

CHAPTER

5

CRUDE PALM OIL EXTRACTION BY SUBCRITICAL WATER

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5.1 INTRODUCTION

In Malaysia, the cultivation of palm oil began in 1875 when it was first introduced as an ornamental plant in the Botanical Gardens of Singapore. The notion of commercial palm oil plantations emerged in the early 1900s in Southeast Asia, eventually expanding to Indonesia and Malaysia in 1915 and 1917, respectively. The inaugural Malaysian commercial oil palm plantation was established at Tennamaran Estate in Selangor by Henri Fauconnier. This endeavour is aimed to replace an unsuccessful coffee plantation. Its development in Malaysia can be delineated into distinct phases as illustrated in Figure 5.1.

During its early development, the palm oil industry faces significant challenges, particularly during World War II in 1941 and the communist insurgency that persists until the late 1950s. By 1960, the total planted area for oil palm stood at just 0.054 million hectares. The subsequent introduction of an organized palm oil production system in Malaysia revitalizes the industry. At that time, the majority of crude palm oil (CPO) is exported to Europe and the United States. This progress is supported by agricultural diversification initiatives,

leading to the establishment of key statutory bodies such as the Federal Land Development Authority (FELDA), the Federal Land Consolidation and Rehabilitation Authority (FELCRA) and other government agencies.

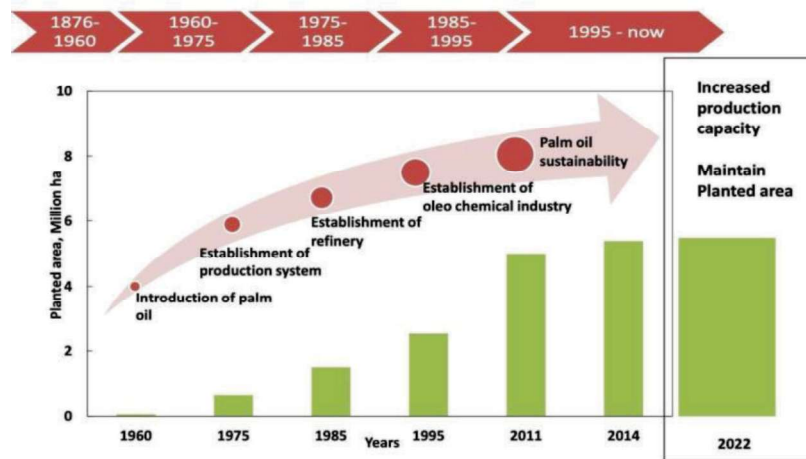


Figure 5.1 Palm oil development in Malaysia

Currently, the industry is progressing into a new phase, with a strong focus on sustainability and efficiency enhancement, while reducing environmental impact. Several initiatives have been implemented, including genetic engineering to develop high-yielding seed varieties, strategies to maximize soil fertility, minimize oil losses during milling, utilize palm oil waste and biomass for renewable energy, integrate palm oil mill operations and other process improvements. In its drive towards sustainability, the industry has emphasized on production efficiency, improved process yields and enhanced plantation management practices.

Notably, in 2022, the planted area for oil palm is approximately 5,674,742 hectares, producing around 18,453,420 tons of crude palm oil (CPO). This represents an increase in output compared to 2021, when 5,737,731 hectares yield 18,116,354 tons of CPO (Malaysia Palm Oil Board (MPOB), 2022). Despite a reduction in planted area by 62,989 hectares, or 1.1% between 2021 and 2022, the CPO production is increased by 1.8%, highlighting the improvements in productivity and yield efficiency.

5.2 PALM OIL MILL

The palm oil processing begins with the extraction of CPO at the palm oil mill, which holds significant potential for process improvement. It continues at the palm oil refinery, where the CPO is refined, bleached, and deodorised (RBD). The RBD palm oil is then fractionated into palm olein and palm stearin. These fractions undergo further processing for the production of specialty fats, oleochemicals and biodiesel.

The palm oil milling process can be divided into five main stages: Fresh fruit bunch (FFB) pre-treatment, CPO extraction, CPO post-treatment, fibre separation, and palm kernel treatment. After harvesting, FFB is transported to the mill raised ramp within 24 hours to ensure high-quality CPO production. The FFB is then transferred into the sterilizer using fruit cages for the pre-treatment process. This involves exposure to saturated steam at a pressure of 3 kg/cm² and a temperature of 130–140°C for 75 minutes to 90 minutes. The sterilization is to deactivate endogenous lipases and microorganisms, thus preventing microbial and enzymatic hydrolysis. It also helps to loosen and soften the fruits to facilitate the stripping process and precondition the nuts to minimize breakage during pressing.

Modern mills generally use horizontal sterilizers operated in either batch or continuous flow, replacing the older vertical designs. After sterilization, the fruits are transferred to the stripper or thresher, where the fruits are separated from the bunches. The stripper is typically a rotating horizontal drum operating at around 22 rpm, with spacing between bars that allows the fruitlets to pass through while retaining the bunch.

Following stripping, the fruits are then moved to the digester, a vertical cylinder equipped with beater arms that pulverize and disrupt the mesocarp, with additional heating via direct steam injection or heating jacket. The digested mash is then transferred to the CPO extraction stage, the core of mill operations. This stage determines the CPO yield and overall productivity.

Several extraction methods have been developed for palm oil milling, including centrifugation, hydraulic pressing and screw pressing.