CHAPTER I

INTRODUCTION

The majestic, tall growing coconut palm (*Cocos nucifera* L.) is the most widely cultivated tree species in the tropical world. In the tropics perhaps no other crop has so much to offer to mankind than the coconut. Because of the usefulness of each part of the palm and the vast magnitude of people that it supports through ancillary and small scale industries, it is often called the “Tree of Heaven” or “Kalpavriksha”. Coconut provides food, drink and shelter at the community level, copra and coconut oil for local cash and coir products for export earnings.

1.1. Area, Production and Utilization

Coconut is commercially cultivated in 93 countries especially on the small and marginal holdings over an area of 11.8 million hectares and produced about 10.26 million tonnes (copra equivalent) in the year 2002 (Rethinam, 2003). India is the largest single market for coconut, consuming almost the entire production of 12.6 billion nuts. Indonesia is the next largest market for coconut, consuming nearly 11.2 billion nuts accounting for about 74% of its production. India and Indonesia together account for more than 60% of the domestic market. Thailand, Sri Lanka, Malaysia, Vietnam and the Philippines, together with the countries in the Pacific region account for the bulk of the balance 40% of the domestic market for coconut. Coconut production in India increased from 3.4 billion nuts in 1949-50 to 6.0 billion nuts in 1974-75 and further increased to 12.6 billion nuts in 2002. The area under coconut increased from 0.60 million hectares in 1949-50 to 1.11 million hectares in 1974-75 and to 1.75 million hectares in 2002. The four southern states of India, Kerala, Karnataka, Tamil Nadu and Andhra Pradesh account for more than 90% of the country's total coconut cultivated area and production (Rajagopal and Bosco, 2002).
As much as 50.8% of the total coconut area is concentrated in Kerala and the state accounts for 43.63% of the total production. Kerala is a small state along the west coast of India, which accounts for only 1.18% of the total land area of the country. Though India is one of the largest coconut producing countries in the world, the per capita availability is only 10 nuts per annum as compared to 225 in the Philippines, 145 in Sri Lanka and 55 in Indonesia (Arumughan and Dhamodaran, 1993). About 60% of the total production in the country is consumed as fresh nuts and 40% is available for copra production (Satyawati and Mathew, 1985; Thampan, 1981).

1.2. International Trade of Coconut Products

The main industrial use of coconut is still in the production of copra from which coconut oil is derived. One spectacular change observed after 1970 was that many of the Asia Pacific Coconut Community (APCC) member countries started producing their own copra and coconut oil and hence copra export has declined and coconut oil export increased from 1,993,000 tonnes (1960-1990) to 4,036,000 tonnes in 2001, but the percentage share of coconut oil has considerably reduced from 9.58 to 5.99% for the above period (Rethinam, 2003).

Export trade of coconut products in India is practically restricted to coir products, oil cake and desiccated coconut. India has made improvement in exporting 144 million tonnes of copra meal during the year 2001 to 300 million tonnes during the year 2002. This clearly indicates that there is a bright chance for increasing not only the copra trade but also production by modernizing the processing technique (Rethinam, 2003).

Coconut serves as the basic raw material for a series of agro-processing activities and sustains the livelihood of over 10 million people in the country. The main unit operations in copra processing are de-husking, splitting, de-shelling and drying.
1.3. De-Husking

De-husking of coconut is done manually as well as mechanically. In the manual de-husker, the main part is a sharp-pointed shard of steel (a part of the native plow) positioned vertically with the point up and the broader part firmly placed on the ground. The operator impales the coconut on the sharp point with a strong determined downward movement. A few impaling strokes loosen the husk, making it come off (usually) in one piece. Impaling requires accuracy and nerve. Attempts are being made to develop manually as well as power operated de-huskers world over, to overcome the risks involved in the process.

1.4. Nut Splitting

After coconut is de-husked, the hard but brittle shell is exposed and can be split open into two halves using a machete. The nut water is drained off leaving the cups ready for drying. In India, coconut is broken transversely into two cups using a traditional knife having a long handle and a sharp edge. This operation is carried out in the bending posture, which is a tedious and tiresome work. In other countries, the coconut is split open into halves using a machete (Punchihewa el al, 2001). Some farmers split nuts using a heavy machete even without de-husking. After splitting the nut water is allowed to drain off. This is a labour intensive, semi-skilled job and time consuming. Hammonds (1991) reported that each coconut was broken into halves by a sharp blow with a file along the less sharply curved portion of the equatorial circumference. Sankat_ (1990) reported that whole de-husked nuts are usually split into halves using a wooden mallet and dried with kernel, in the Caribbean Island. Friend (1991) reported that in the Solomon Islands nut splitting is performed with an axe and copra is scooped out with a knife. There are reports of severe hand injury in case the knife slips. Attempt to develop an improved device for splitting coconut has not been reported so far. The water of matured nut is wasted as there are no gadgets to collect the same hygienically during the splitting operation. Thus there is a
pertinent need to develop a coconut splitting device for the benefit of small and large scale processing units and Co-Operative Societies engaged in copra processing.

1.5. De-Shelling

After partial drying of split coconuts when the moisture content of copra comes down to about 25-30 % (w.b.), the shell and copra are separated using a traditional wooden knife. Individual cups are taken in hand and the kernel scooped out. Some farmers split the whole nut into halves with meat still attached to the shell and the shell to the husk; the half nuts are dried under direct sunlight. During the drying process, the meat gets partially detached or is scooped out from the shell with a scooping knife. The cups of meat are then further dried into copra. Even in large processing units, de-shelling is done manually employing 15-20 labourers for deshelling 20,000 to 30,000 nuts. This is also a labour intensive operation and takes several hours to separate shell and copra. However, no attempt has been made so far to develop a mechanical de-shelling machine.

1.6. Copra Drying

Drying is a widely adopted technique in food preservation. It is a simultaneous heat and mass transfer operation in which moisture is carried away by hot air (Sogi et al, 2003). Traditional method of copra drying is to dry it in sunlight. About seven days are needed to reduce the moisture content of coconut to about 6 % w.b. from the initial 45-55 % w.b. (Purseglov, 1977; Thampan, 1981; Patil., 1983; Kochhar, 1986; Annamalai et al, 1989; Sankat et al., 1990; Persely, 1992; Lozada et al., 1995; Guarte et al., 1996; Singh el al, 1999; Madhavan et al, 2003). During rainy season, when sun drying is not possible, drying by artificial method is the only viable solution for processing the produce (Patil, 1984 a ; Annamalai et al, 1989). The direct type kiln dryers are not desirable as the product become inferior in quality due to smoking and improper drying (Grimwood, 1975). Copra which has been smoke dried using coconut husk or fire wood is often highly contaminated with high polycyclic aromatic hydrocarbon (PAH) than that dried using coconut shell. Some of the
PAH are carcinogenic and pass onto edible oils during extraction (Wijeratne et al, 1996). Hence, copra produced is relatively of poor quality, principally caused by improper drying techniques. The common quality defects are high free fatty acid (FFA) content, extensive fungal contamination, notably *Asperillus sjip*. which may produce carcinogenic aflatoxins, high PAH content particularly in directly smoke dried copra (Drew, 1993).

Aflatoxins are produced due to inadequate or lengthy drying (Nagler, 1991). Coconut oil and copra cake thus produced may contain unacceptably high levels of aflatoxin (Conning and Lansdown, 1983; Samarajeewa and Arsecuieratne, 1983). Smoke contamination can be avoided by using heat exchangers to heat the drying air indirectly (Areuleratne, et al 1976). Extraction of coconut oil by converting the coconut into copra continues to be the most economic and efficient method in spite of several disadvantages (Samarjeeva, 1993). Many types of dryers have been developed to dry coconut (Patil, 1985; Annamalai et al, 1989; Sreenarayanan et al, 1989; Hammonds, 1991; Lozada, 1995; Sudaria, 1996 and Singh, et al, 1999). Reports on optimization of drying parameters are not available in literature. It is also reported that most of the small holders resort to direct drying which causes smoke contamination. Thus, there is a need to develop a small dryer for the farmers which can be left operating by itself for 5 - 6 h and provides even temperature distribution for uniform drying and produces copra which is smoke free. The drying models being used to describe convective drying of grains have not been applied to model copra drying.

1.7. **Engineering Properties**

The analysis of basic engineering properties of plant material is important in the development of new equipment for processing and control conditions of crop storage (Joshua, 2000). According to Mohsenin (1970) knowledge on physical and mechanical properties constitutes important and essential engineering data in the design of machines, storage structures, process and controls. The bulk density and porosity are the main
considerations in designing near ambient drying and aeration systems as these properties affect the resistance to air flow of the stored mass (Bern et al., 1975). The frictional properties are important for proper design of agricultural product handling equipment (Kaleemullah, 2002). The shape of the material is important for an analytical prediction of its drying behavior (Dutta et al., 1988).

It seems that there are only few published literature related to physical, mechanical and thermal properties of coconut and sorption isotherms of copra.

Further, it is important that the practices adopted and constraints experienced by the cultivators and processing units pertaining to the splitting, de-shelling and copra production are analyzed so that efforts could be made for developing or improving appropriate gadgets to reduce the requirements for skilled labour and to reduce the drudgeries involved in these operations.

1.8. Objectives

Keeping the above facts in view, the present study entitled “Studies on improving engineering aspects of copra processing and optimization of drying parameters in Kerala” was undertaken with the following specific objectives.

- To analyze the practices adopted and constraints experienced by the farmers and processing units in splitting, de-shelling and drying of coconut in Kerala region.
- To study physical, thermal and mechanical properties of coconut and sorption isotherms of copra.
- To develop and test appropriate engineering gadgets for splitting and de-shelling of coconut.
- To study drying characteristics of coconut in thin-layer and deep-bed, optimize drying air parameters and to evaluate the suitability of some of the existing drying models.
- To develop a copra dryer and evaluate its performance.