

## **CASHEW NUT PROCESSING: SOURCES OF ENVIRONMENTAL POLLUTION AND STANDARDS**

**ATUL MOHOD<sup>1</sup>, SUDHIR JAIN<sup>2</sup> AND POWAR A.G.<sup>3</sup>**

<sup>1,3</sup>Department of Renewable Energy Sources, College of Agril. Engg. and Technology, Dr. B.S. KonkanKrishi Vidyapeeth, Dapoli, At.Po.Dapoli-415712, Dist. Ratnagiri, MS, India

<sup>2</sup>College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur

\*Corresponding author. E-mail: [agmohod@rediffmail.com](mailto:agmohod@rediffmail.com), Ph.+919423874260

Received: March 15, 2011; Accepted: July 01, 2011

**Abstract-** India is largest producer, processor, exporter and second largest consumer of cashew in the world with annual production of 6,20,000 MT (Anon 2007). India processed about 1.18 million MT of raw cashew seeds through 3650 cashew processing industries scattered in many states of country provided employment to over 0.5 million people, 95% of these are women (Nair, 1995). The cashew industries in India employed different unit operations/ methodology for processing depend on variety of raw material, location, technological mechanization and availability of secured energy supply. There are two commonly followed methods of cashew nut processing, viz. Roasting process and Steam (roasting) Cooking process. Due to lack of skilled man-power for cutting process of cooked nut and difference in taste of nut, many of the industries in India are following roasting process. In the cashew nut roasting process, thick black smoke is released from the rotating roasting drum through the stack. The smoke, when it reaches the ground, has irritating odour and is public nuisance in the neighborhood. Borma heater is also a source of air pollution. Wastewater is generated from the quenching operation of the roasted cashew nut discharged. Cooking process also discharges wastewater from the steam cooker and emits air pollutants by Baby Boiler for steam generation and Borma heater. The sources of different environmental pollutant discharged in to the atmosphere during the cashew nut processing have been revealed in the article. The environmental standards for air pollution emission for roasting process, steam cooking process and broma oven have been presented. The waste water discharge from the quenching operation in roasting process and vessel discharge during steam cooking process have been presented in the article. The solid waste disposal practice and new and relocation sitting criteria have been discussed for cashew processing industries.

### **Cashew Nut Processing**

Cashew (*Anacardium Occidentale* L.) is one of the important tropical crops called as "poor man's crop, rich man's food". The cashew nut is native of Brazil from where Portuguese travelers took the cashew tree to colonies in India, first recorded in Cochin by 1578, in Goa by 1598 (Smith *et al.*, 1992). The crop is grown mainly in peninsular states of India particularly along the coastal states like Kerala, Karnataka, Goa, Maharashtra, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal. India processed about 1.18 million MT of raw cashew seeds through 3650 cashew processing industries scattered in many states of country provided employment to over 0.5 million people.

The cashew industries in India employed different unit operations/ methodology for processing depend on variety of raw material, location, technological mechanization and availability of secured energy supply. There are two commonly followed methods of cashew nut processing, viz. Roasting process and Steam cooking process. In cooking process vegetable oil is extracted from the cashew shell of the seeds, which has market in paint and adhesive industry. Due to lack of skilled man-power for cutting process of cooked nut and difference in taste of nut, many of the industries in India

are following roasting process. In the cashew nut roasting process, thick black smoke is released from the rotating roasting drum through the stack. The smoke, when it reaches the ground, has irritating odour and is public nuisance in the neighborhood. Borma heater is also a source of air pollution. Wastewater is generated from the quenching operation of the roasted cashew nut discharged. Cooking process also discharges wastewater from the steam cooker and emits air pollutants by Baby Boiler for steam generation and Borma heater.

Since these industries are small and cottage category units and no conventional and techno-economically cost effective pollution abatement systems are in operation elsewhere, it has become necessary to study the entire cashew nut processing industry sector in India to suggest techno-economically feasible environmental standards. Even though the pollution load from individual unit is relatively low, the magnitude of pollution problem from the cluster of units is very high.

The general processing steps involved in cashew processing are Drying of freshly harvested raw seed for storage, Soaking of seed, steam cooking or roasting, Shelling, Separation, Kernel drying, Peeling and

Packaging. The general process flow chart for cashew processing adopted in India is shown in Fig.1.

### Drying of raw nuts

Sun dried in yards, weight loss may vary from 3% to over 10% depending on time of harvesting and area of origin. The raw nuts after harvest are sun dried for 2-3 days to reduce the moisture from 25 % to 8-9 % and stored in gunny bag. The raw cashewnut contains the kernel and papery seed coat (testa); these account for 20-30 percent and 2-3 percent, respectively, of the raw nut weight; the remaining 70-75 percent is the shell.

### Roasting / Steam Cooking

#### A.ROASTING:

i. Drum Roasting- Nuts passed through heated drum where it catches fire for 2/3 minutes.

ii. Oil Roasting-Dried nuts conditioned with water passed through a hot oil (Cashew Nut

Shell Liquid – CNSL) bath by conveyer. The oil in nuts comes out.

#### B.STEAMING

This method now a days adopted widely all over the India. The dried nuts are steam cooked. Well dried raw nuts are subjected for steam boiling which is commonly adopted method of nut conditioning in India. The raw nuts are steamed conditioned about 90-100 lb pressure for 25 -30 minutes and then allowed for 24 cooling.

### Decordication

A.SHELLING – Roasted nuts have to be shelled by breaking shells with wooden mallets or

B.CUTTING – Steamed nuts have to be cut with blades mounted on wooden tables. Raw nuts after conditioning and cooling are to be shelled to remove kernels with the help of hand cum pedal operated shell cutter. After shelling the kernels and shell pieces are separated manually. The kernel after shelling will have moisture content more than 10 %.

### Drying of the kernels

The kernels are dried to moisture content about 3.5-4.5 %. Drying the kernel in hot chamber at 65-70 degree centigrade in perforated tray for 6-8 hours does this. After drying, the kernels are kept in moist chamber for 4-6 hours for easy removal of testa and minimum broken kernel.

### Peeling

The testa is peeled off and initial grading by wholes, pieces and colour takes place. The peeling process involved removal of testa from the kernel with the help of sharp knife.

### Grading

The kernels are graded by hand/sieve. CEPC (Cashew Export and Promotion Council ) specifications are adopted for grading of cashew kernels.

### Filling

The graded kernels are:

(a) Vita packed in 25lbs tins – after vaccuming and infusing carbon dioxide, or

(b) Packed in 25lbs or 50lbs gas infused flexi packs.

### Packing

(a) Two 25lbs tins are packed in a corrugated box. or

(b) Two 25lb/one 50lb flexi pack/s are packed in a corrugated box.

### Sources of Environmental Pollution in cashew nut processing

The cashew nut processing is highly manpower intensive, generally carried out during 0600 hrs - 1800 hrs only during the day time.

### Roasting Process

The roasting of cashew seeds is carried out in a manually rotating open drum of dia 600 mm and 2.5m length, with an inclination of axis ( 15° – 20°) to facilitate the flow of the material from inlet to outlet by rotation of the drum and gravity. The drum is placed in a 'dog-house' Initially the drum is heated externally by firing about 25 to 30 kg of roasted cashew shell for about 15 to 20 minutes. Once the drum is heated up, the cashew nuts are fed manually through an elevated hopper into the inlet of the hot drum. The drum is rotated manually, so that the cashew nuts are moved from inlet to outlet of the drum. Due to the high temperature of the drum, the Cashew Nut Shell Liquid (CNSL) in the cashew nut (calorific value 6000 kCal/kg) catches fire spontaneously and the nuts are roasted through the entire length of the drum without any supporting fuel. The hot gases from the inlet of the drum are discharge into atmosphere by a natural draft stack of about 15 – 18m height. The cashew nuts, in burning state, are discharged at the outlet of the drum and quenched immediately with spray of water to prevent further roasting. (Fig.2). The water consumption by quenching process is in the range of 14 – 21 litre/ 100 kg of nut roasted. The ash generated from the drum initial firing with roasted shell is sprinkled on the wet nuts to prevent sticking. The quench water is collected in a oil trap and discharged on ground as wastewater. The water vapour and fumes generated while quenching are discharged by independent short vents connected to the dog-house. In some units, these vents are also connected to the main chimney.

The cooled nuts are sent for shelling. The manual feeding of the cashew nut and the rotation of the drum are so synchronized that about 6 to 7 bags ( Each bag weighs about 80kg of cashew nut) of cashew nut are roasted in an hour.

### Cooking (Steam Roasting) Process

The steam roasting process, commonly known as "cooking process" consists of a baby boiler followed by a steam cooker where the cashew nuts are cooked with steam.

### Baby Boiler

The baby boiler is a hand stoked fire tube boiler, which produces steam at 7.0 – 8.5 kg/cm<sup>2</sup>. The roasted cashew shell or de-oiled cake are fed manually ( about 2 to 3 kg fuel once in 15 to 20 minutes) at the bottom of the boiler. The combustion air is drawn through the grate by natural draft stack at the top of the boiler. The flue gases from the boiler are discharged into atmosphere through the stack 12 – 15m high. The flue gas emissions from the boiler are the source of air pollution.

### Cashew Nut Cooker

A cylindrical steam cooker with provision of cashew nut feeding at the top and discharging of cooked nuts from the side near bottom, has a capacity of holding 4 bags ( 80 kg each) of cashew nut in a batch. Once the cashew nut is loaded, steam from a boiler is introduced into cooker at a pressure of 7.0 – 8.5 kg/cm<sup>2</sup>. The cashew nuts in the cooker are steam cooked and when all the nuts are sufficiently cooked, the excess steam starts releasing near the bottom outlet. The steam is injected into the cooker till the steam starts escaping from the outlet mouth of the cooker. This process takes about 10 – 20 minutes time. Then the steam injection into the cooker is stopped and the condensed water at the bottom of the cooker is discharged in to a container and disposed on ground through septic tank . In cashew nut cooking process in Kerala have different process in steam injection quantity. The steam is injected for about 15 minutes even after the steam starts escaping from the outlet mouth of the cooker. This method consumes more steam.

The cooker condensate water is the source of water pollution. The cooked cashew nut are removed from the bottom of the cooker and spread on the floor for cooling. The cooled nuts are sent for cutting section to cut open and collect the kernel. The total batch time is about 40 – 45 minutes. Usually, the units are provided with a baby boiler and minimum two cookers, while one cooker is in cooking operation, the other cooker is in unloading and loading operation. Normally the cooking operation is carried out for 2 – 4hrs in a day, cooking 5 to 10 batches of nuts, depending on the production capacity of the units.

### Kernel Drying (Broma)

The kernel coming from the shelling section ( Roasting Process) as well as Cutting Section (Cooking Process) contains a brown cover, known as 'testa', over it. To remove testa over the kernel and also control the moisture content in the kernels, they are exposed to prolonged and controlled heating with hot air at 80 - 90°C for about 6-7 hrs in the chamber. About 5 – 8% of moisture is removed from the kernels in the process. This process is known as "Broma". Indirect heating of atmospheric air generates the hot air over hot surface in a "Oven". The Broma Ovens are fired with cashew shell (from Roasting Process) or de-oiled cashew cake (from Cooking Process) for about 4 – 6 hrs depending on the quantity of kernels to be dried (Fig.3). The flue gases

from the oven are discharged by a natural draft stack of about 13 – 15m high. In Kerala and Maharashtra most of the small scale units carried out the Borma operation by electric heaters which consume large electricity and the process will be dependent on power supply. The process description and environmental pollution discharge is shown in fig.4. The yield of various products from cashew processing from both the methods are shown in fig.5.

### Environmental Standards For Cashew Processing Industries

The environmental standards approved by the Peer & Core Committee of Central Pollution Control Board for the cashew Seed Industry are approved as follows

#### Air Pollution Emission Standards

The approved environmental standards for Roasting Process, Cooking Process and Borma Operation of cashew processing are summarized in Table 1.

#### Sulphur Dioxide, Nitrogen Oxides and Phenolic Compounds

The suggested stack heights results in better dispersion of these pollutants into atmosphere resulting in minimum possible ground level concentrations. Hence no separate emission standards are proposed for these parameters.

#### Wastewater Discharge Standards

The wastewater generation from different sources of cashew nut roasting and cooking process are as follows: Quenching operation in roasting process: 200 liters/day ( 2 – 4 hrs of operation in a day ) – after oil & grease trap (or) Vessel discharge from 5-10 batches in Cooking Process: 70 - 80 liters/day

In view of such infrequent nature of wastewater generation and BOD of 5000 mg/l, COD of 10000 mg/l and Oil & Grease (Extractable, mostly in the form of phenolics compounds) at 2000 mg/l, the following alternatives are recommended to comply with following waste water discharge standards for disposal on land (Table2.).

#### Solid Waste Disposal Practices

- The use of cashew shell generated especially by roasting process, as fuel, has to go through bio gasification route to convert into less polluting fuel gas as a long-term measure
- The ash generated at the bottom of 'Borma' air heater as well as the Steam Boiler and excess ash from initial firing of the roasting drum, have to be properly land filled with necessary precautions so that there are no secondary air emissions.
- The cashew shell or de-oiled cake should not be sold to retail users for domestic and commercial firing purposes due to their obnoxious odour .

### **Cashew Nut Industry - New and Relocation - Siting Criteria**

Even though the pollutant emission load in to environment by a single cashew nut unit is low, it has been observed that the total emissions load by number of such units in a cluster causes considerable environmental degradation. To avoid the combined effect by number of units on the environment, the cashew nut processing industries with roasting/cooking process have to be located with the following criteria

- 1.0 Cashew Seed Processing Industry shall be established at least 1.0 km away from residential area, hospital, schools, public building or a place where flammable substances are stores / processed.
- 2.0 Cashew Seed Processing Industry shall be established 5.0 km away from notified municipal limits of any town/city or airport.
- 3.0 Cashew Seed Processing Industry shall not be constructed within 200 m from the middle of Railway Tracks, National Highway and State Highway and 50 m from the middle of other roads.
- 4.0 In normal circumstances, installation of new cashew seed processing industry shall not be allowed in sensitive areas notified by the State Pollution Control Boards / Pollution Control Committees under the provisions of the National Air Quality Guidelines using coal as fuel.
- 5.0 The distance between two Cashew Seed Processing Industry shall not be less than 500 meter to avoid clustering of Cashew Seed Processing Industry in an area if a new Cashew Seed Processing industry is being installed.

### **Conclusion**

India is largest producer, processor, exporter and second largest consumer of cashew in the world. Since cashew processing industries are small and cottage category units and no conventional and techno-economically cost effective pollution abatement systems are in operation elsewhere, it has become necessary to study the entire cashew nut processing industry sector in India to suggest techno-economically feasible environmental standards. Even though the pollutant emission load in to environment by a single cashew nut unit is low, it has

been observed that the total emissions load by number of such units in a cluster causes considerable environmental degradation. The cashew nut processing by cooking (steam roasting) process, which is relatively less pollution intensive and an alternative process to roasting process may be considered to reduce the environmental discharge load.

### **References**

- [1] Anonymous (2003) *Cashew production Technology, Technical Note, National Research Center for Cashew, (ICAR), Puttur, Karnataka*, 12-34.
- [2] Anonymous (2006) *Comprehensive Industrial Document And Environmental Standards For Cashew Seed Processing Industries, Central Pollution Control Board, N.Delhi*, 2-29.
- [3] Anonymous (2008) *Statistical Information, Annual Report, Directorate of Cashew and cocoa development, Kochi, India 2006-2007*. 23-28.
- [4] Balsubramanian D. (2006) *J of Mechnization in Asia, Africa and latin America*. Vol.37(1): 58-64.
- [5] Balasubramanian D. (2007) *J. Agril. Engg. Today*. Vol. 32 (2): 35-41.
- [6] Eapen Mridul, Jeyaranjan J., Harilal K.N., Swaminathan Padmini and Kanji Nazneen (2003) *Liberalization, gender and livelihoods: The cashew nut case Working Paper. 3 Madras Institute for Development Studies, Chennai*, 7- 8.
- [7] Mandal R. C. (1992) *Cashew Production and Processing Technology, Agro Botanical Publishers (India): Bikaner, India*, 195.
- [8] Nagaraja K.V. (2007) *J of food science technology*, 44 (1): 1-9
- [9] Nair K.G. (1995) *Cashew: A crop with unlimited potential. The Cashew*, 16-18.
- [10] Rao E.V.V. (2003) *Integrated production practices of cashew in India, FAO Corporation Document Repository*.
- [11] Smith N.J., William J.T and Talbot J.T. (1992) *Tropical Forests and Comstock Publishing Associate. Ithaka and London*: 211-214.

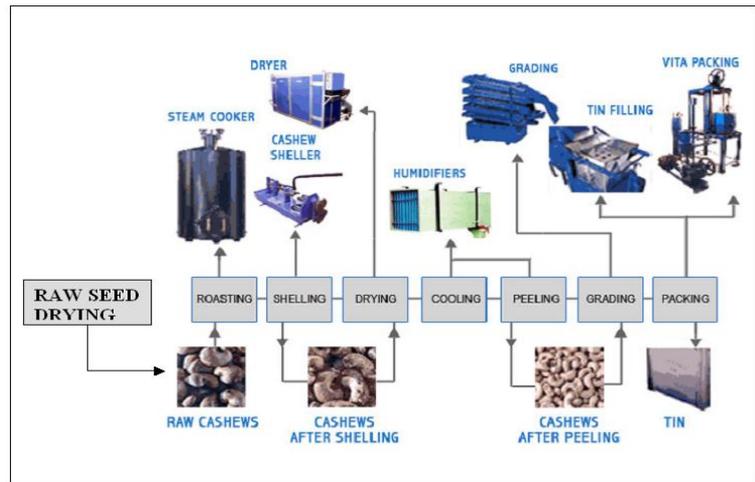
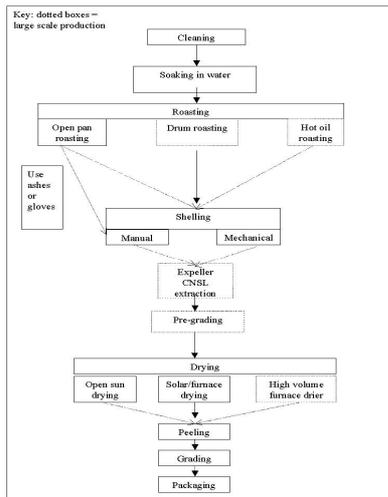


Fig.1- Process flow chart for cashew nut processing

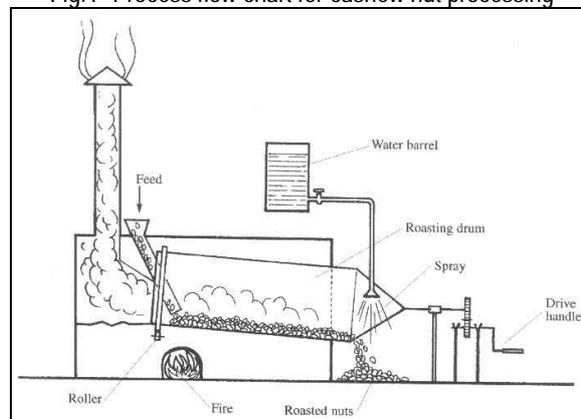


Fig. 2- Drum roaster for cashew nut roasting

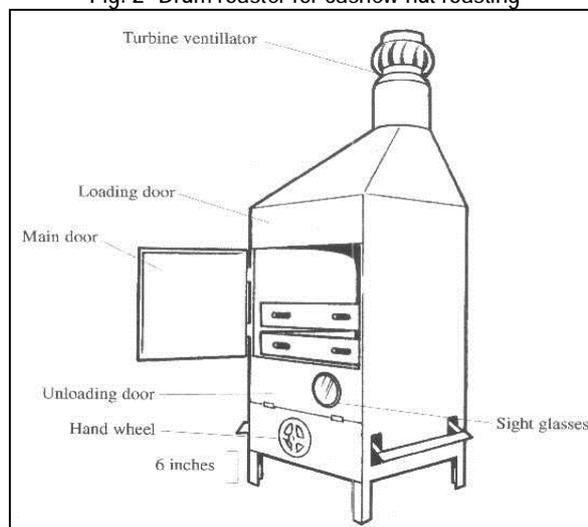


Fig.3- Broma Oven for cashew kernel drying

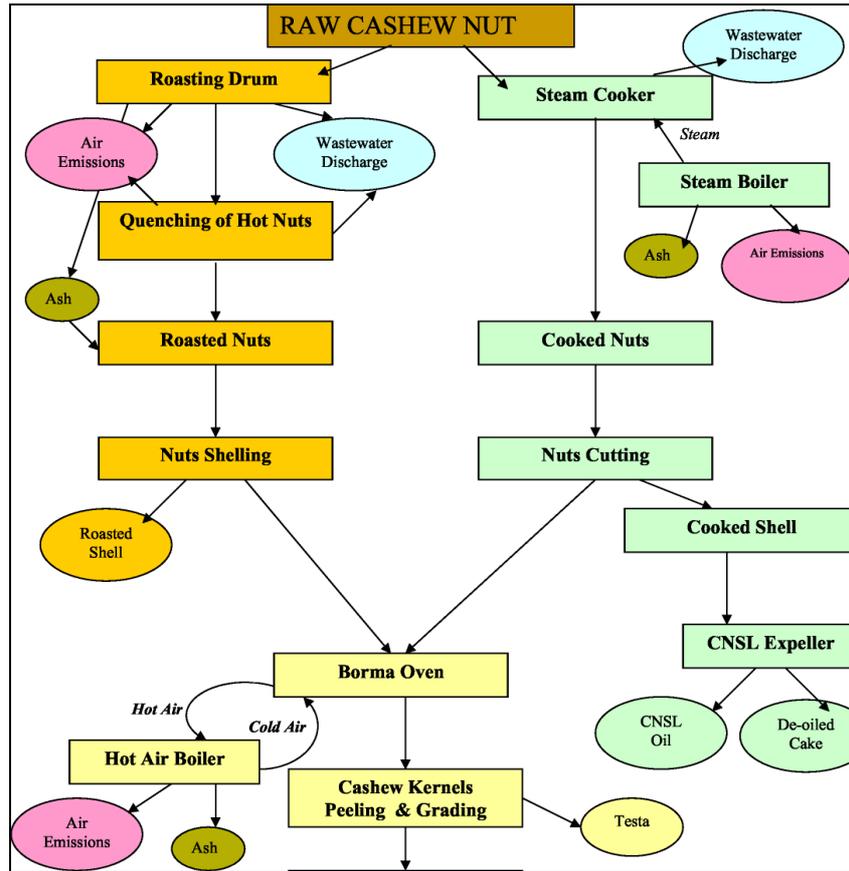


Fig.4- Environment discharge through cashew nut processing

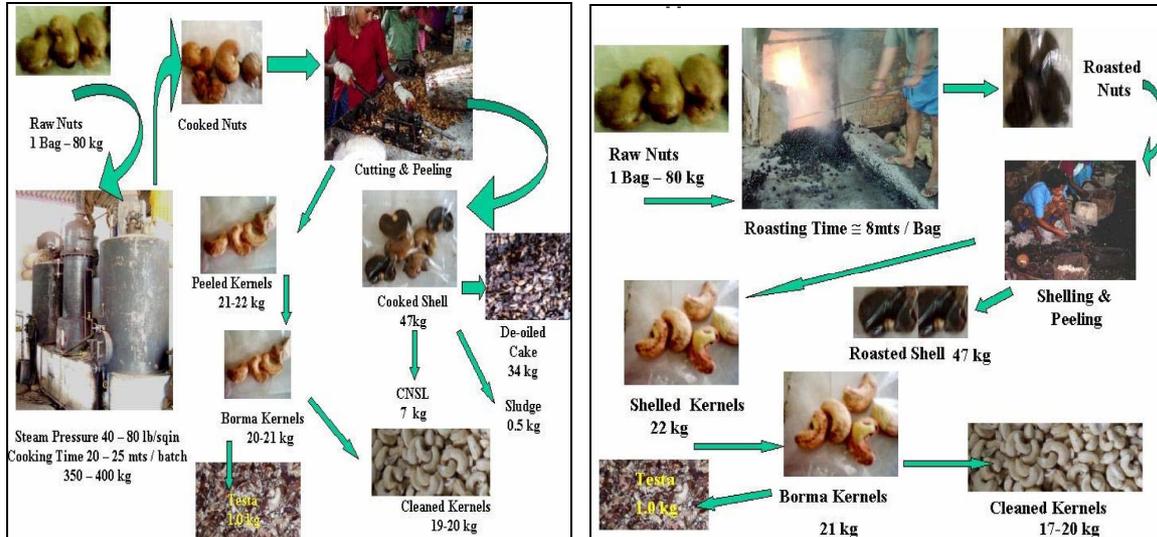


Fig.5- Yield of cashew nut processing

Table 1- Air pollution standards for cashew processing

Parameter	Roasting Process Stack (2-4 hrs of operation and 560 - 640 kg/hr of cashew nut processing )	Cooking Process – Steam Boiler (4-6 hrs of operation )		Borma Oven Heater (4-6hrs of operation)	
		Roasted Shell	Deoiled Cake	Roasted Shell **	Deoiled Cake
Particulate Matter	150mg/Nm <sup>3</sup> at 4 % CO <sub>2</sub>	150mg/Nm <sup>3</sup> at 4 % CO <sub>2</sub>	150 mg/NM <sup>3</sup> at 4 % CO <sub>2</sub>	150mg/NM <sup>3</sup> at 4 % CO <sub>2</sub>	150 mg/NM <sup>3</sup> at 4 % CO <sub>2</sub>
Minimum Stack Height, m	20m from ground level	15m from ground Level or 2m above the height of the nearest building, which ever is higher		15m from ground Level or 2m above the height of the nearest building, which ever is higher	

Table 2- Waste Water Discharge Standards

S.No	Parameter	Limit, mg/lit
1	BOD ( 27 oC and 3 days)	100
2	Oil & Grease	10
3	Suspended Solids	100
4	Phenol	1.0
6	PH	6.5 – 8.5