# A REVIEW OF CASHEW NUT SHELLING MACHINE FOR CASHEW NUT GROWERS

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**Abstract- Cashew is highly appreciated in a large number of countries and cultures. India is the largest cashew processor in the world. Export of cashew nut shell liquid from India stood at 11,677 million tonnes (MT). Cashew *which* belongs to the family is native to the tropical parts the USA, Mexico, Brazil and the West Indies. However, it has since become naturalized in many lowland tropical areas. It is one of the most nutritious food crops of the tropical world, with high protein and fat content. The US is the largest market for Indian cashew kernels, followed by the UAE and the Netherlands, while Indian Cashew nut shell liquid is largely exported to South Korea, followed by China and the US. The cashew industry ranks third in the world production of edible nuts. The major exporters of cashew in the world are India and Brazil with 60% and 31% respectively of the world market share. The major cashew nut importers are the United States (55%), the Netherlands (10%), Germany (17%), Japan (5%) and the UK (5%). Cashew kernels are ranked as either the second or third most expensive nut traded in the US. Also process of cashew nut is very much important as to improve production rate. Now days there are various machineries used to save the time and to improve the quality. The Industries are using manual, Semi-Automatic and fully automatic machineries to increase the production rate. But In conventional process, it takes more time to complete operation and hence production rate is very low. Thus to reduce human injuries in conventional methods and to increase the production of cashew nut the present study has been studied.**

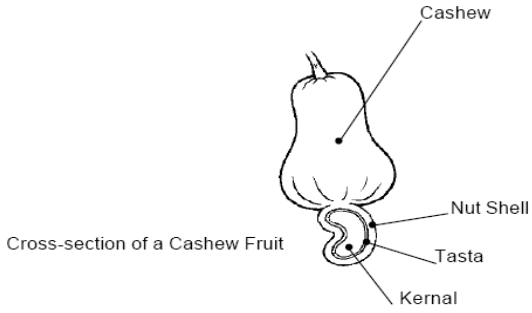
**Keywords: cashew nut, nutrition, human injuries, machineries**

## 1. INTRODUCTION

The term "Cashew" has originated from the Brazilian name "Acajaiba" and the Tupi name "Acaju" which the ortuguese converted into „Caju‟ and is commonly known as "Kaju" in India. The cashew tree is a tropical evergreen, resistant to rought, unexacting as to soil (although it prefers deep, sandy soil),which grows up to 12 metres high and has a ymmetrical spread of up to approximately 25 metres. Cashew nuts, unlike the Brazil nut, have traveled well away from Brazil, and today India is one of the major producers of cashews, so much so that people think that cashews are native to India. In India, cashew was first introduced in Goa from where it spread to other parts of the country. In the beginning it was mainly used for soil binding to check

erosion. The major cashew nut producing states in India are Maharashtra, Kerala, Andhra Pradesh, Orissa, Karnataka, Tamil Nadu, Goa and West Bengal. The annual production of cashew nut varied throughout the study and the variation ranged from -16.27 per cent to 14.37 per cent.

The nut is attached to the lower portion of the cashew apple which is conically shaped. The cashew nut (seed) hangs at the bottom of the apple, and is c-shaped. The cashew seed has within the outside shell the edible kernel or nut. In its raw form the cashew kernel is soft, white and meaty. When roasted it changes color and taste. Cashew apples and cashew nuts are excellent sources of nutrition.



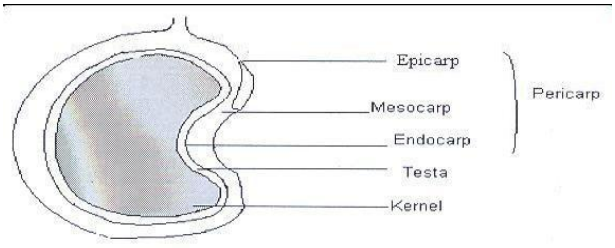




Fig1. Sectional view of cashew nut

The cashew nut is kidney shaped and has the sectional view shown in Fig. 1. It consists mainly of a nutshell (pericarp) and a kernel, which is the main product of the cashew. The pericarp consists of a hard shell (epicarp), a

honey combed structure (mesocarp), in the cells of which is contained a useful but toxic natural resin, known commercially as Cashew Nut Shell Liquid (CNSL) and a hard and brittle inner shell (endocarp) which protects the kernel. There is a covering of thin membrane on the kernel known as testa or peel, which protects the kernel.

The processing of cashew nut involves series of unit operations before it finally gets to the consumer. These operations are cleaning, sorting, roasting, shelling and packing. But the two main unit operations in cashew nut processing are the removal of the cashew nut shell liquid (CNSL), which is an irritant that could contaminate the nut and blister human skin if not handled properly, and shelling the nut to remove the kernel. The traditional method of removing the cashew nut shell liquid is to roast the nuts over an open fire. This removes the CNSL which is a valuable source of natural phenols. The improved technique is to roast the nuts in vats of hot (190–200oC) oil which removes the CNSL from the cashew nut.

## 2. MATERIAL AND METHOD

There are two commonly followed methods of cashew nut processing, like

1. Roasting process and
2. Steam cooking process.

In the roasting process the nuts (without any conditioning) are fed into a rotating drum, which is heated initially to red hot sufficiently to allow the shell portion of the nut to ignite and burn. Once ignition starts no further heating is necessary and the drum maintains the temperature on its own because of the burning of oil, which oozes out of the nuts. The temperature of the drum is fairly high. It is stated that in this method of roasting shell becomes very brittle and the rate of shelling and out-turn of whole kernal is higher compared to other methods. The roasting generally takes about 3-5 minutes and the drum is rotated by hand. The roasted nuts, which are still burning are removed from the discharge end and immediately covered by ash to absorb the oil that is found on the surface. Kernels obtained in this process have a better color than in the other processes.

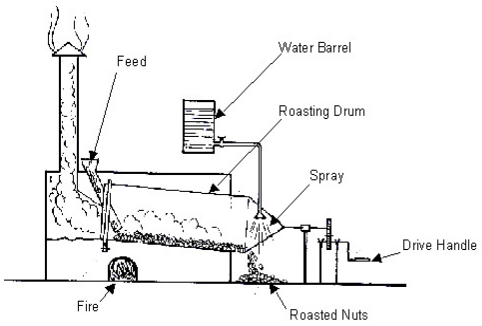


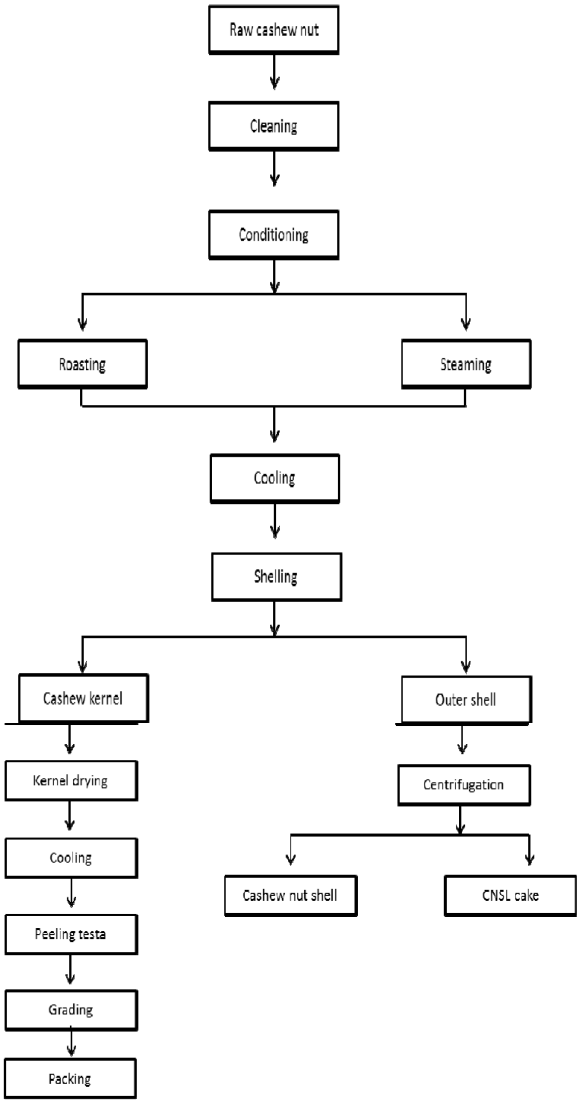
Figure 4: Diagramme of a Drum Roaster Fired from a Furnace Below

In the steam process, the raw cashew nuts are treated in a cooker filled with steam for about 15 minutes. The treated raw nuts are spread out on the floor for cooling and then sent to the shelling section the next day. The turnout and appearance of whole kernels from raw nuts treated in this method are said to be better than in any other method. The cashew nut shell liquid (CNSL) obtained in this method from the shells is very clear and command a premium price. About 75% of the CNSL can be extracted from the shells.

Shelling of the cashew nut is the act of removing the kernel from the cashew nut. Shelling is perhaps the greatest bottleneck along the processing line. Local shelling is carried out by hand with a hammer or using mortar and pestle. The shelling methods employed by cashew nut processing industries are the use of simple shelling devices, which usually are not efficient in their performances, and in few cases use of complex and expensive shelling machinery, which are usually imported.

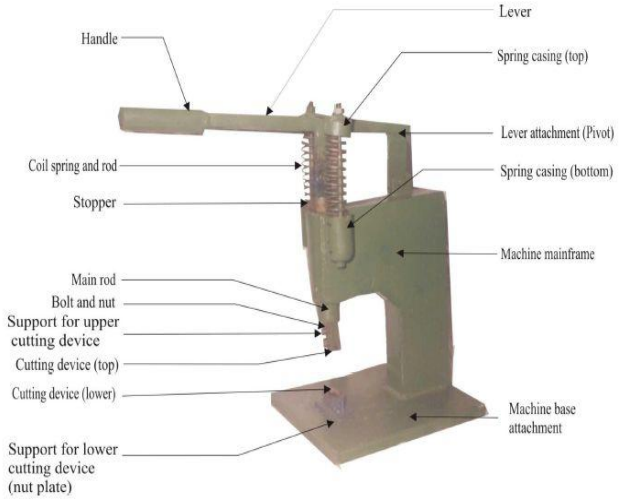
Shelling is the most difficult operation in cashew processing. There are different methods for manual cashew shelling. The most simple consists of placing the prepared nuts on a stone and using a hardwood stick to crack the shell. In the manual processing method, all the steps involved in the processing are undertaken by human labour. Although this is time and energy consuming, the quality of kernels is of high order. In India shelling is mostly done by cheap female labour. Shelling is carried out by using special wooden mallets and pieces of bent wire, at a rate of about 200 nuts per hour. The equipment use by hand and leg to control for shelling raw cashew, for capacity depend of skill of labour. An average sheller can shell 10 nuts per minute or 21 kg/day yielding about 5 kg of kernels. Experienced shellers in India can shell twice as much with 90% whole kernels.

WOMAN WORKING IN THE SHELLING SECTION




**Semi-automatic cashew nut Sheller**

The prime mover is switched on to start the machine and the operator has to place a nut on the bottom holding assembly in between two side support plates and pull the mechanical lever forward. The power is transmitted to the gear box through the front flange and the belt-pulley drive. The cam assembly is rotated by the worm gear to conduct the shelling operation. As the cam rotates, the spring loaded actuating assemblv helps the top shelling assembly to result in the impuls~ action followed by the tensile action to complete shelling of the nut. The next stroke of operation starts again with the placement of another cashew nut in between the side supports. The depth of penetration of the pins through the shelling unit and the holding unit are adjusted as per the size of the cashew nut. For a particular grade of the cashew nut this arrangement can be fixed and can be adjusted when the grade is changed.




Semi-automatic cashew nut sheller

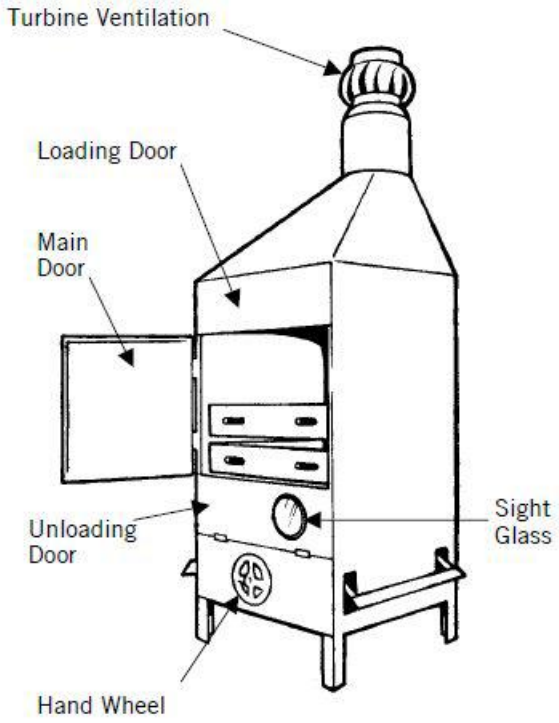
The mainframe and the base are made of mild steel. These provide support to the cracker. The frame is in the form of inverted capital letter L, with minimum height of 300 mm on both sides separated by a gap of 50 mm. Part of the gap houses the cracking system and flat sheets of metals to which the two sides are welded. The cut side is 130 mm in length and 170 mm from the cracker base. The lever-hand is made of mild-steel. It has minimum length of 506 mm and is attached to the cracker mainframe thr ough the pivot with bolt and nut. The hand attachment of the lever is fabricated for easy grip. The cracking assembly is made-up of two return springs for quick return of lever-hand to its original position before actuation. The springs contain two steel rods to prevent severe bending and ease of movement of the lever-hand, the threaded top of the rods contains hexagonal
nuts which are used for height adjustment for upper cutter. The springs contain top and bottom casings. The bottom casings are welded to both sides of the cracker frame for stability. The top casings are welded to the leverhand at minimum distance of 176 mm from the pivot. The lever-hand is joined to the main rod through attachment bolted

together. The cashew nut to be cracked is placed on the nut plate. When the lever-hand is activated downward, the upper cutter descends towards the lower cutter. The upper blade cut through the nut concave side while the lower blade cut through the convex side. The nut is removed by hand protected with hand gloves smeared with palm oil. The movement of the upper cutter is adjusted through the thread nuts latching the spring-rods to the lever-hand. The return springs return the upper cutter to its initial position.

### Drying

The shelled kernel is covered with the testa, the removal of which is facilitated by drying the shelled kernel, to produce the blanched kernel. Drying causes shrinkage of the kernel, thereby allowing the testa to be easily removed either mechanically or by hand with a knife. Drying also protects the kernel from pest and fungal attack at this vulnerable stage. All processors dry the shelled kernels prior to peeling. Sun drying, where the kernels are spread out in the sun in thin layers is possible. It is however heavily reliant on a constant supply of sunshine. Although sun-drying does not pose any risk of scorching the kernels, it may be prolonged under conditions of bad weather, which can lead to mould development. Artificial drying is more reliable and is required in medium or large-scale operations. Drying usually takes six hours, at a temperature of around 70°C.

A uniform temperature throughout the drier is essential to avoid under-drying or scorching. Various drier designs are available. Figure 11 shows a tray dryer, designed by ITDG, for drying cashew kernels. The dryer contains a series of mesh-bottom trays that are slotted into the drying cabinet. The trays would be of a size that can be lifted when full. A lever mechanism automatically moves the trays down when dried trays are removed and when new ones are entered into the cabinet. Hot air circulates over the trays and is exhausted through the chimney. The heat source can either be a gas or electric powered heater. Burning cashew shells or other sources of fuel can also be used to provide a heat source. Drying programmer are generally organized so that the kernels from one day' s shelling go directly into the oven for overnight drying.




Kernels in the dried state are most vulnerable, since they are brittle and break very easily. It is essential that the Kernels are carefully handled in order to minimize damage.

## II. OBJECTIVES

- Design and development of mechanized cashew nut shelling machine with locally available materials.
- The Sheller will be easily maintainable, durable, portable and comfortable in use and competitive in the market.
- Machine fabricated with low prize because of peoples also afford it easily.

## 3. LITERATURE REVIEW

Cashew nut is produced in almost all the continents but cultivated only in some limited countries. The cultivation has been distributed in Asian countries such as all South Indian states in India, Vietnam, Thailand, Indonesia, West and East African countries, and Brazil. The nut is also cultivated in some packets of Sri Lanka, Australia, etc.

Among the countries producing cashew, the Asian countries alone contribute about 65 per cent of global production followed by African countries, which contribute 30 per cent of the total production.

In India there are two main methods of processing. The “steam and cut” process was invented in Mangalore and is known to give whiter kernels and fewer scorched kernels. This has spread with many of the Kerala manufacturers adopting the “steam and cut method”. The traditional

"drum roast" method is still often seen. The roasted nuts are cracked by striking the nut.

The global cashew production during 2012-13 was nearly 2.72 million tons from an area of 5.31 million hectares. It can be seen from the Figure that West Africa ranks first in global production (33.37 per cent) followed by India (27.68 per cent), Vietnam (9.26 per cent), East Africa (7.42 per cent). Brazil, Indonesia and other minor countries contribute rest of the production. The cashew nut has been introduced into India in 16th century in order to prevent soil erosion only. Later the kernels from this nut become a major source of income for most of the people in coastal tropical regions of India.

Though the African countries are producing more cashew nuts, due to their backwardness in processing makes them to export more than 80 per cent of their produce to India and other South-East Asian nations for processing.

During 2012-13 Brazil has experienced poor crop (76054 ton) due to unfavorable climatic condition. And during 2013-14 expected production in Brazil is 138474 tons.

In India, cashew was first introduced in Goa from where it spread to other parts of the country. In the beginning it was mainly used for soil binding to check erosion. Commercial cultivation began in the early 1960s and, over the years, cashew has become a crop of high economy and attained the status of an export-oriented commodity, earning considerable foreign exchange for the country. Now days India is one of the leading producers, processors and exporters of cashews in the world. Research work on cashew was initiated on a relatively small scale in early 1950's resulting in the development of several production techniques. These efforts were further strengthened when the national research mandate was delegated to the Central plantation Crops Research Institute (CPCRI), Kasaragod, in 1970 which spearheaded the All India Coordinated Spices and Cashew improvement Project from 1971. These research activities received further impetus with the implementation of a World Bank aided multi-State Cashew Project in the States of Andhra Pradesh, Kerala, Karnataka and Orissa from 1982-86. A National Research Center for Cashew was established at Puttur to increase the production and productivity of cashew with the mission-mode approach in 1986. At present, India has a processing capacity of nearly seven hundred thousand metric tons and to meet the raw nut demand, the country depends partially on imports from several African, and in recent years, from south-east Asian countries. This has considerable drain on the country's foreign exchange reserves and there is an urgent need to increase local production to substitute imported raw material in order to derive the maximum benefits from a strong processing and marketing capability developed over the years by the Indian cashew industry.

Mechanical shelling methods are difficult to design because of the irregular shape of the nut, hardness of the shell and brittleness of the kernel. In some mechanical processing plants compressed air is used to crack the nuts.

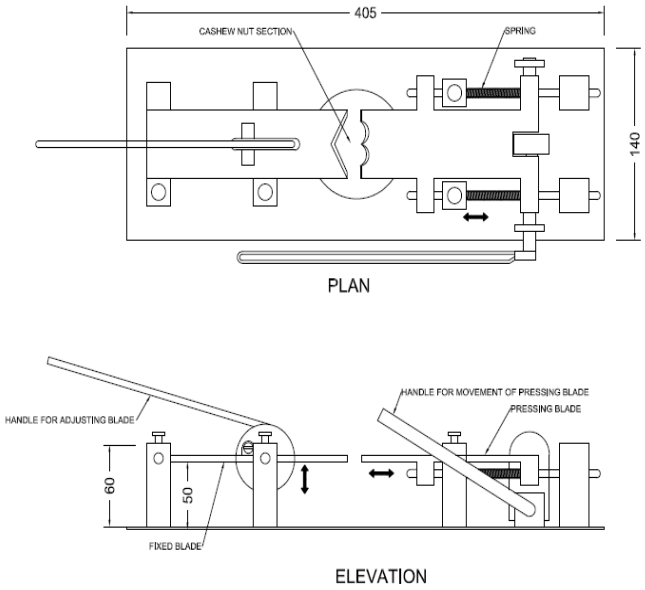
Cashew nut processing becomes cumbersome due to the presence of the highly corrosive material called CNSL. The major constraints in cashew nut processing are….

- Irregular shape of the nut
- Tough leathery nature of the shell with CNSL
- Corrosive nature of CNSL

Cashew industry in India is concentrated in Kollam district of Kerala, Dakshina Kannada district of Karnataka, Panruti area of Tamil Nadu and to some extent in Goa and Maharashtra. The industries at Kollam (Kerala) so far have been concentrating on drum roasting followed by manual shelling. The raw nuts after humidification are also subjected to drum roasting or oil-bath roasting. The roasted nuts are shelled manually. In Karnataka, the processing involves steam roasting, machine cutting. Wherever steam roasting and machine cutting are followed, CNSL extraction either by pressing or by solvent extraction is also followed. In Panruti area of Tamil Nadu, there is a special type of processing. Here, instead of drum roasting and steam roasting, raw nut is dried in the hot sun and subjected to cutting.

Indian cashew industry as on today largely depends on manual labour for cashew nut processing. The processing system followed in Africa and Brazil is mostly mechanical involving more amounts of machineries.

## 4. METHODOLOGY



## 1. GEOMETRY AND PROPERTIES OF CASHEW NUT

Information about properties of the material, which a machine will handle, is very important in any engineering design. If the machine is to perform efficiently for the purpose for which it is designed. In designing a cashew nut shelling machine some physical and mechanical properties of the nut will be measure. The physical properties measured include nut length, width, thickness, density, shell thickness, kernel weight and shell weight. The mechanical properties measured are those having to do with the behavior of material under applied force.

Cashew nut differs in their size (weight, length, breadth and thickness), shape, colour and kernel characters. Broadly raw nuts can be grouped in to three catogories viz. small, medium and large, based on nut weight. Generally nut weight varies from 3 to 15 g. The nut length may vary from 3 to 6 cm where as the nut width varies from 3 to 4 cm. The nut thickness varies from 2.5 to 3.0 cm.

The length, width, thickness and weight of a random sample of cashew nuts of different size groups (small, medium and large) recorded at Cashew Research Station, Kerala Agricultural University, Madakkathara are shown in Table

| Nut size | Length (mm) | Width (mm) | Thickness (mm) | Mean wt. (g) |
|---|---|---|---|---|
| Small | 37.26 | 29.86 | 28.05 | 4.56 |
| Medium | 47.80 | 34.74 | 28.99 | 9.90 |
| Large | 60.01 | 39.65 | 31.05 | 12.80 |

## 2. DESIGN CONSIDERATION OF MACHINE

On the basis of above geometry and properties design of mechanism will created with suitable dimensions.

## 3. SELECTION OF MATERIAL AND MANUFACTURING COMPONENT

With the help of design of mechanism select the suitable material for machine which help to process it properly and manufacturing.

## 4. ASSEMBLY OF COMPONENT

With the help of designing of mechanism the manufactured component will assembled together for making suitable machine for shelling cashew nut.

## 5. MODE OF OPERATION

First roasted cashew nut will pour into manufactured machine. Machine will done its internal process by crushing the shell of cashew nut and the output will displayed with the sheild of cashew nut.

## 6. TESTING OF MACHINE

To compare the efficiency of the machine with the manual method, three different methods of shelling are adopted for the test. These are hand shelling, using a hammer, mortar and piston and shelling using the fabricated Sheller. In each case, thirty roasted cashew nuts will used for the test.

$$Shelling\ rate = Weight\ of\ kernel\ obtained\ per\ unit\ time \quad (kg/hr)$$

$$Shelling\ \ Efficiency = \frac{weight\ of\ cashew\ nut\ shelled}{total\ weight\ of\ cashew\ nut\ used} \quad (\%)$$

$$Whole\ kernel\ recovery = \frac{weight\ of\ whole\ kernel\ obtained}{Total\ weight\ of\ kernel\ obtained} \quad (\%)$$

## 5. Conclusion

The conventional cashew nut process and shelling is more time consuming and with low rate of production. Hence all conventional processes must be mechanized. Shelling of roasted cashew nut is conventionally accomplished by cracking the nut by manual hand beating method to release the edible kernel. The irregular shape of the cashew nut and the brittleness of the kernel inside the hard shell make the shelling process complicated and results in breakage of kernels leading to reduction of market price and acceptability for export. The cashew nut shell liquid (CNSL) present over the drum roasted cashew nut shell surface causes a blistering effect on human skin, and to avoid that ash is mixed with them before shelling. This method is very difficult and time consuming. Also in conventional methods, labour quantity is more and work output is less. Hence there is need of mechanization to save time and improve the quality.

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