Palm oil factory process handbook pdf

Palm oil production process. Palm oil pressing process. Palm oil processing steps. Palm oil manufacturing process. Palm oil process.

The evolution of oil palm processing involved significant research and development across various disciplines, leading to the creation of efficient processing steps for extracting high-quality oil from harvested bunches. The process begins with receiving fresh fruit bunches, followed by sterilizing and threshing to extract the palm fruit, which is then mashed and pressed to produce crude palm oil. The crude oil undergoes purification and drying before storage and export. Large-scale plants can handle significant quantities of fruit bunches per hour, typically ranging from 3 to 60 tonnes. These installations feature advanced mechanical systems, boilers that generate superheated steam, and turbines for electricity generation. Automated controls ensure smooth operation, while process control laboratories monitor the quality of the oil. The refinement process involves removing impurities and oxidation products, followed by separation into liquid and solid phases through thermo-mechanical means. The resulting refined oil is widely used as a cooking oil in tropical climates, competing with other expensive alternatives. Oil extraction from palm kernels is often carried out separately, using equipment such as oilseed expellers or petroleum-derived solvents. Small-scale village processing has also persisted in Africa, although efforts to mechanize traditional manual procedures have been limited and piecemeal. The process of extracting and refining palm oil involves several stages, including harvesting and handling techniques that can impact the quality of the final product. The oil content in palm fruits increases rapidly as they approach maturity, but this also makes them more susceptible to damage during handling. Harvesting typically involves cutting the bunch from the tree and allowing it to fall to the ground by gravity, which can cause bruising of the fruit. Further opportunities for damage occur during loading and unloading of bunches into transport containers, where the fruit may be bruised or exposed to rough handling. In many African countries, palm oil processors have developed small mechanical digesters that are scaled-down versions of large-scale units used in other parts of the world. These units vary in terms of mechanization and materials transfer mechanisms, affecting process quality control and product efficiency. The general flow diagram for palm oil processing involves several stages, including harvesting technique and handling effects. The free fatty acid (FFA) content in fresh ripe fruit is below 0.3%, but can increase to 60% within an hour if the fruit is bruised. Research suggests that early processing of fruit after harvest may not be ideal, as the increased FFA content adds a "bite" to the oil flavor and has laxative effects at worst. Connoisseurs of good edible palm oil consume the crude oil directly, but high FFA content poses a problem for oil refiners due to neutralization issues. The technical terms referred to in earlier diagrams will be described later. Overall, careful handling of palm fruits during harvesting, transportation, and processing is crucial to achieve optimal quality control and product efficiency. Fresh fruit bunches arriving at processing sites are first checked for quality and then emptied into wooden boxes suitable for weighing on a scale to monitor quantities. Large installations use weighbridges to measure materials in trucks, while small-scale processors may have limited control over factors affecting palm oil quality such as genetic predisposition, tree age, agronomy, environment, harvesting technique, handling, and transport. Threshing is the process of removing fruit from bunches. Manual threshing involves cutting spikelets with an axe or machete and then separating fruit from spikelets by hand, often performed by children and elderly villagers for income. Mechanized systems use rotating drums or fixed drums equipped with beater bars to detach fruit from bunches. For small-scale operations, fruits are cooked in water after threshing, while high-pressure steam is more effective for larger mills that can generate steam for sterilization. Small-scale operators often use bunch waste as cooking fuel, whereas larger mills incinerate the waste and return the ash as a rich source of potassium fertilizer to the plantation. Sterilization or cooking involves using high-temperature wet heat treatment of loose fruit, typically with hot water but pressurized steam in large-scale installations. This process serves several purposes: destroying enzymes that split oil, arresting hydrolysis and autoxidation, weakening fruit stems for easy removal during threshing, solidifying proteins to facilitate oil release, disrupting pulp structure to detach fibrous material, and breaking down gums and resins that cause oil foaming. When palm fruits are processed, hydrolyzed compounds within them must first be removed through sterilization. This process involves high-pressure steam that causes moisture in the nuts to expand and contract when pressure is reduced, loosening kernels from shells and making them easier to crack later on. Sterilization is crucial for oil processing, as it sets the stage for other operations. However, it's essential to ensure proper evacuation of air from the sterilizer to prevent oxidation risks and over-sterilization that can reduce bleach ability and protein value. Digestion follows sterilization, releasing palm oil by rupturing or breaking down oil-bearing cells. This process uses a steam-heated digester with rotating arms that pound the fruit, reducing viscosity, destroying the outer covering, and disrupting oil cells. However, small-scale digesters may not have proper heat insulation or steam injections, increasing the risk of contamination and oxidation. There are two main methods for extracting palm oil: mechanical presses ('dry' method) and hot water leaching ('wet' method). The 'dry' method involves applying mechanical pressure to a mixture of oil, moisture, fibre, and nuts to squeeze out the oil. Batch and continuous presses exist, with differences in plunger movement, pressure levels, and cage size. Different designs use either a screw thread (spindle press) or hydraulic system (hydraulic press) to move the plunger. Hydraulic systems can reach higher pressures but require careful handling of the fluid to avoid contamination. Screw threads, on the other hand, are easier and cheaper to maintain as they wear out slower than their surrounding nuts. The size of the cage varies widely from 5 kg to 30 kg with an average size of 15 kg. Pressures should be increased gradually to allow time for oil escape. To prevent trapped oil, heavy plates can be inserted into the raw material. Production rates depend on cage size and time needed to fill, press, and empty each batch. Hydraulic presses are faster than spindle screw types, and powered presses outperform manual ones. Some manual presses require significant effort but do not alleviate drudgery. Continuous systems have replaced early centrifuges and hydraulic presses with specially designed screw-presses for other oilseeds. These consist of a cylindrical perforated cage and a closely fitting screw that conveys digested fruit towards an outlet, creating pressure to expel oil through the cage perforations. Screw presses can effectively break open unopened oil cells and release more oil due to turbulence and kneading action on the fruit mass in the press cage. However, moderate metal wear occurs during pressing, potentially introducing iron contamination. High pressures have been reported to affect the bleach ability and oxidative conservation of extracted oil negatively. Clarification aims to separate oil from its entrained impurities by adding hot water to the press output mixture in a ratio of 3:1, creating a barrier that causes heavy solids to fall while lighter oil droplets rise to the top. The diluted mixture is then boiled and allowed to settle for gravity separation, resulting in clear palm oil rising to the top. The clarified oil from the decantation process still contains some moisture and impurities that can lead to an increase in free fatty acid (FFA). To prevent this, the moisture content must be reduced to between 0.15% and 0.25%. This can be achieved by re-heating the oil and skimming off any remaining impurities. In larger-scale operations, continuous clarifiers are used to treat the crude mixture and remove excess moisture. The wastewater from the clarification process is then drained into nearby pits for disposal. No further treatment of the sludge is performed at small mills, but it can be collected in buckets and used to kill weeds around the processing area. Large-scale mills store their purified oil in tanks at a temperature of around 50°C to prevent oxidation and solidification. Small-scale operations, on the other hand, pack their dried oil into drums and store them at ambient temperature. The residue from the pressing process consists of fibre and palm nuts. In small-scale operations, these are separated by hand, with the fibre being pressed to recover a second-grade oil used in soap-making. The nuts are then dried and sold to other operators who process them into palm kernel oil. In large-scale mills, the recovered fibre and nutshells are used as fuel for steam boilers, generating electricity for the mill. This makes it economically viable to recover these materials. The process of crude palm oil extraction involves several steps: fermentation, bunch chopping, sorting, boiling, digestion, pressing, purification, fibre-nut separation, second pressing, and nut drying. These operations loosen fruit base from spikelets, facilitate manual removal of fruit, remove and sort fruit from spikelets, sterilize the mixture, coagulate protein, and expose microscopic oil cells. Proper equipment design is essential for small-scale oil extraction, taking into account the quality required for different markets. The edible oil refining industry prioritizes low free fatty acid content, minimal oxidation products, and easily removable colour. In contrast, domestic consumers value flavour, with fermentation enhancing taste after three or more days of rest. Herbs and spices are added during oil-drying to mask off-flavours. The presence of free fatty acids and tocopherols in crude palm oil has a laxative effect, which is desirable for African consumers who prefer the 'bite' it imparts. This quality requirement may conflict with those of other markets, where rigid process control during oil clarification is not necessary. The traditional manual methods are referred to as "low technology" production, while mechanised units are considered "intermediate technology". The village traditional method involves washing pounded fruit mash in warm water and hand squeezing to separate fibre and nuts from the mixture. The process of extracting palm oil involves several steps, including filtering out fibre and nuts using a colander or vessel with fine perforated holes. A wet mixture is then brought to a boil before being cooled and having herbs added if desired. Palm oil can be skimmed off the mixture once it has reached blood temperature. In contrast, the dry method uses a digester to pound boiled fruit, which can be labor-saving and reduces waste by allowing fibre and nut shells to be used as boiler fuel. The wet method involves using a vertical digester with a perforated bottom plate to discharge aqueous phase components, while the dry method uses a press to separate oil from digested or pounded pulp. Motorized mechanical presses are preferred in large-scale operations due to efficiency and reduced environmental impact. Recent developments have focused on integrated machines that combine several process operations into one assembly, such as digestion, pressing, and fibre/nut separation. These machines fit into two key process groupings: batch systems and semi-continuous processes. Batch systems work directly on successive loads of boiled fruit to extract oil in one operation for clarification. The wet method uses a vertical digester with a perforated bottom plate to pound a batch of fruit and then flush out the oil and non-oil solids from the mashed pulp with hot water. Flushing pulp involves diluting viscous oil from mechanical presses, which is essential for clarification. However, inexperienced operators may use excessive hot water, wasting wood fuel and reducing yields. When using cold water, the 'wet' method's efficiency decreases, causing an increased tendency to form oil/water emulsions that are difficult to separate from fibre mass. This can lead to significant oil loss if proper care is not taken during digestion. Vertical flushing digesters require batch operations due to their specific loading and discharging requirements. In contrast, continuous systems work sequentially, with careful engineering necessary to minimize discontinuities in material flow. Semi-continuous systems have distinct stages, which are fed into each other based on arrangement and timing of machine operations. Dry extraction systems often employ semi-continuous operations, especially when digestion and pressing stations are combined or operate separately. The efficiency of various presses can vary significantly, ranging from 60 to 87 percent for different types of presses. The quality of oil extracted also differs, with the first press typically yielding a higher percentage of oil than subsequent presses. The estimation of processing unit size and type for a Village Group's oil palm program involves several factors, including raw material availability, machine costs, and processing techniques. The plant is expected to operate two shifts during peak season. According to projections, the estimated annual yield per hectare increases steadily from year one to ten, with yields ranging from 3 tons to 20 tons. The table also shows that the total FFB (fresh fruit bunches) yields after planting and related plant capacity will increase significantly over time. The analysis suggests that the community would require a fully mechanized mill using motorized digesters and presses by year five. However, large-scale operations are not suitable for rural Africa due to the lack of skilled labor and social infrastructure. The establishment of large-scale operations requires importing labor from other parts of the country, which can lead to resentment among local communities. Instead, decentralized small-scale processing operations seem more viable. These operations require less capital investment, as they can be set up alongside existing facilities or in another village to minimize bunch transportation costs. However, the cost structure of these establishments has made their output products non-competitive on the international market. In summary, the text highlights the challenges and limitations of establishing large-scale oil palm processing operations in rural Africa, while small-scale decentralized operations seem more feasible due to logistical and social considerations. The cost of machinery plays a significant role in determining the efficiency of palm oil processing units in Africa. A larger budget allows for more equipment to be purchased, reducing the workload and increasing productivity. Various options are available, ranging from manual spindle-presses to motorised vertical wet process digesters and combination horizontal digester and screw-press systems. However, capital investment costs can vary widely, from $5,000 to $15,000 or more per unit. Mechanising drudgery-alleviation tasks in small-scale fruit processing can increase efficiency while reducing costs. By outsourcing less strenuous tasks, such as fruit separation and fibre/nut separation, to elderly women and unemployed youth, communities can benefit from increased accessibility and reduced post-harvest losses. Traditional technologies rely on women's decisions regarding processing and trade forms, which inform innovation efforts. To alleviate female processors' drudgery, machinery should be developed that is easily operable by them, while maintaining some labour-intensive operations to ensure employment opportunities. Considering prime mover power, diesel engines are a primary source of energy in rural areas, making mechanisation a cost-effective option. However, reliance on diesel power limits the number of unit operations that can be mechanised and powered, necessitating alternative solutions such as electricity generation or mechanical systems like pulleys and gears.