hence, producer's cooperative, Self Help Group (SHG) or government should intervene to improve jaggery marketing system in India. Producers should have knowledge of market intelligence such as daily prices, arrival and price fluctuations, seasonal variation in product demand and supply. The efforts should be made to improve jaggery products marketing and optimize middlemen profit margins. Lack of infrastructural facilities and daily jaggery price broadcasting should be address on priority. This could help producers to reap remunerative prices and make it profitable business for survival of agro-based jaggery units in rural areas.

Jaggery industry co-products utilization

Rising population has higher wood demand for fuel, furniture and constructions *etc*. It leads to depletion of natural wood resources, spoil environment, biodiversity and pose threat to food security. Hence, utilization of reconstituted woods such as particle boards, substitute timber, energy fuel from crop residues and processing by-products has mammoth potential. Similarly, pulp and paper industry uses bamboos and soft woods are also in scarcity due to which these mills underutilize production capacity. Jaggery industry should come forward for making handmade papers, if it realize heat efficiency and save bagasse for other uses.

Strategic policy initiatives for jaggery industry

Keeping in view, jaggery sector need, technological interventions and infrastructure facilities following points may be considered as policy measures for modernization of traditional jaggery sector.

- Jaggery unit plan layout should be compact and adhere with HACCP norms for processed quality products.
- Develop efficient cane crushing system for 65-70% juice extraction efficiency.
- Automation of juice handling and transportation to boiling pans for maintaing products hygiene and quality of jaggery. The vegetative and eco-friendly clarificants should be used to minimize harmful effect of chemicals.
- Solar and bagasse co-power generation system could be a viable alternative for jaggery units.

The steam engine operated power system should be tested and adopted.

- Develop high combustion, vacuum-cum-open pan hybrid furnaces for optimal fuel efficiency and divert surplus bagasse for pulp and paper production.
- Efforts should be made to develop semi-automatic continuous jaggery making (Pilot plant) to produce chemical free, hygienic products with moulding, packaging accessories and labelling provisions for better marketing.
- Juice heating in open pans make jaggery unhygienic and gives non-attractive working atmosphere. Mechanical vapour recompression technology could be utilized to concentrate juice in multiple effect evaporators for improving quality and efficiency.
- Research work should be initiated to develop quality parameters, protocols matching FSSAI, AGMARK and ISO 22000:2005 for export promotion of jaggery products in niche markets.
- Government should make mandatory to all jaggery units to adhere with quality and hygiene norm .
- State government should provide economic incentives to modernize jaggery units with superior crushing technology, maceration, efficient juice concentration furnaces, moulding accessories and packaging facilities .
- Involve self help groups and co-operative societies for jaggery processing, packaging, storage, branding and marketing strategies.
- Establish small pilot scale units of pulp and paper making from bagasse and other wastes material for their integration with jaggery units.
- Possibilities for diversification of jaggery with other value added products processing such as pelted and wafer cattle feeds making with molasses should be explored.
- Dynamic linkages must be developed with public and private sector institution involved in R and D on jaggery to form producer's organization for benefits of cane farmers and revival of industry.
- Modern jaggery units should be optimized for per unit operations, manpower, energy, processes and products quality to make them feasible and profitable.

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