Patent Landscape Report: Palm Oil Production and Waste Treatment Technologies

In cooperation with the Intellectual Property Corporation of Malaysia (MyIPO) and the Malaysian Palm Oil Board (MPOB)

Patent Landscapes

2016

INTELLECTUAL PROPERTY CORPORATION OF MALAYSIA

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WORLD INTELLECTUAL PROPERTY ORGANIZATION

PATENT LANDSCAPE REPORT ON PALM OIL PRODUCTION AND WASTE TREATMENT TECHNOLOGIES

Authorship and Acknowledgements

The present report was prepared by Dr. Haopeng Wang, Dr. Anthony Coleman, Kapil Dhall (visual design) and Mahender Singh (visual design) from Landon IP (CPA Global), at the request and in cooperation with the Malaysian Intellectual Property Corporation (MyIPO) and the Malaysian Palm Oil Board (MPOB), under the coordination and with inputs of Irene Kitsara (WIPO). We would like to thank the Malaysian Intellectual Property Corporation (MyIPO), in particular Mr. M. Amran Abas (MyIPO) for the provision of Malaysian national patent data and the constructive inputs, as well as the Malaysian Palm Oil Board (MPOB), in particular Ms. Zarina Binti Ridzwan (MPOB) for their useful feedback.

Online resources

The database with the patent families the present report was based on is available at www.wipo.int/patentscope/en/programs/patent_landscapes.

Conditions of use

2016

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Extended Executive Summary

Palm oil is the most produced edible plant oil in the world and the demand is rapidly growing. Palm oil industry is an essential part of Malaysia's economy and plays an important role also for other economies in South-East Asia, Latin America, and Africa. As the growth of the industry has imposed tremendous pressure on ecological systems and environment, a more sustainable growth and use of oil palms are highly in demand. Understanding the state of the art of technologies in this field is essential in the effort of making policies, conducting research and development and establishing collaborations. The present Patent Landscape Report is intended to raise awareness on the added value of patent information, and to promote the use of patent analytics as a tool for business intelligence and strategic planning of development and investment in research. This report was prepared at the request of and in collaboration with the Intellectual Property Organization of Malaysia (MyIPO) and the Malaysian Palm Oil Board (MPOB). This report also serves, in the context of WIPO's patent landscape activities, to promote patent analytics and the advanced exploitation of patent information in developing countries, as palm oil plays an important role for other economies in South-East Asia, Latin America and Africa.

In this report, we have investigated the patenting activity related to technologies in the following areas:

A) Production of palm oil and palm kernel oil, i.e. growing and harvesting the fruit, processing of the fruit, extraction, and refining of the oils, etc.; and

B) Treatment of waste from palm oil production, extraction of phytonutrients, utilization of palm bio-mass and/or by-products generated by the palm oil for food and beverage, cosmetics, biofuel, and other industrial areas.

The patent search in this study was performed in English, using a global patent search tool, Questel Orbit. The search strategy was shared with MyIPO and followed to recover patent applications filed in Malaysia, as national patent data from Malaysia are not included in the used patent database. This patent search following the same patent search strategy was intended to make the global search comprehensive, and the search results comparable. The patents were organized based on simple patent families.[1] During the project we searched more than 8,600 simple patent families, among which 2,370 were determined as relevant. The relevant patent families were first separated into two major categories: 1) Palm Oil Production; and 2) Waste Treatment and Exploitation. Under each major category patent families were further categorized into subcategories, based on the technology disclosed in the patent documents. For Palm Oil Production, the subcategories followed the entire palm oil production steps, while for Waste Treatment they covered all relevant waste materials and their utilization approaches.

The 2,370 simple patent families include in total 5,711 individual patent applications. 68% of patent families in this study contain only domestic filings from only one country, without any international (PCT) or foreign filings. This indicates most patent filings in this study focus primarily on local jurisdictions/countries, not seeking broader protection in foreign countries.

Most of the large patent families (with 10+ member applications) were relevant to advanced palm tree seed technology, primarily led by US and European agrochemical and agricultural biotechnology corporations (e.g. BASF, Monsanto). It is worth noting that their patents normally covered a broad variety of oil-producing plants, including oil palm as specified in patent claims.

The history of the patent filing showed activities increasing consistently from late 1990s, from about 50 applications per year to more than 300 applications per year in recent years. The global economic recession occurred in 2008 did not have a big impact on patenting activities in palm oil production field. Number of patent families relevant to Waste Treatment and Exploitation category surpassed those to Palm Oil Production by a big margin in recent years. However, the applicants filing applications in the Waste Treatment and Exploitation category filed primarily applications in their domestic jurisdictions, without seeking broader geographical patent protection.

The overall grant rate in Palm Oil Production category is 55%, significantly higher than that in Waste Treatment and Exploitation category (30%). The low grant rate in Waste Treatment and Exploitation category could be attributed to the following two reasons, 1) a large number of recent filings that are still being examined or awaiting examination; and 2) increasing difficulties in getting patent grants due to lack of novelty.

Applicants in Palm Oil Production category filed more PCT applications than those in Waste Treatment and Exploitation Category. Significant PCT filings in Waste Treatment and Exploitation category started after 2006, much later than that in Palm Oil Production category, and the overall percentage is much smaller. This again proved that the applicants filing in Waste Treatment and Exploitation category focused primarily on domestic market.

In Palm Oil Production category United States, Malaysia, and China are the leading three (3) jurisdictions where inventions are originated, judged from Office of First Filing (OFF), applicant nationality and inventor nationality. Patenting activities in the US peaked in mid 2000s but has stayed at a lower and steady level recently. Patenting activities in Malaysia has increased steadily since 2005. China saw the most dramatic increase after 2010, from a few filings per year to more than 30 per year. United Kingdom is ranked the fourth in the filing activities, but the activity has been very low recently.

In Waste Treatment and Exploitation category the leading countries are China, Japan, Malaysia, and Korea. There is quite a long history in patent filings in Japan while the activities appeared to be peaked in mid 1990s. While all four countries are gaining momentum recently, China surpassed the other three (3) by a large margin after 2010.

PCT filings were the preferred approach as extensions after first filing. MPOB filed in a broad range of foreign countries, with WIPO (PCT) and US as the two (2) most important offices, but also heavily in other key palm oil production countries, such as Indonesia and Colombia. Other Malaysian applicants also filed WO and US significantly. Most US and European applicants have a broad coverage of Office of Second Filing (OSF), although they rarely filed in Malaysia, Indonesia, and Colombia. Chinese applicants rarely filed in any of the above OSFs.

Among all the applicants MPOB has the most versatile profile. MPOB has patents filed heavily in advanced seeds, fruit growing and harvesting, pressing, and refining. The other applicants tend to focus only on one category. For example, BASF, Agrinomics, and Monsanto focus primarily on advanced seeds. They were active in 2000s, but their activities are very low now. CATAS became very active after 2010. Its patents also covered multiple categories, but they focus on tree seeding and cultivating. Not surprisingly, the leading applicants in oil refining are major food oil makers, such as Fuji Oil, Nisshin Oil, and Nestlé.

Many of the applicants in Waste Treatment and Exploitation category showed patenting activities only in a year or two. Malaysian applicants, such as MPOB and Universiti Putra Malaysia, have been active for the past ten (10) years. The most investigated category of MPOB is the extraction of phytonutrients. CSIR of India also has a long history in this field. Many Chinese applicants filed heavily in making mattresses and cushions using palm fibers. MYWOOD 2 (Japan) focuses on making composite wood materials by palm tree trunk. Obtaining fermentation products, such as sugar and alcohols, are the important technology of Du Pont, Arter and Universiti Putra Malaysia.

Significant collaborations among applicants were observed in this study. Most collaborations involved private entities. MPOB led collaborations with many public and private entities.

Patenting activities in Malaysia were particularly analyzed, with an objective to compare the local with the global trends. Similar to the global trend, there was a dramatic increase in filing activity in the recent years. However, a more balanced technology distribution between Palm Oil Production and Waste Exploitation was noticed. This demonstrates that Malaysia has developed significant experience in the entire value chain of palm oil production. Malaysian patent filings were predominantly from domestic applicants. Foreign applicants were not actively filing in Malaysia.

In recent patent filings (2010-2015), the most active areas of technology related to Palm Oil Production were Advanced Seed, Tree Seedling and Cultivation, Fruit Growing and Harvesting, Pressing and Refining. For Waste Treatment and Exploitation, the recent trends are Mattress/Cushion, Composite Material, Adsorbent, Filter and Biomass Fermentation.

The patenting activity related to advanced seeds has been high since the early 2000s. More than 80% of the patent families in the search results are related to genetic engineering methods to improve certain traits. Improving oil content of these transgenic plants is an important goal addressed by these patent applications. BASF, as the most active applicant, has 85% of its patent portfolio in this category, making BASF the absolute leader here. However, BASF patents usually cover a large variety of oil producing plants, without a specific or exclusive mention to palm oil. MPOB is also very active in this field, while its patent applications are always specific to palm oil. Seed selection or diagnostic technologies also heavily rely on genetic information. Here, patented inventions are more specific to oil palm, for example, WO201389557 to Sime Darby, titled “Methods for obtaining high-yielding oil palm plants”.

The patenting activity related to palm oil refining has span more than 40 years and is still very active now. The recent filings have been led by MPOB and international food/oil manufacturers.

The technology is driven by the growing demand for high quality oil, free of contaminants. With current consumer preference for low saturated fat products, fractionation of palm oil to obtain high oleic oil is very often disclosed.

Chinese applicants have led the recent filing activities in palm tree seeding and cultivating. China CATAS became very active after 2010. The recent initiation of research is driven by a huge edible oil market in China which imported about 6 million tons of palm oil annually from Southeast Asian countries. Although there are no commercial oil palm plantations available in China due to failure in trial planting of oil palm introduced from abroad, it was reported that some accessions of oil palm collected by CATAS-RRI seemed promising in yielding fresh fruit bunches, and are now on trial planting for regional adaptability.

While almost all major waste materials from palm oil production have been disclosed in patent documents, some of them have attracted much more research interest than others. Palm fibers have not surprisingly found the most applications, such as in mattresses, brushes, polymer composites, and filters.

The study of the lignocellulosic biomass which is produced from the oil palm industries is also very active. Obtaining fermentation products, such as sugar and ethanol showed promising opportunities. US and European biotech companies are leading in this field, based on the patent data. Extracting phytonutrients from biomass waste, for example antioxidants, is a key technical strength of MPOB.

POME is the primary liquid waste from palm oil mills. Due to its large quantity, its decomposition is very challenging. Both anaerobic and aerobic methods have been disclosed in patent prior art, but the high concentration of suspended solids reduces their effectiveness and leads to higher operating cost. More effective palm oil extraction methods to significantly reduce the amount of POME discharged will be a feasible alternative.

It should be noted that the data coverage in this study for some important palm-oil producing countries, such as Indonesia, Philippines, Latin American and African countries might not be sufficient for reliable patenting activity analysis. Among the limited available patent collection, Thai applicants are very active. Filings in Latin American countries are high, but predominantly come from foreign applicants, such as BASF and Monsanto. MPOB is also an important applicant filing in Thailand, Brazil and Colombia. Very few patents were originated from African countries. Searches using other search terms in other, native languages, such as French and/or Arabic, could reveal further information in relation to this geographic region.

As the executive summary only provides highlights of the report findings, it is recommended to read the full report for detailed and interesting facts, technology features and detailed findings.

1. Introduction

Palm oil and palm kernel oil are edible plant oils derived from the fruits of palm trees. Palm oil is extracted from the pulp of the fruit of oil palm; palm kernel oil is derived from the kernel seed of the oil palm. Palm oil has been used in food preparation for over 5,000 years and is the most widely produced edible vegetable oil in the world. According to United States Department of Agriculture (USDA), the annual production of palm oil reached 61.5 million metric tons (MMT) in 2014, surpassing that of soybean oil (48.6 MMT), and has experienced an average annual growth rate of 6% (Figure 1).[2] Indonesia (33 MMT) and Malaysia (19.8 MMT) account for 85 percent of global production of palm oil. In the meantime, global palm oil market demand was 74.01 MMT in 2014, and is expected to reach 128.20 million tons by 2022, growing at a CAGR (Compound Annual Growth Rate) of 7.3% from 2014 to 2022, according to Grand View Research.[3]

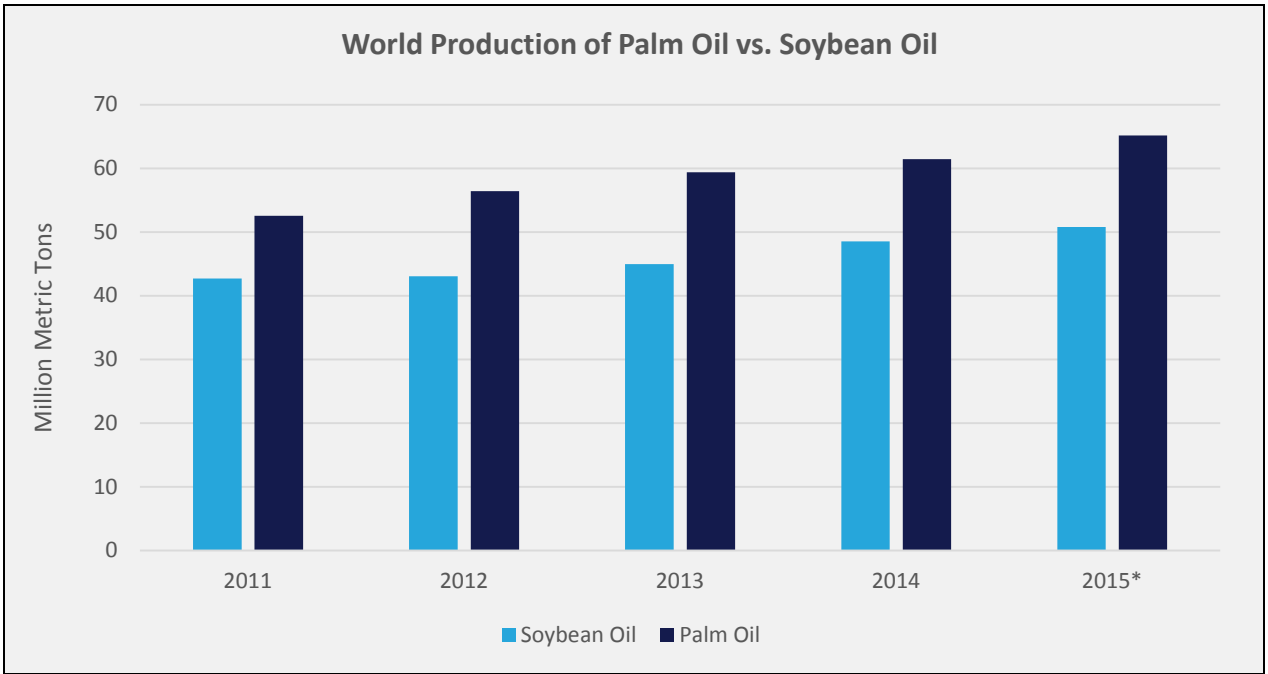


Figure 1 World Production of Palm Oil vs. Soybean Oil. *2015 data estimated.

The whole palm oil production chain includes seed germination, cultivation, tree plantation, fruit growing, harvesting, milling and refining. Palm oil milling process is shown in detail in Figure 2, to demonstrate important materials and technologies involved. Fresh fruit bunches (FFB) are cooked during sterilization using steam. In threshing the sterilized fruit bunches are stripped to separate the sterilized fruits from the empty fruit bunches (EFB). The sterilized fruits are then reheated and agitated in steam-heated vessels known as digesters to loosen the mesocarp from the nuts in preparation for pressing. The screw press expels a liquor of oil, water and finely divided solids, and a press cake of fiber and nuts. The oil in the press liquor has to be separated from the water and solids and this takes place during clarification. Crude palm oil is further

processed in refining. Water-rich sludge from the separation is called palm oil mill effluent (POME). The press cake of fiber and palm kernel nuts are also further utilized.

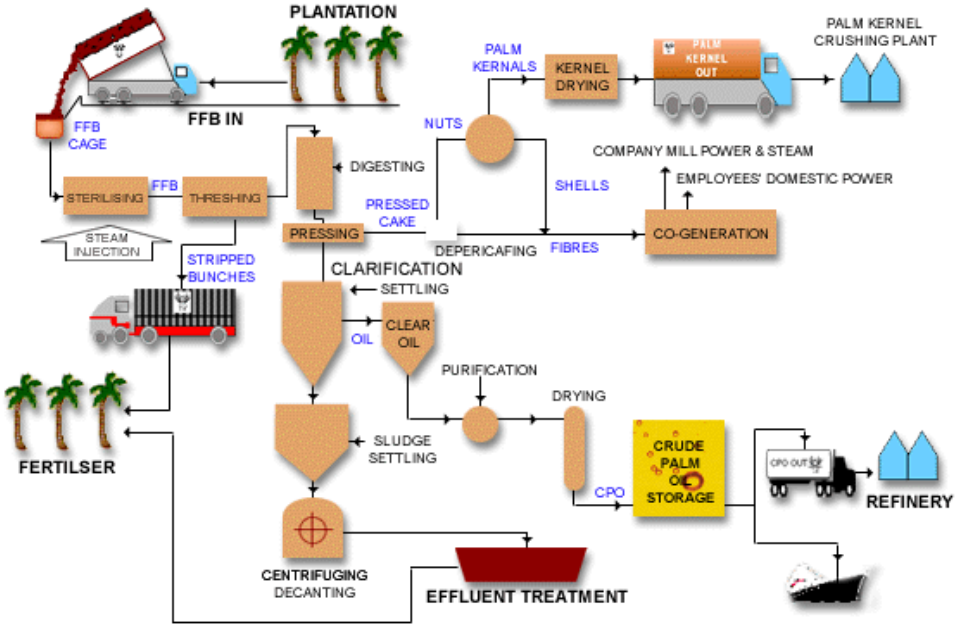


Figure 2 Crude palm oil milling process (Source: http://www.oilrefineryplant.com/palm-oil-processing)

The oil palm industry is very land-intensive. The rapid expansion of oil palm cultivation has raised concerns about the sustainability and environmental impact of oil palm plantations, in particular with regard to biodiversity, destruction of rainforest and air pollution. [4,5] Palm oil mills also significantly contribute to environmental degradation. Crude palm oil mills use large quantities of water and energy, and generate large quantities of solid waste, wastewater and air pollution. The solid wastes may consist of EFB, mesocarp fruit fibers and palm kernel shells (PKS). The liquid waste is primarily POME. As examples, during POME digestion, odor released into surrounding air, thus, reduces air quality. Disposal of EFB into oil palm plantation without recovering remnant oil in the EFB contributes to oil spills. Incineration of EFB means wasting renewable energy source and heat. Due to these environmental risks and the associated impact, simply disposing the waste from palm oil production is no longer affordable or sustainable, particularly when there is an economically beneficial and useful alternative.

As palm oil production is a critical component of Malaysian agriculture and economy, the Malaysian government has been fully committed to support a sustainable growth of palm oil industry, an issue that has been addressed also by all other countries heavily involved in palm oil production. Sustainable practices adopted by the Malaysian oil palm industry include[6]:

- Adopting Environmental Policies and requirements
- Implementing Good Agriculture Practices (GAP)
- Implementing Codes of Practices (COPs)
- Completed MPOB LCA Studies along oil palm supply chain
- Conservation efforts

Both the public and private sector have actively sought technology solutions to expand palm oil production in a more sustainable manner. Understanding the state of the art in this field, particularly the intellectual property rights, is essential in the effort to develop better technologies to produce palm oil. The present Patent Landscape Report is intended to raise awareness on the added value of patent information as sometimes unique resource of information related to research conducted in a field and the emerging trends in a technology; the report also intends to promote the use of patent analytics as a tool for business intelligence and strategic planning of development and investment in research. This report was prepared at the request and in collaboration with the Intellectual Property Organization of Malaysia (MyIPO) and the Malaysian Palm Oil Board (MPOB). As palm oil plays an important role for many other economies in South-East Asia, Latin America and Africa, this report also serves, in the context of WIPO's patent landscape activities, to provide useful information on palm oil-related technologies to the developing countries which are active in this field and can benefit from the findings.

The purpose of this report is to investigate the patenting activity related to technologies in the following areas:

A) Production of palm oil, i.e. growing and harvesting the fruit, processing of the fruit, crude palm oil, refining of the oils, with technologies related to palm oil derived from the mesocarp of the fruit and palm kernel oil derived from the fruit kernel to be covered; and

B) Treatment of waste from palm oil production, extraction of phytonutrients, utilization of palm bio-mass and/or by-products generated by the palm oil for food and beverage, cosmetics, biofuel and other areas of industry.

This report describes the search methodology and tools used to perform a global collection of patent documents related to the two above-mentioned areas. It provides a general overview and statistical analysis of all patent documents identified from the search. The history of patenting activity related to each area was examined over the course of several decades. The most common technologies for each area were identified and their developments were followed and analyzed over time. Information related to the key applicants and inventors, their history of patenting activity and their technology strength were identified and are included in the report. By synthesizing important findings from the analysis, the report also aims to contribute to projections on new technology creation and the related opportunities for developing countries.

2. Methodology

A patent landscape report is a comprehensive analysis based on patent documents in a specific technology area, covering global patenting activity or patenting in a certain geographical area. The first step in preparing such a landscape report is to understand the main objectives and the technology scope. The main objectives usually lead to a series of more specific questions to be addressed. The technology area is usually broken down into sub-categories representing various technical aspects. Next a state-of-the-art patent search is performed to collect relevant patent information. The patent search results are then analyzed to provide answers to those questions regarding the main objectives.

2.1. Search strategy

The patent search started with identifying relevant patent classification codes. International patent classification (IPC)[7] was chosen as the primary patent classification scheme, because it is used by the vast majority of patent jurisdictions, and because it is the only patent classification system used in key countries for palm oil industries, such as Southeast Asia, Africa, Brazil, etc. The Cooperative Patent Classification (CPC)[8], currently adopted by the United States Patent and Trademark Office and European Patent Office, and File Index (FI) used by Japan Patent Office were also searched to supplement IPC search results.

We first searched in IPC definitions for those that specifically cover any subject features within the scope of the project. The IPC subgroup A01F11/8 was identified, because its definition covers threshing apparatus specially adapted for palm fruit, part of fruit processing. As its definition falls entirely within the scope of the project, all patent documents (granted patents or patent application publications) that have been classified in this subgroup were all searched (search #1).

We then searched IPC codes that broadly cover the subject features of the scope. Since these codes are not specific to oil palm or palm oil, it was necessary to use keywords to combine with these IPC codes. We further limited the search results from IPC search to those containing oil palm or palm oil keywords. As the scope of this project was broad, including all areas relevant to palm oil production, in most cases it was necessary to use IPC codes at a high hierarchical level, such as subclasses or groups. For example, subclass A01F is relevant to processing of harvested produce. As it is not specific for palm fruit, the results were limited by keywords relevant to oil palm fruits (search #4).

The IPC codes searched are summarized as “Patent Classifications” in the Appendix. Some examples of those are:

- Group A01H1, A01H3, A01H4, A01H5, and C12N15 were searched for new oil palm plant varieties.
- Subclass A01C, A01D, A01F, and A01G were searched for oil palm growing technologies.
- Subclass A23N was searched for machines for treating harvested palm fruits.

- Subclass C11B was searched for palm oil producing technologies, such as pressing, extraction, refining and preserving.
- Group B30B9 (pressing for oil) and B01D9 (crystallization separation) were also searched since they are relevant to palm oil production.

The search results which were found after using the above-mentioned IPC codes were always further limited by words relevant to oil palm or palm oil.

In order to find relevant patent documents that were not covered by the classification codes used above, we also performed a broad keyword search. Besides oil palm and palm oil relevant keywords, we also added plant growing and oil producing keywords (search #23). In order to limit the search results to the most relevant ones we applied proximity operators (i.e. within five words) to make sure the keywords are closely connected. This approach increased the chances that we found relevant results.

Regarding the scope of waste treatment from palm oil production, we found that waste from palm oil production was utilized in many industrial fields. Therefore, we started with a keyword search (search #24 and #25). Proximity operators were also used; proximity operators define the allowed distance among the search keywords used, in order to avoid irrelevant results. We also identified a few important classes that are relevant to palm oil waste treatment, such as:

- Class C02, treatment of waste water;
- Subclass C12P, fermentation process; and
- Class D21, paper making, production of cellulose.

These classes were searched with keywords (search #32).

Another approach we used was focusing on important patent applicants (assignees). They are usually the entities that own the patent rights and can be searched in many patent search tools. In this search, we searched all patents filed by the Malaysian Palm Oil Board (search #33).

All search results were reviewed manually by patent analysts to remove irrelevant results (the so-called “noise”). The relevant results were further categorized into different technologies related to the palm oil production, waste treatment and exploitation. The search strings used for the search are included in the Appendix.

2.2. Data coverage and limitations

Questel Orbit was used as the primary patent search tool and all the searches were conducted in English. The patent data coverage of Orbit among various jurisdictions can be found through the following link.

http://www.questel.com/index.php/en/2012-11-20-10-09-15/pluspat

The coverage particularly for major countries of palm oil production is listed in an Annex.

In this study Landon IP also provided support to the Malaysian Intellectual Property Office (MyIPO) for searching in their national patent database in order to supplement the search results and capture also the the ones related to Malaysian national patent applications. The search strategy used was shared with and followed by MyIPO. The search by MyIPO added published MY (Malaysian) patent applications that were not covered by Orbit, and which made the data and the results of the report more complete. All MY patents and published applications can be searched in English in the MyIPO online search system (https://iponline.myipo.gov.my/ipo/main/search.cfm). The search results from MyIPO were incorporated in this report.

As many important countries in palm oil production, such as Indonesia, Thailand, Philippines and Colombia, have their patent applications filed in native languages other than English, a patent search in English had certain limitations in these countries. In this project we maximized the coverage in these countries by the following two approaches:

The search is patent family-based.[1] When a patent family has a member publication in English that is recalled as relevant, the other members will be included as well. This approach covers these national patent applications with (subsequent) foreign filings or PCT filings;

The queries also included machine-translated English translations of foreign documents provided by Orbit, for those non-English patent documents.

The detailed geographical distribution of patenting activities will be discussed in the analysis section.

As specified in WIPO's request for proposal, a separate patent landscape report on palm oil covering the national patenting activity in the Philippines was planned and carried out by the Philippines Intellectual Property Office (IPOPHL), since this topic is of great interest to the country´s economy. The data will be compared to the global patent landscape report and can also serve stakeholders in the field of palm oil in Malaysia to identify potential partners.

2.3. Patent data formatting

All the patent data were reduced into simple patent families.[1] Orbit FAMPAT[9] was utilized to organize the patent data. The patent data spreadsheet that includes all relevant simple patent families which is available in a separate Excel table, with sorting (e.g. for dates) and filtering functionalities. Each simple family was identified and represented by the publication number of a single published family member, preferably the earliest published PCT publication number[10], if available. If the family has no PCT family member, the family member published in English was selected.

The patent data included the following bibliographic information for each family (when appropriate derived from the publication representing the family):

- Title

- Abstract
- Claims
- Applicant/assignee name(s)
- An indication as to whether at least one applicant is a private sector and/or a public sector entity (names of individuals are considered neither private nor public sector entity)
- Inventor name(s)
- Priority information
- Earliest priority date (or application date in case no priority is claimed), i.e. the date of first filing in the family
- Priority country of earliest priority, i.e. office of first filing (OFF)
- Further priority dates with respective priority countries/jurisdictions
- The size of the simple family and the size of the related INPADOC family
- Publication numbers of all members of the simple family
- The country codes of all offices of second filing (OSF, each OSF indicated only once, OFF excluded)
- Number of OSF (each OSF counted once);
- IPC symbols
- An indication as to whether the family comprises at least one publication of a patent grant
- Number of forward citations

Each patent family (representative member) was indexed/tagged according to the technology and use categories to which it belonged, as explained next.

3. Technology Categorization

Relevant patent families were categorized based on the technology features as disclosed therein. At the top level patent families were broken into two main categories: 1) Palm Oil Production and 2) Waste Treatment and Exploitation. Each main category was further divided into sub categories. The subcategories are briefly explained with sample patents listed below.

Palm Oil Production Category

1. Advanced palm tree seeds (e.g. genetic engineering, seed selection, etc.)

This subcategory includes advanced seed technology, such as genetic engineering methods to produce transgenic oil palm seeds, and biotechnologies to select superior oil palm seeds. As an example, in WO2014168759A1 to MPOB, it disclosed a genetic method controlling fruit color phenotype in palm, as shown in Figure 3.

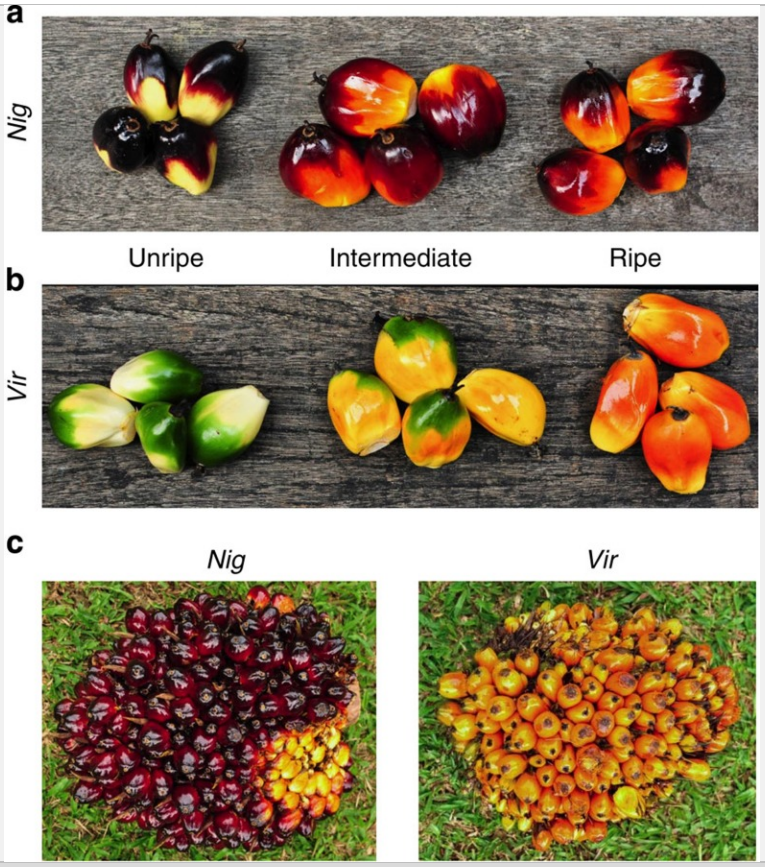


Figure 3 Fruit exocarp colour phenotypes. (a) Individual oil palm fruits from a nigrescens (Nig) fruit bunch. Unripe fruits are deep-violet to black at the apex (visible in the bunch) and undergo minimal colour change upon ripening. (b) Individual oil palm fruits from a virescens (Vir) fruit bunch. Unripe fruits are green at the apex and change to reddish orange upon ripening. (c) ripe nigrescens and virescens fruit bunches. Image source: Nat Commun. 2014 Jun 30;5:4106. doi: 10.1038/ncomms5106

2. Tree seedling and cultivating

This subcategory includes methods of germination, seedling, cultivating and transplanting of oil palm. Figure 4 shows a cultivating process disclosed by Rubber Research Institute, Chinese Academy of Tropical Agricultural Sciences (CATAS-RRI). An example of the patents from this applicant is CN102893862A “Oil Palm Embryonic Callus Induction Method”.

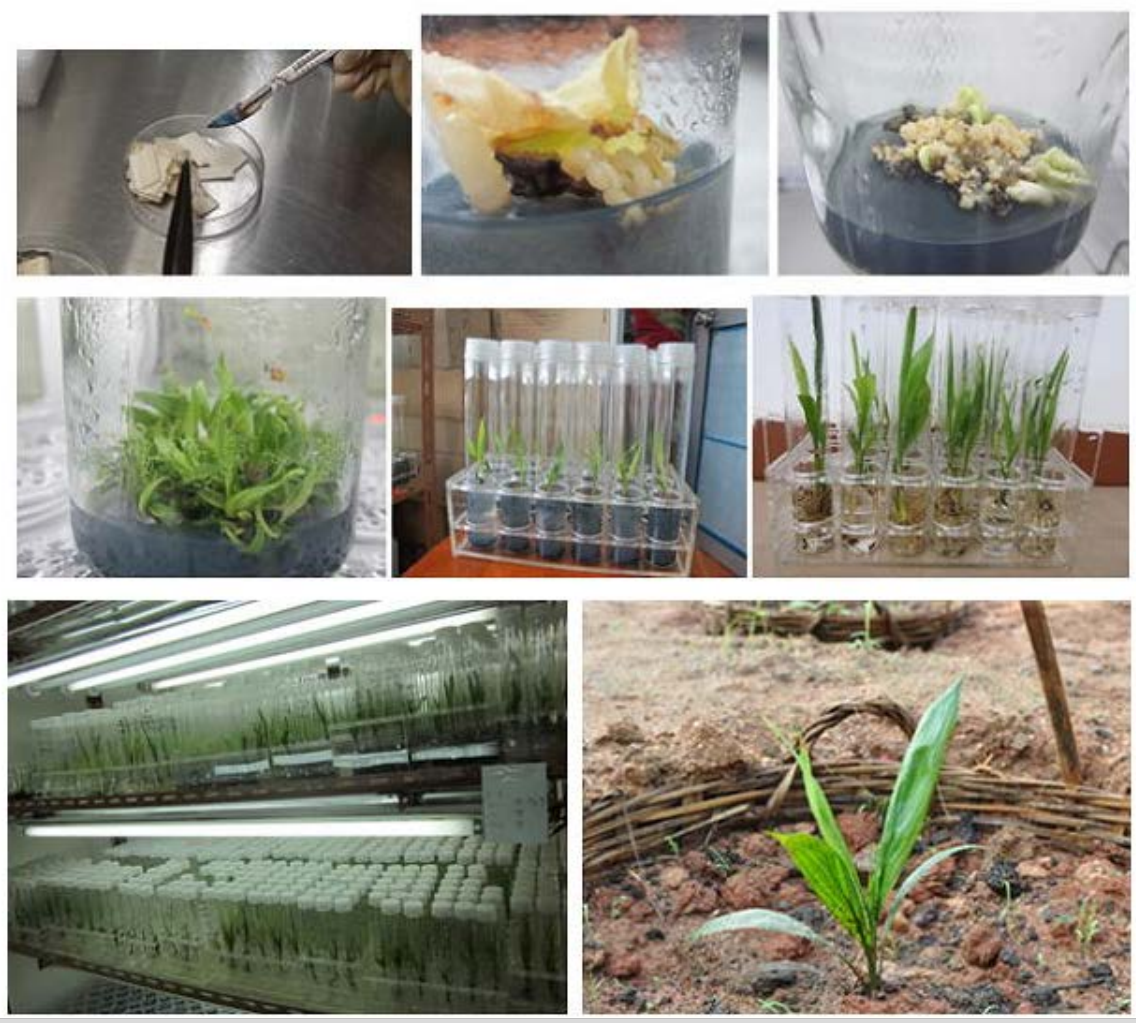


Figure 4 Tissue culture of oil palm with young folded leaf explants and field planting of the tube plants. CATAS-RRI as developed a leaf-based tissue culture. With this technique detached immature (spear) leaves of oil palm are used as explants and induced into embryonic calli which are then proliferated and initiated to somatic embryos, and the somatic embryos germinate to form plantlets that are then cultured on rooting medium to produce complete plantlets. The rooted plantlets have been successfully planted in the field with a high survival rate. A micropropagation system for oil palm has been established by CATAS-RRI in China over years of efforts. Image source: CATAS-RRI (http://rri.catas.cn/en/research/?44.html)

3. Fruit growing and harvesting

This subcategory includes methods and/or tools of growing oil palm fruits and harvesting them. As shown in Figure 5. Technologies relevant to in fruit growing, such as MYPI2010006305 “A method of predicting oil content of oil palm fruit and a device for performing the same” assigned to Universiti Putra Malaysia, are also included in this subcategory.

Figure 5 Tools and machineries for palm fruit harvesting. Image source: MPOB (http://www.mpob.gov.my/images/stories/pdf/cb_complete.pdf)

4. Sterilization of bunches

As the fresh fruit bunches reach the processing plant, the sterilization process uses steam to destruct the enzymatic process inside fresh fruits that produces free fatty acid, which is an unwanted component of palm oil. An example of oil palm fruit sterilizing tank disclosed CN203498354 by CATAS is shown in Figure 6.

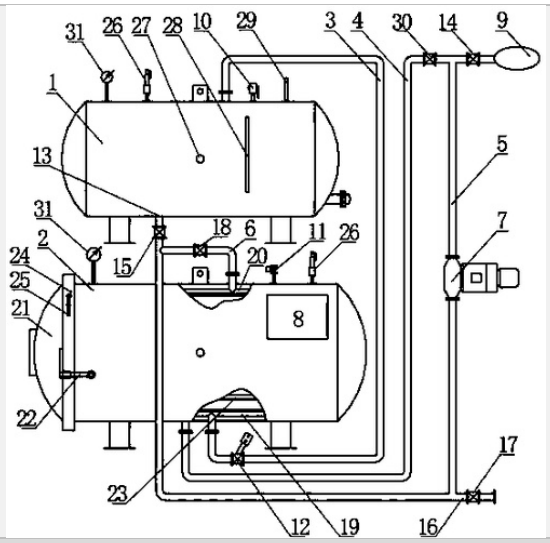


Figure 6 A semi-automatic double-layer hot water circulating oil palm fruit sterilizing tank as disclosed in CN203498354

5. Threshing (removal of fruit from the bunches)

After sterilization bunches consist of oily and soft fruit were threshed by rotary beater to remove the fruit from the bunch. An example of threshing machine is shown in Figure 7.

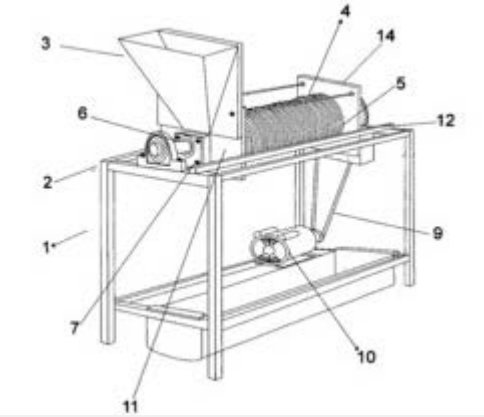


Figure 7 Palm fruit threshing machine disclosed in BRPI1001226 by Souza Carlos Alves De.

6. Digestion of the fruit

Digestion is the process of releasing the palm oil in the fruit through the rupture or breaking down of the oil-bearing cells. Pounding, or digesting the fruit at high temperature, helps to reduce the viscosity of the oil, destroys the fruits' outer covering (exocarp), and completes the disruption of the oil cells already begun in the sterilization phase.

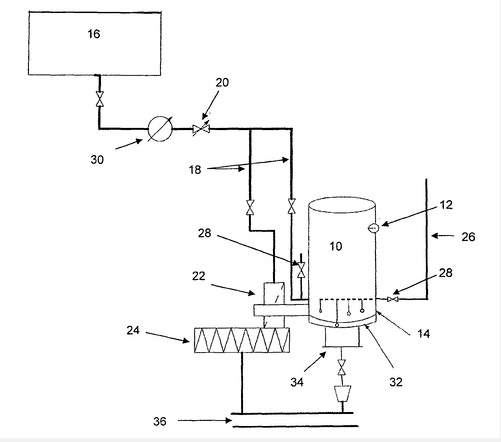


Figure 8 Palm fruit digesting machine disclosed in WO2014185769 by Sime Darby.

7. Pressing (Extracting the palm oil)

8. There are two distinct methods of extracting oil from the digested material. One system uses mechanical presses and is called the ‘dry’ method. The other called the ‘wet’ method uses hot water to leach out the oil. A mechanical press was disclosed in CN203567230 by CATAS, as shown below.

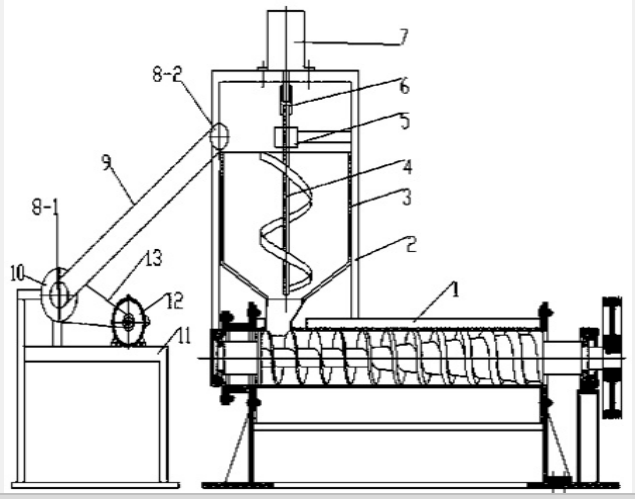


Figure 9 An oil press for palm fruit disclosed in CN203567230 by CATAS.

9. Palm Oil refining

Oil refining includes clarification and drying of oil. The main point of clarification is to separate the oil from its entrained impurities, such as water, cell debris, fibrous material, etc. The refining process of palm oil is schematically shown in Figure 10.

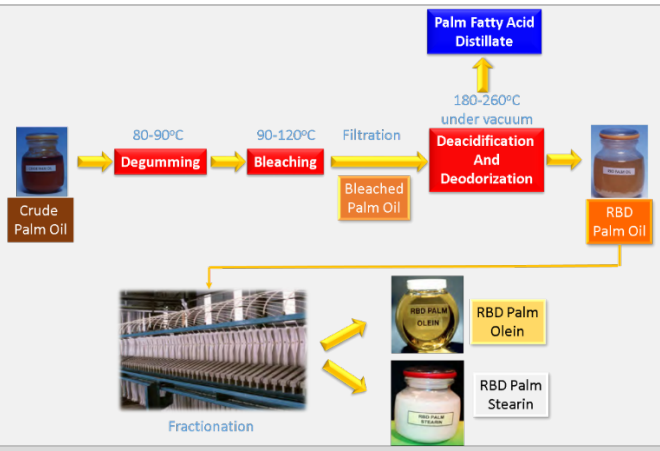


Figure 10 Palm oil refining process. Image source: MPOB (http://www.mpoc.org.my/upload/PAPER_3-POTS%20Myanmar-Datuk-Choo-Yuen-May.pdf)

10. Oil storage

In large-scale mills the purified and dried oil is transferred to a tank for storage prior to dispatch from the mill. Temperature and atmosphere need to be controlled to avoid oxidation. As disclosed in US2003068426A1 by MPOB, a process to delay clouding in palm olein by the addition of a crystallization inhibitor to the palm olein, the palm olein is first heated to a temperature of between 60 to 140° C then small proportion of crystallization inhibitor with a hydrophilic-lipophilic balance value between 1 and 16 is added to a sample of palm olein and the mixture is stirred until homogenous. The stirred mixture is then added to the pre-heated palm olein and the resultant mixture is stirred until homogenous and is cooled before packing into individual containers.

11. Kernel recovery

The residue from the press consists of a mixture of fiber and palm nuts. The nuts are separated from the fiber for palm kernel oil. They are then dried and cracked in centrifugal crackers to release the kernels. A palm husk-kernel separator was shown below as an example, disclosed in CN103386357 by Nantong Safe Machinery Equipment.

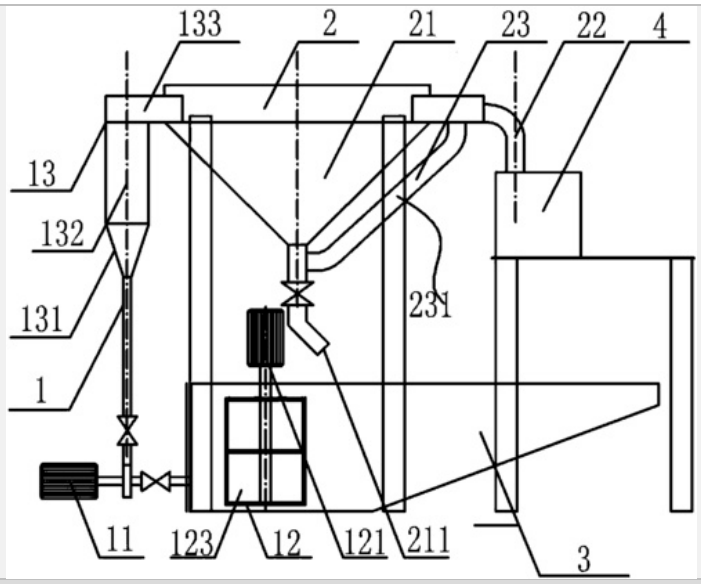


Figure 11 A palm husk-kernel separator disclosed in CN103386357 by Nantong Safe Machinery Equipment.

12. Kernel oi extraction/pressing

Mechanical pressing is used to extract palm kernel oil form kernel flakes. Other technologies to improve kernel oil recovery are also included in this subcategory. For example, a processes for treating palm kernel cake by enzyme-catalyzed hydrolysis of palm kernel cake was disclosed in WO2014189355 by Sime Darby.

Waste Treatment and Exploitation

1. Extraction of palm oil

Waste materials from palm oil mill are further processed to recover more palm oil. As an example, WO2014084718A1 by Eonchem Technology disclosed a continuous process extracting residual from single or multiple oil bearing waste feedstock, especially from potential oil laden waste materials in conventional screw press oil milling process, screw press kernel crushing plant, as well as refinery plant deodorizer wastes (spent bleaching earth).

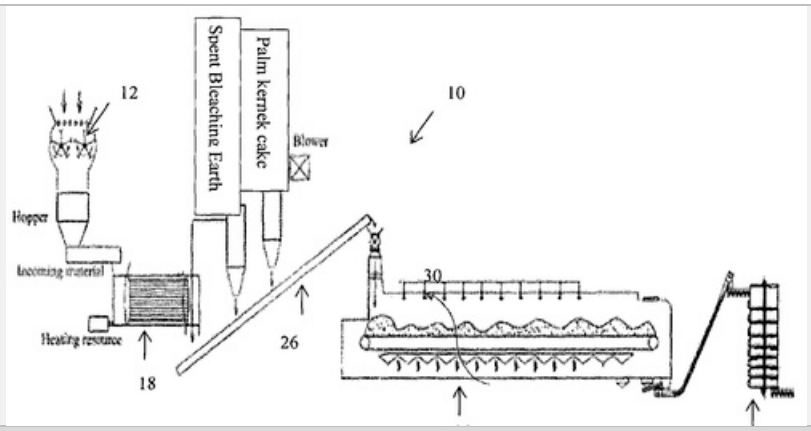


Figure 12 A process for extracting residual oil from oil bearing waste feedstock in WO2014084718A1 by Eonchem Technology

2. Extraction of phytonutrients

Phytonutrients (also referred to as phytochemicals) are compounds found in plants. Waste materials from palm oil mill contain various types of functional phytonutrients that can be used in food, medicine and cosmetics. As an example WO201250425 by MPOB disclosed a process for extracting antioxidants from oil palm biomass, such as oil palm leaves, palm pressed fiber and empty fruit bunches. Phenolic compounds can be extracted and recovered by way of solvent free process.

3. Direct fuel

Solid oil palm wastes such as EFB, fiber, shell and palm kernel cake can be processed into a uniform and solid fuel through briquetting process. As an example WO2009070292A1 by Cargill disclosed a system for customizing a fuel pellet formulation. The system includes a first memory portion configured to store fuel ingredient data representative of pelleted fuel ingredients, a second memory portion configured to store at least one evaluation criteria constraining the generation of the formulation data, and a data processing circuit in communication with the first and second memory portions and configured to generate a fuel pellet formulation representative of a combination of fuel ingredients, the fuel pellet formulation data being generated by the data processing circuit based upon the fuel ingredient data and evaluation criteria.

4. Charcoal

Solid wastes can be further carbonized to produce charcoal and other carbonaceous materials. For example WO2011142001 by Steel Plantech disclosed a method and a device for producing a palm kernel shell (PKS) charcoal, having a fixed carbon content of 80% or more and a volatile matter content of 12% or less, using a direct heating type rotary kiln in which self-sustaining combustion can proceed.

5. Biodiesel

Bio-oil can be produced from dried biomass including dried oil palm wastes through a process known as fast pyrolysis. It contains fragments of cellulose, hemicelluloses, lignin, and extractives and can be burned in diesel engines, turbines or boilers. For example Petrobras disclosed, in WO2010012997, a process for production of Bio-Oil by delayed coking with modified feedstock, in which the feed of the conventional coke unit envisages, in addition to the usual fresh feed of hydrocarbon (vacuum residue, atmospheric residue etc.), the feeding of a biomass for coprocessing.

6. Adsorbent (e.g. activated carbon)

Carbonaceous materials such as activated carbon are widely used as adsorbents. WO2006108683A1 by Schloegl Robert and Sharifah Bee Binti disclosed a method preparing nanosize carbon structures (e.g. CNT or CNF) from vegetable sources containing silicate, such as palm kernel shells.

7. Filter

Palm fibers, leaves and other waste material can be used as air and water filters. For example, in WO201429317 Jiahe County Lvyang Environmental Equipment disclosed a waste gas purification device where the flue gas washing adsorption purification tower are provided with palm fiber filter screens.

8. Composite material

Palm fibers, truck and fronds are combined with other materials, such as polymers and concretes, to form composite materials. For example, in CN203004420U Haochen Wuxi Plastic Industry disclosed a polyethylene composite film shown as below, wherein a palm fiber sieve mesh is arranged between the monolithic films.

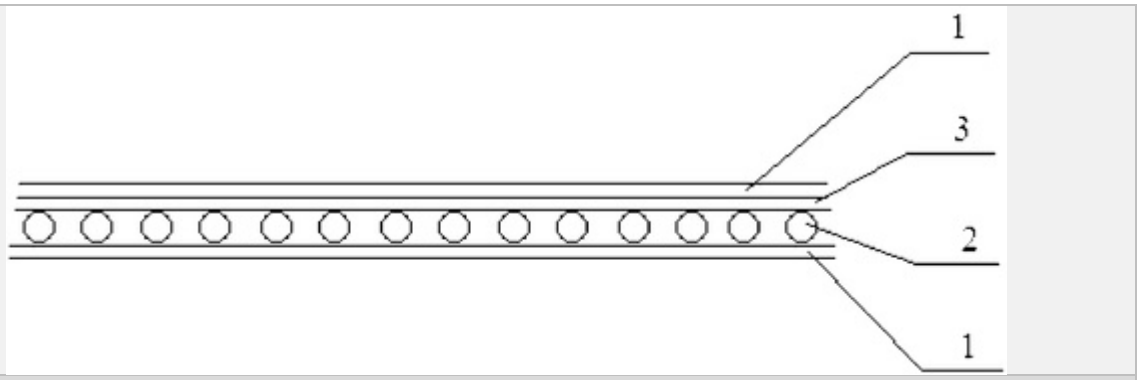


Figure 13 A polyethylene composite film containing palm fiber sieve mesh (2) disclosed in CN203004420U by Haochen Wuxi Plastic Industry.

9. Animal feed

Decomposed biomass is used as animal feed. As disclosed in WO2014130578 by Palm Silage an animal feed formed with a base of palm fronds and combined with palm fruit, such as dates, is a sustainable and affordable feed product that can be developed in hot climates.

10. Fertilizer

Fertilizer can be derived from both solid biomass and palm oil mill effluent (POME). For example, in WO2012123779 SIPEF CI SOC disclosed an organic fertilizer made from palm oil extraction residue. As cited from the patent abstract, production begins with the separate shredding of the stems and the fibers originating from the milling of the oil-palm bunches. The fibers are combined with dried potassium-rich insects (oritex). The resulting homogeneous powders are heaped for a first decomposition level. Said powders are mixed with the palm oil settling sludge. Subsequently, vermicomposting and screening are performed. The product is then heaped in the shade. Moringa leaves are added to catalyze ion chelation in the vermicompost so as to obtain the organic fertilizer of the invention.

11. Cultivation structure

Palm fibers, leaves and other wastes are used as a structure material for cultivating other plants. As disclosed in WO2005115127 by AIBA TOSHIYUKI a plant growing bed produced by mixing 100 pts.wt. of non-wood fibers composed of bamboo fibers having undergone expression processing to fibers and poaceous plant fibers from reed, straw, pampas grass, etc. with 30 to 70 pts.wt. of palm fibers having undergone crushing processing and 1 to 3 pts.wt. of vegetable starch, further adding thereto an appropriate amount of water enough to cause the starch to absorb the same and thereby generate viscosity; effecting agitation and kneading of the mixture; pressuring the kneading product so as to shape into an arbitrary thickness and configuration; and drying the shaped product.

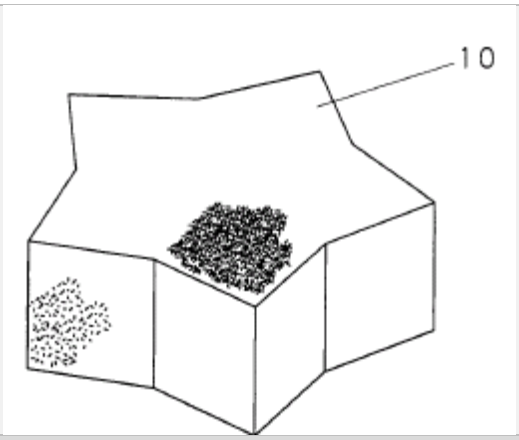


Figure 14 A plant growing bed disclosed in WO2005115127 by Aiba Toshiyuki.

12. Biomass fermentation product (ethanol, sugar, etc...)

Palm biomass is rich in lignocellulosic materials. Through fermentation bio-ethanol or hydrocarbons can be obtained. For example, in WO2012093041 Novozymes disclosed a method for producing biogas from pectin and lignocellulose containing material. The processes comprise the steps of providing a slurry comprising a lignocellulose- and pectin-containing material, water and two or more enzyme treatments; allowing the two or more enzyme-treatment steps to degrade the lignocellulose- and pectin-containing material, and adding the degraded material to a biogas digester tank at a suitable rate and ratio to effectively convert the material to biogas in the digester.

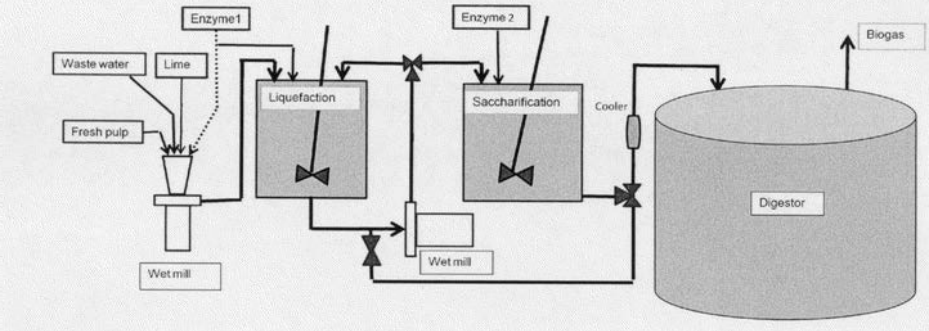


Figure 15 A biogas production process as disclosed in WO2012093041 by Novozymes.

13. Paper making

Pulps made from lignocellulosic residues such as empty fruit bunches are fiber-rich and make high quality paper. As an example Sky global disclosed in WO2015083903 a method for manufacturing pulp using palm sludge. The method comprises: a raw material mixing step for mixing palm sludge powder and wood chips; a nitrocarburizing step for mixing the mixture manufactured through the raw material mixing step and a sodium hydroxide aqueous solution and heating the same; a first washing step for washing the mixture nitrocarburized through the nitrocarburizing step; a first drying step for drying the mixture washed through the first washing

step; a cleaning step for cleaning the mixture dried through the first drying step; a second drying step for drying the mixture cleaned through the cleaning step; a bleaching step for adjusting the whiteness index of the mixture dried through the second drying step; a second washing step for washing the mixture bleached through the bleaching step; and a third drying step for drying the mixture washed through the second washing step. In the pulp manufacturing method comprising the afore-mentioned processes, raw material obtained by mixing palm sludge powder and wood chips is used, thereby reducing manufacturing time and cost for pulp and providing pulp having excellent physical properties and various whiteness indices.

Figure 16 Empty fruit bunches (left), pulp made of EFB (center) and paper products (right). Image source: Oil Palm Products (oilpalmproducts.com).

14. Waste water treatment

Palm oil mill effluent is the primary liquid waste from palm oil production. Its dispose always requires treatment to lower the impact to the environment. The treatment system usually consists of anaerobic and aerobic ponds to for biodegradation. Silting of ponds due to the high concentration of suspended solids reduces their effectiveness and leads to higher operating cost. POME treatment under anaerobic conditions also leads to the emission of methane a greenhouse gas. Enclosed anaerobic digestion systems are needed to capture methane (Figure 17).

For example, in WO200577485 Cargil disclosed a method of treating an aqueous stream comprising suspended matter, an oleaginous material and an emulsifier having an emulsification activity is disclosed. The method includes reducing the emulsification activity of the emulsifier. A concentrated solution, separated solutes, fertilizer or animal feed produced by the process of reducing the emulsification activity of an emulsifier in an aqueous stream comprising suspended mater, an emulsifier and an oleaginous material is disclosed. The solution, fertilizer or animal feed has a relatively low concentration of emulsifier.

Figure 17 An effluent pond (left), an aerobic pond with surface mechanical aerators, (middle) and anaerobic tank digesters (right).

15. Mattress/cushion

Palm fibers are a popular material to make mattress and cushions. China, Japan and Korea are the major markets. For example in CN102861755 Guizhou Daziran disclosed a method for recovering palm fiber from waste material for producing palm mattress.

Figure 18 Palm fiber (left) and mattress made of palm fiber (right).

4. Analysis of Patenting Activity

Highlights of this section:

- Since 2007 there were more patent filings in the area of Waste Treatment and Exploitation than in the field of Palm Oil Production.
- Most active countries in Palm Oil Production are United States, Malaysia and China.
- Most active countries in Waste Treatment Exploitation are China, Japan and Malaysia.
- Malaysian patents are predominantly filed by domestic applicants, led by MPOB, Sime Darby and Universiti Putra Malaysia. Technology distribution between Palm Oil Production and Waste Treatment are very balanced among Malaysian patent portfolios.
- Malaysian applicants are also active in foreign filings, particularly in other palm oil producing countries, such as Thailand, Brazil and Colombia.
- The PCT filing route is the most preferred approach to seek patent protection in multiple jurisdictions.
- 68% of patent families in this study contain only domestic filings from only one country. This indicates that most patent filings in this study focus primarily on local jurisdictions, not seeking broader protection in foreign countries.
- 63% of large patent families (10+ in size) are relevant to Advanced Seed technology.
- Most active applicants in Palm Oil Production are MPOB, BASF and CATAS.
- Most active applicants in Waste Treatment and Exploitation are MPOB, Guizhou Daziran and Universiti Putra Malaysia.
- In recent patent filings (2010-2015) the most active technologies relevant to Palm Oil Production are Advanced Seed, Tree Seedling and Cultivation, Fruit Growing and Harvesting, Pressing and Refining.
- For Waste Treatment and Exploitation, the recent trends are Mattress/Cushion, Composite Material, Adsorbent, Filter and Biomass Fermentation.
- Data coverage in other palm oil producing countries are limited. Among the limited collection, Thai applicants are very active. Filings in Latin America countries are high but predominantly from foreign applicants, such as BASF and Monsanto. MPOB is also an important applicant in Thailand, Brazil and Colombia. Very few patents were originated from African countries.

4.1. Overview

During the project we searched more than 8,600 simple patent families,[1] among which 2,370 were determined as relevant. In these 2,370 simple families there were 116 Malaysian (MY) patents or application publications from MyIPO search that were not covered by Orbit. Each of these 116 MY patent documents was treated as one single simple family. Among the 2,370 simple families there were 2,187 (92%) that did not belong to a larger extended family

(INPADOC family). [1] The information of whether a certain simple family belongs to a larger INPADOC family and the size of the corresponding INPADOC family are provided in the Excel sheet. In the subsequent statistical analysis when the count of family is presented it refers to the count of simple families.

4.2. Family size

The 2,370 simple patent families include in total 5,711 single patent applications. The average size of a simple family is about 2 applications per family. Family size is defined as the number of patent applications included in a simple patent family. The family size distribution histogram is shown in Figure 19.

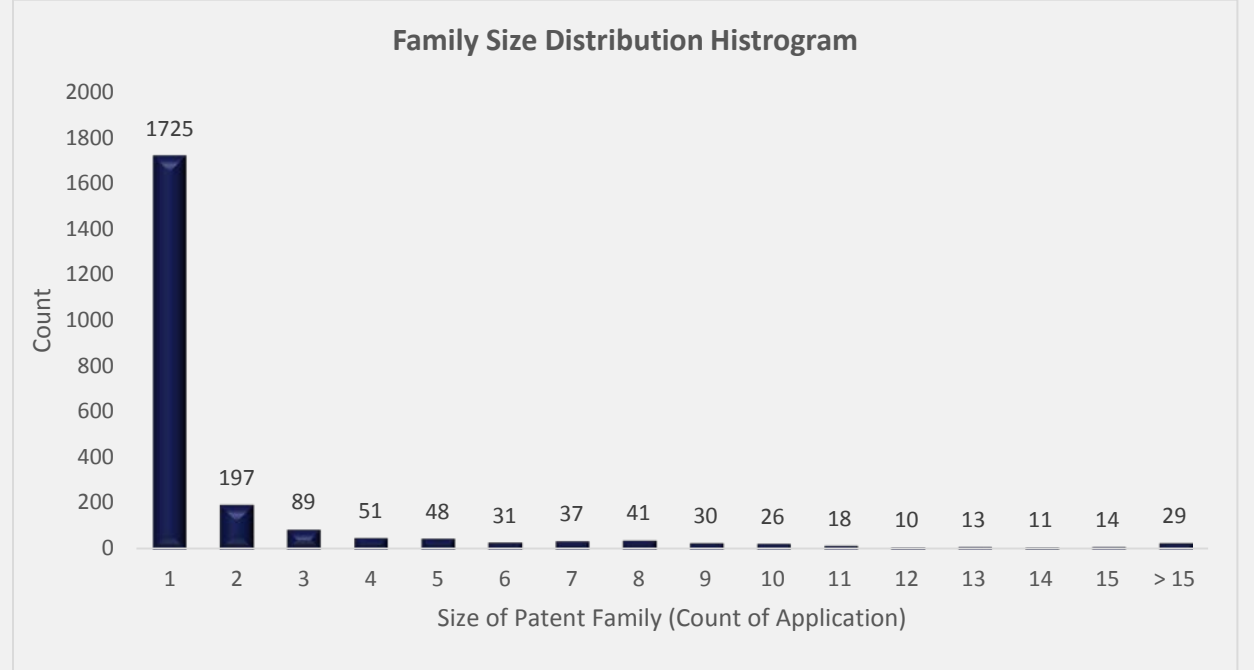


Figure 19 Family size distribution histogram

As can be seen here more than 1,700 (73%) families have only 1 member application. Overall about 68% of patent families contain only domestic filings from only one country, excluding International PCT filings. This indicates a majority of patent filings in this study focus primarily on local jurisdictions, not seeking broader protection in foreign countries.

The largest family, represented by WO200177355A2 to BASF Plant Science, has 103 member applications. The invention, titled “Signal transduction stress-related proteins and use in plants”, were also filed in United States, European Patent Office, and Canada. In a further look at patent families with 10 members or above we have found a majority of them are relevant to inventions of advance seeds, shown in Figure 20. As detailed discussion on this technology category will follow in Section 5, we like to note here that such inventions, primarily lead by large

agrochemical and agricultural biotechnology corporations (e.g. BASF, Monsanto, etc.), normally cover a broad variety of oil-producing plants, including but not specific to oil palm.

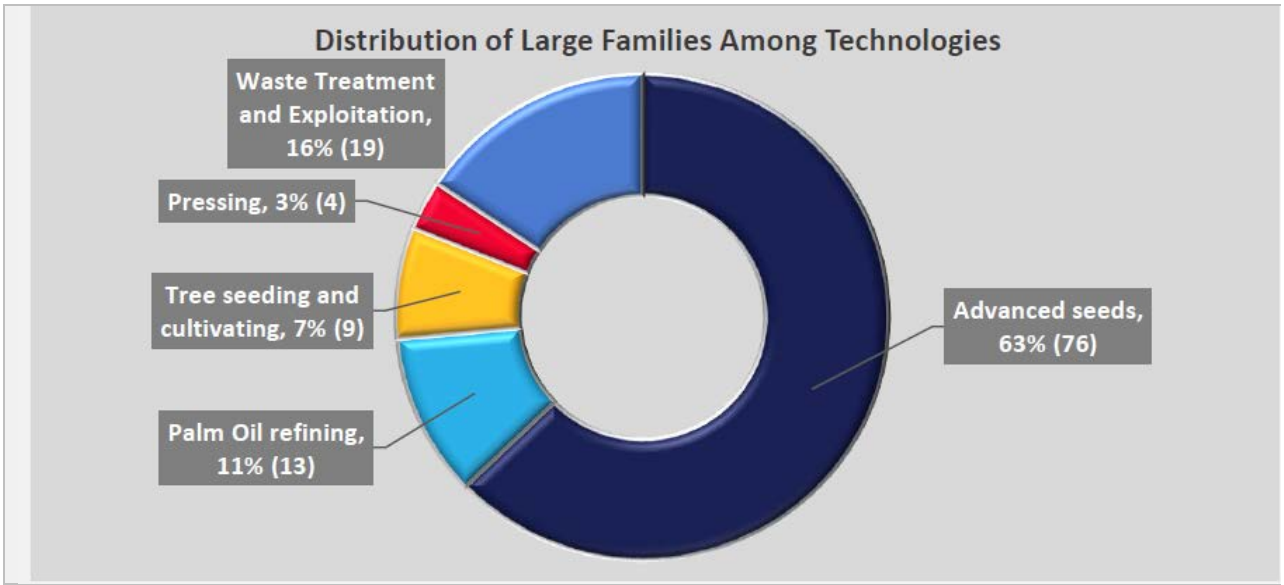
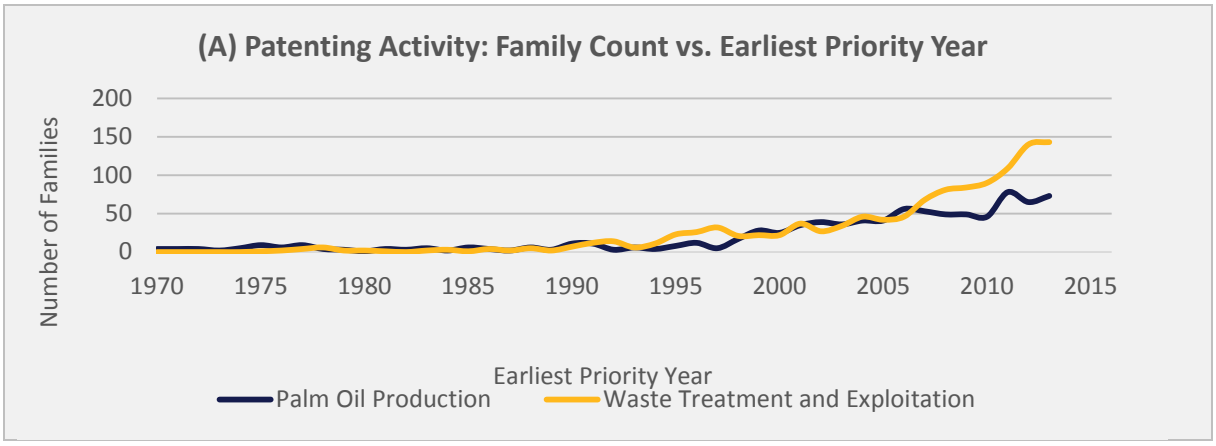


Figure 20 Large families (size 10+) distribution among technologies.

4.3. Chronological patenting activity

The chronological patenting activity is shown in Figure 21 by family count (A) and by application count (B). Although our search results covered patents filed in early 1900s we only included in the graphs patents filed since 1970s as the activity before that was quite low. Also it should be pointed out that for patents with priority dates and application dates in the last 2 years, i.e. in 2014 and 2015, the data collection is not complete because the publication of application is usually delayed within eighteen (18) months.[11] Therefore, the data from 2014 and 2015 are not shown. We would expect 2014 and 2015 data to follow the trend from 2010-2013 if all of the data is available. In order to confirm this, the study should be updated in the next 18 months.



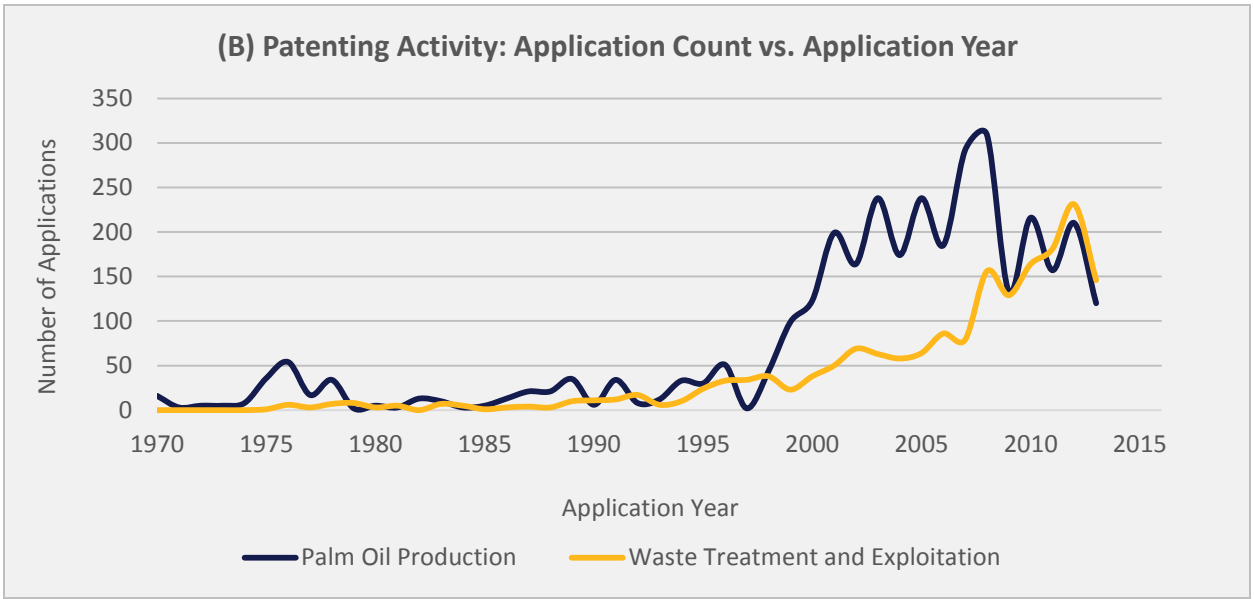


Figure 21 Chronological patenting activities since 1970. (A) Family count vs. the Earliest Priority Year and (B) Application count vs. Application Year (Note: 2014 and 2015 data are not shown due to incompletion from delayed publication.)

As the chronological trend shows there was a significant increase in patent filings in mid-1970s. Palm oil refining was the focus in that period and the inventions mainly came from Japanese applicants, such as Adeka and Nisshin. From late 1990s the filing activity started to increase consistently year to year, from about 50 applications per year to more than 300 applications per year in recent years. Also it is found the global economic recession occurred in 2008 did not have a big impact on patenting activities in palm oil production field.

When data between Palm Oil Production Waste Treatment and Exploitation is compared, it shows that after 2007 number of patent families filed in Waste Treatment surpassed those in Palm Oil Production by a big margin. A dramatic increase in family counts after 2010 were mainly attributed to patents relevant of Waste Treatment. However, from the count of individual applications palm oil production attracted more counts. This contrast can be further illustrated in Figure 22. In the last twenty years more patent families Waste Treatment and Exploitation category were filed, but patent families of palm oil production contained more applications. This observation is in agreement with the results in Figure 20, which shows inventions of palm oil production tent to have larger patent family sizes, i.e. more applications. Using the same example of the patent family represented by WO200177355A2, this single family contributed seventy (70) applications in 2001.

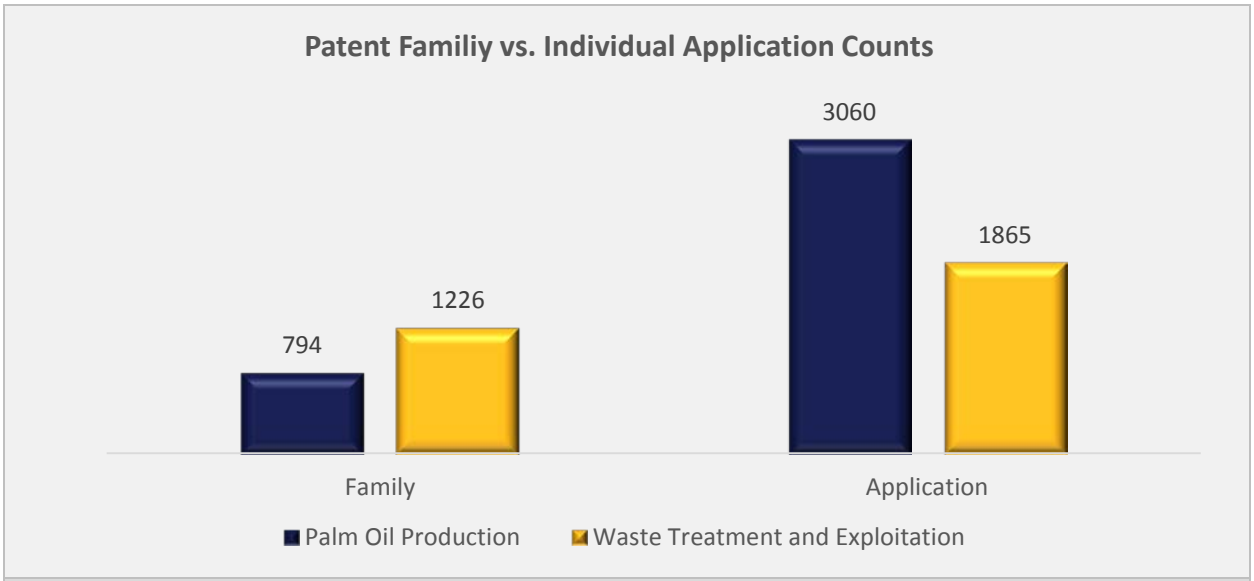


Figure 22 Family counts and application counts of two top categories, from the last 20 years (1995-2015).

4.4. Patent grant

The patent documents we collected comprise not only patents that were granted by individual jurisdictions ("grant"), but also the published applications as filed. The invention disclosed in a patent grant has gone through the examination process and its merits are acknowledged. Also a patent grant actually protects the patent owner from others' infringement. It is important to know how many of the applications have gained grant status. In this study a patent grant is determined only according to the kind codes of publications.[12] No legal status data were researched in order to determine if the grant was revoked after an opposition.

The percentage of patent families comprising at least one patent grant was compared in Figure 23 between the two top categories and per the earliest priority year. Generally it takes several years from the application date for a patent to be granted. Therefore the grant percentage in recent years is always lower than average.

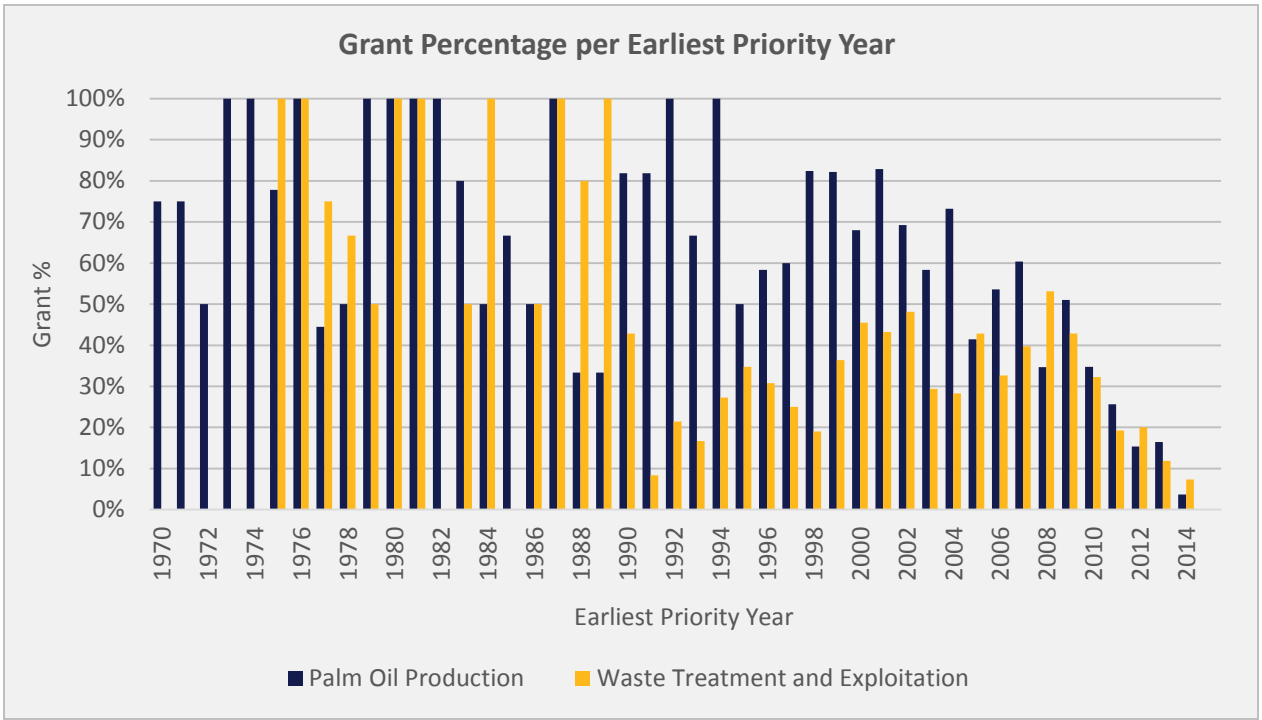


Figure 23 Percentage of families comprising at least one patent grant per the earliest priority year.

The overall Grant percentage in Palm Oil Production category is 55%, significantly higher than that in Waste Treatment and Exploitation category (30%), Figure 24. The low grant percentage in Waste Treatment and Exploitation category could be attributed to the combination of the following two reasons:

1. Large number of recent filings that are still being examined or awaiting examination;
2. Increasing difficulties in getting patent grants due to lack of novelty etc.

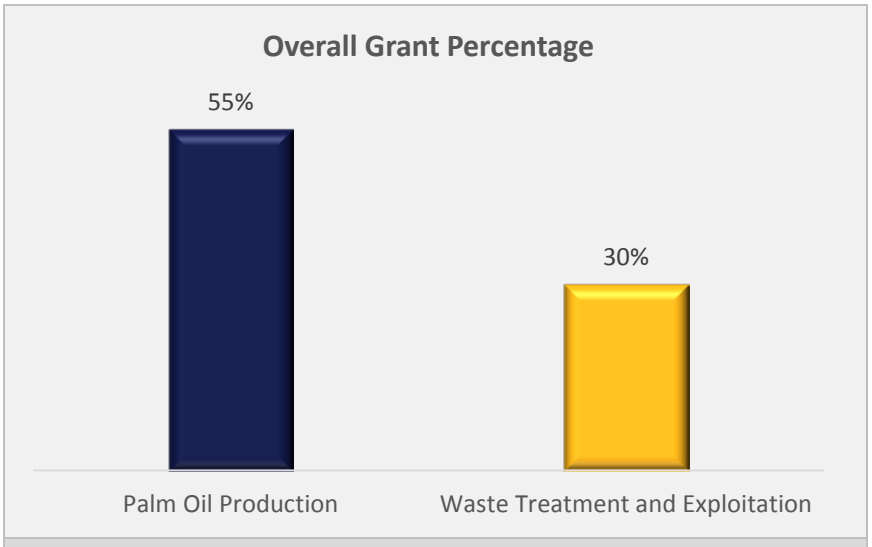


Figure 24 Overall grant percentage

4.5. PCT filings

The Patent Cooperation Treaty (PCT) assists applicants in seeking patent protection internationally for their inventions. In this study we also examined the statistics of paten families with at least one PCT member. Figure 25 showed the percentage for the two top categories, respectively. PCT filings in Waste Treatment and Exploitation category started much later than those in Palm Oil Production category, and the overall percentage is much smaller, Figure 26. The data indicate the applicants in Waste Treatment and Exploitation category seek primarily domestic protection rather than broad, foreign coverage.

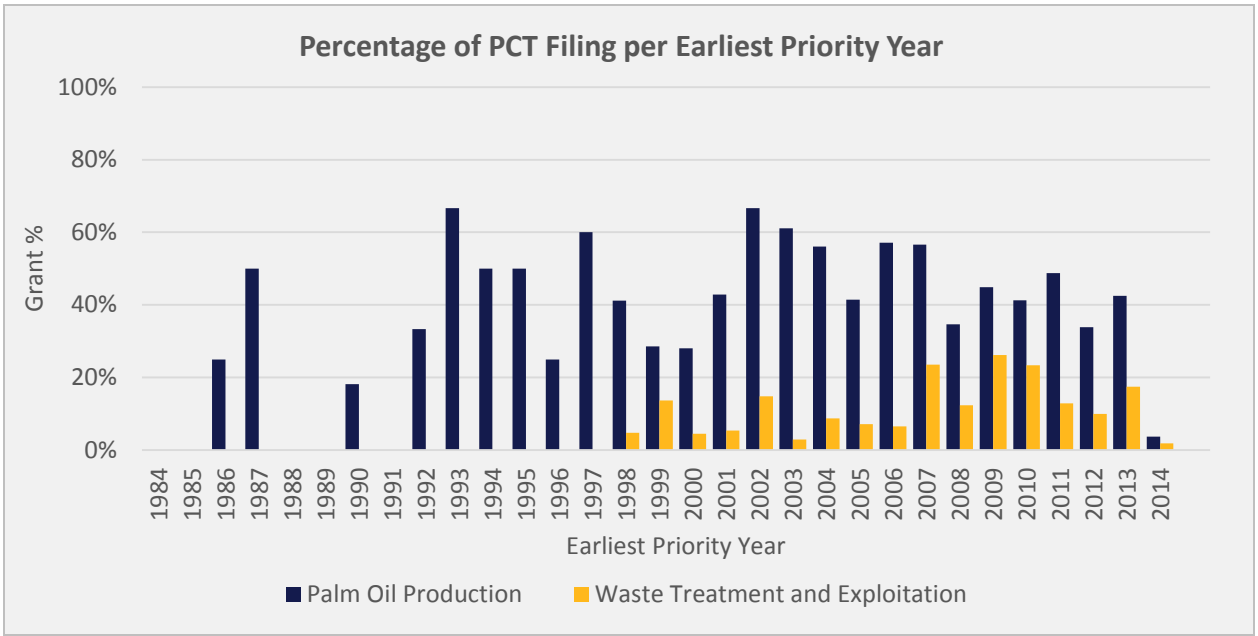


Figure 25 Percentage of families comprising at least one PCT member per the earliest priority year

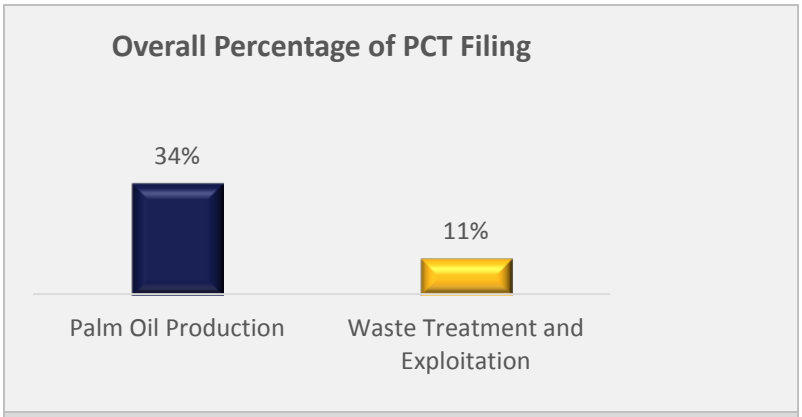


Figure 26 Overall PCT filing percentage

4.6. Geographical distribution

The geographical distribution of relevant patenting activities is presented in this section. For each patent family Office of First Filing (OFF) is defined as the country/jurisdiction where the earliest priority patent application (i.e. the first filing) is filed. Office of Second Filing (OSF) is the country/jurisdiction where any other patent application is filed in the family. OSF indicates where the applicant seek extension of patent right outside OFF. The country code of each patent document is used to determine the country/jurisdiction.[13]

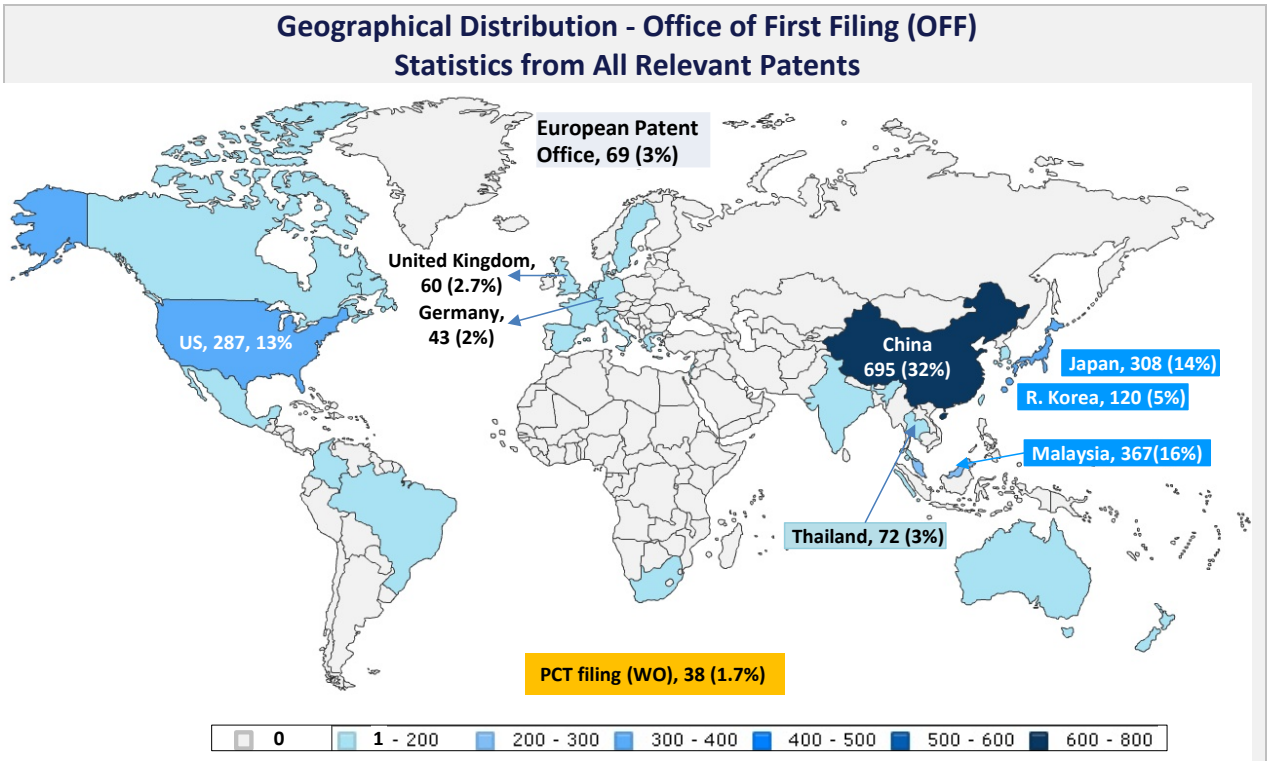


Figure 27 Geographical Distribution-Office of First Filing (OFF) Statistics from All Relevant Patent Families. Patent families with Earliest Priority Year since 1970. Top 10 OFFs are labeled with numbers of family counts and percentage of all relevant patent families.

The distribution over Office of First Filing (OFF) is presented in Figure 27. In this figure the top 10 OFFs from all patent families are noted. China and Japan has led patent filings in Waste Treatment and Exploitation, while United States led in Advanced Seed technology relevant to Palm Oil Production. Malaysia is one of the leading countries very active in both Palm Oil Production and Waste Treatment. Other palm-oil producing countries, such as Indonesia, Thailand, Brazil, and Colombia were also founded as OFF. Section 4.12 provided more data for these countries. Next we will present the geographical distribution in Palm Oil Production and Waste Treatment and Exploitation separately.

For Palm Oil Production category the count of family of each OFF in total and per the earliest priority year are shown in Figure 28 and Figure 29, respectively, while those for Waste Treatment and Exploitation in Figure 30 and Figure 31, respectively. Figure 28 shows that is the leading OFF in Palm Oil Production category, followed by Malaysia and China. Figure 29 shows priority filing activities in United States peaked in mid 2000s but has stayed at a lower level recently. Priority filing activities in Malaysia has increased steadily since 2005. China saw the most dramatic increase in the last ten (10) years, from a few priority filings per year to more than 30 per year. United Kingdom is ranked the fourth in the overall priority filings, but the activity has been very low recently. For more OFF activities please see Annex.

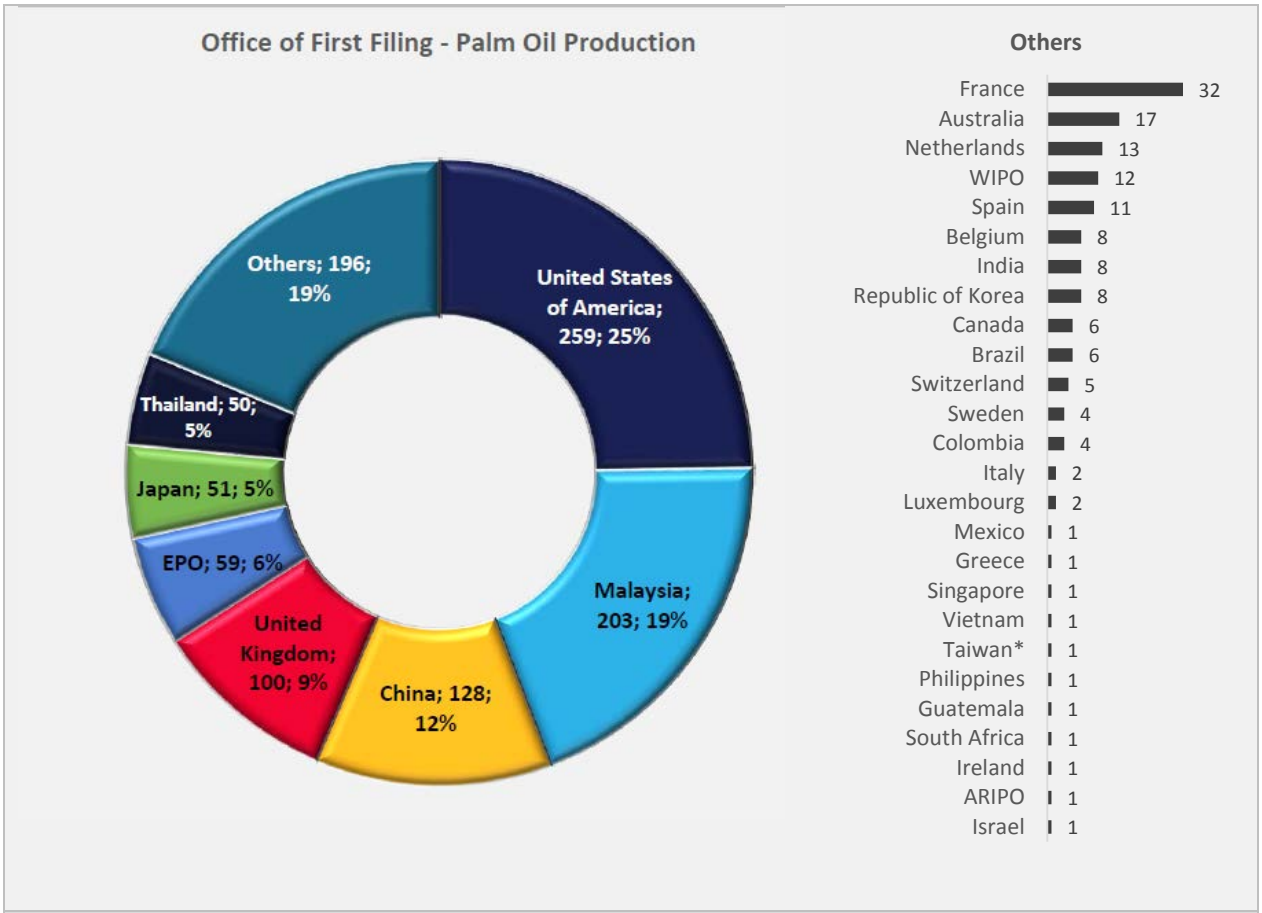


Figure 28 Distribution of the Office of First Filing (OFF) in Palm Oil Production category. Numbers show the family count followed by the percentage. EPO is European Patent Office. The countries included in the slide "Others" are shown on the right. *Taiwan, Province of China.

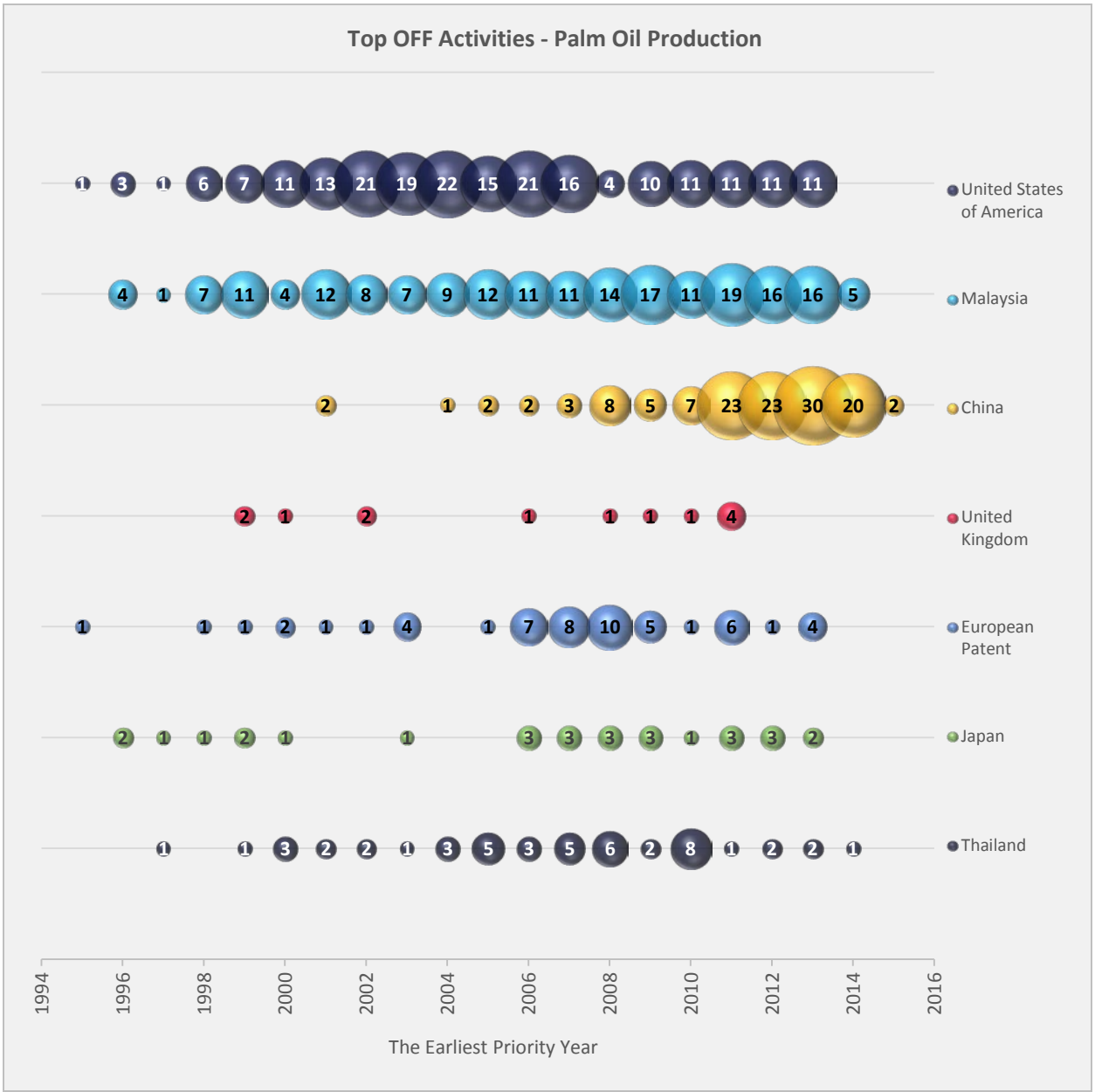


Figure 29 Filing activities from Top OFFs since 1995, by the earliest priority year, for Palm Oil Production. The bubble size and the numerical value represent the number of patent families. More OFF activities are shown in Appendix.

Figure 30 shows the leading county of priority filings for Waste Treatment and Exploitation is China, followed by Japan, Malaysia and Korea. Figure 31 shows there is a quite long history in priority filing in Japan and the activity had a peak in mid 1990s. While all four countries are gaining momentum recently, China really surpassed the other three by a large margin. The detailed technology disclosed in these filings will be discussed later in this report.

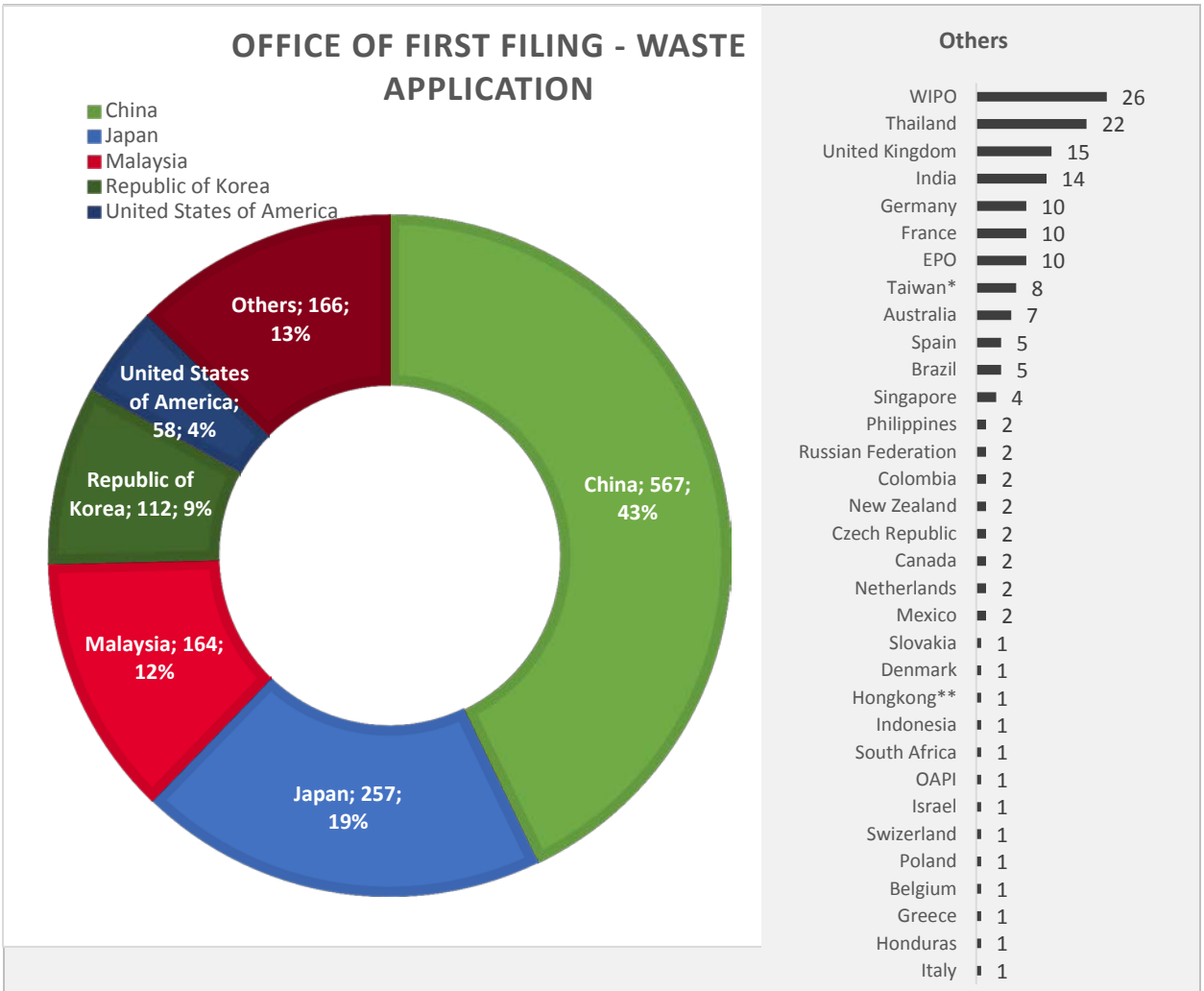


Figure 30 Distribution of the Office of First Filing (OFF) in Waste Treatment and Exploitation category. Numbers show the family count followed by the percentage. The countries included in the slide "Others" are shown on the right.* Taiwan, Province of China.**The Hong Kong Special Administrative Region of the People's Republic of China

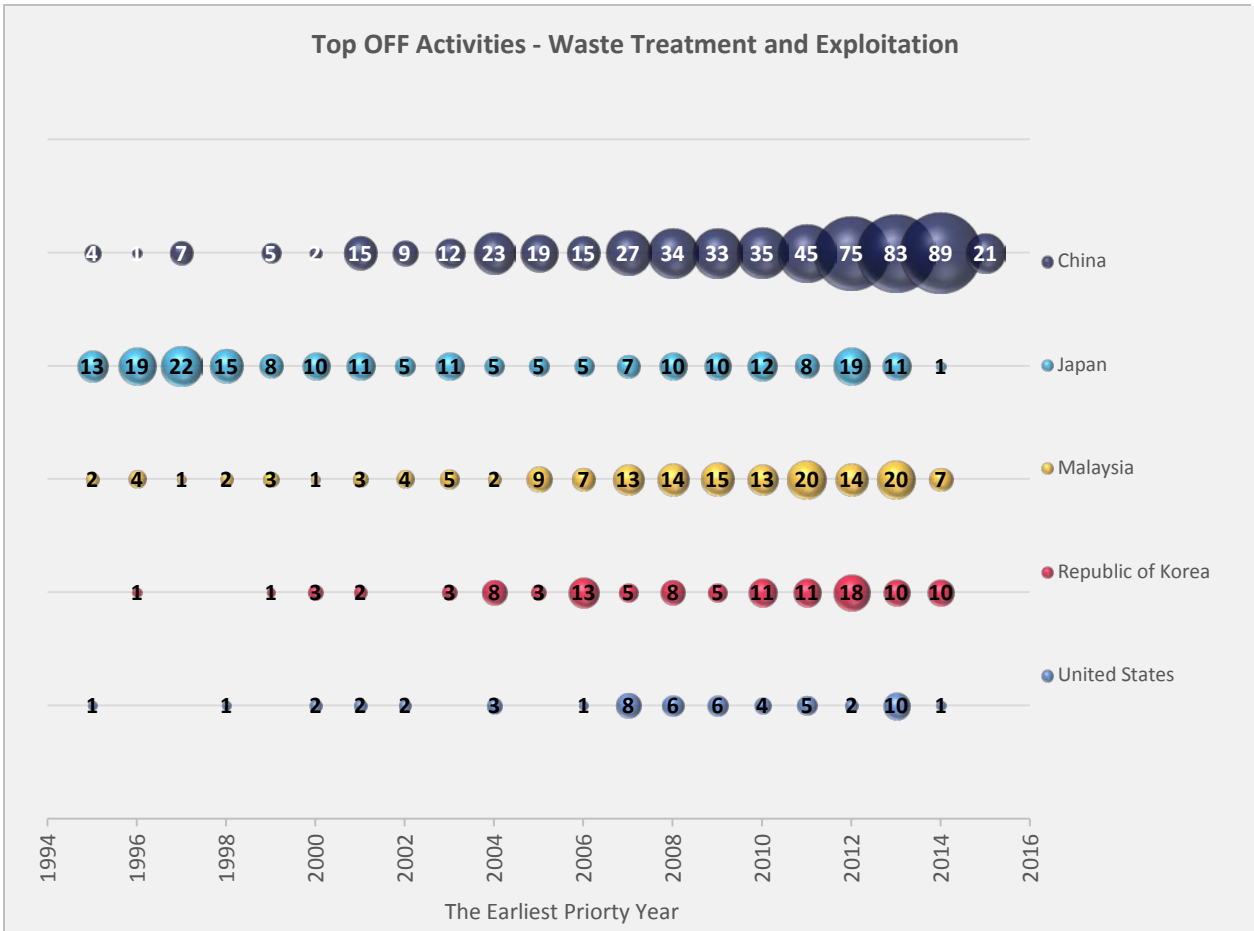


Figure 31 Filing activities from individual OFFs since 1995, by the earliest priority year, for Waste Treatment and Exploitation. The bubble size and the numerical value represent the number of patent families. More OFF activities are shown in Appendix.

Besides the trends in the leading countries we also see the study has provided a broad coverage of important palm oil production countries and regions. Thailand, Colombia, India, and Brazil all showed significant numbers of filings in both categories. The search also found activities in other Southeast Asia countries (e.g. Singapore, Philippines, and Vietnam) and African countries (e.g. South Africa, African regional intellectual property organization). However, as the leading palm oil production country Indonesia did not show significant data in the search results. This is primarily due to the coverage limit induced by the search tools. In order to understand the patenting activities in Indonesia a native language search is recommended.

To examine the geographical distribution of extensions, i.e. filing activities with any Office of Second Filing (OSF) after the priority filing with OFF. In this analysis OFF is excluded and within each patent family the same OSF is only counted only once. For clarity only top 10 OSF are included. The comprehensive OSF results are included Appendix. Figure 32 shows the OSF distribution in Palm Oil Production category, in total and per the earliest priority year for each OSF. Comparing with Figure 28 where there are thirty-four (34) OFFs, there are sixty-eight (68) OSF in this category, indicating patent applicants tend to file more foreign applications or PCT applications, seeking coverage abroad. Among the list of OSFs, PCT applications (WIPO) are the most frequented filed. It shows PCT application is a preferred tool for applicants to obtain international extension beyond domestic filings. Top OSF also include Canada, Australia, Brazil, India, Argentina and Mexico, although they are not the leading OFFs. It indicates these countries are also important in the technology development.

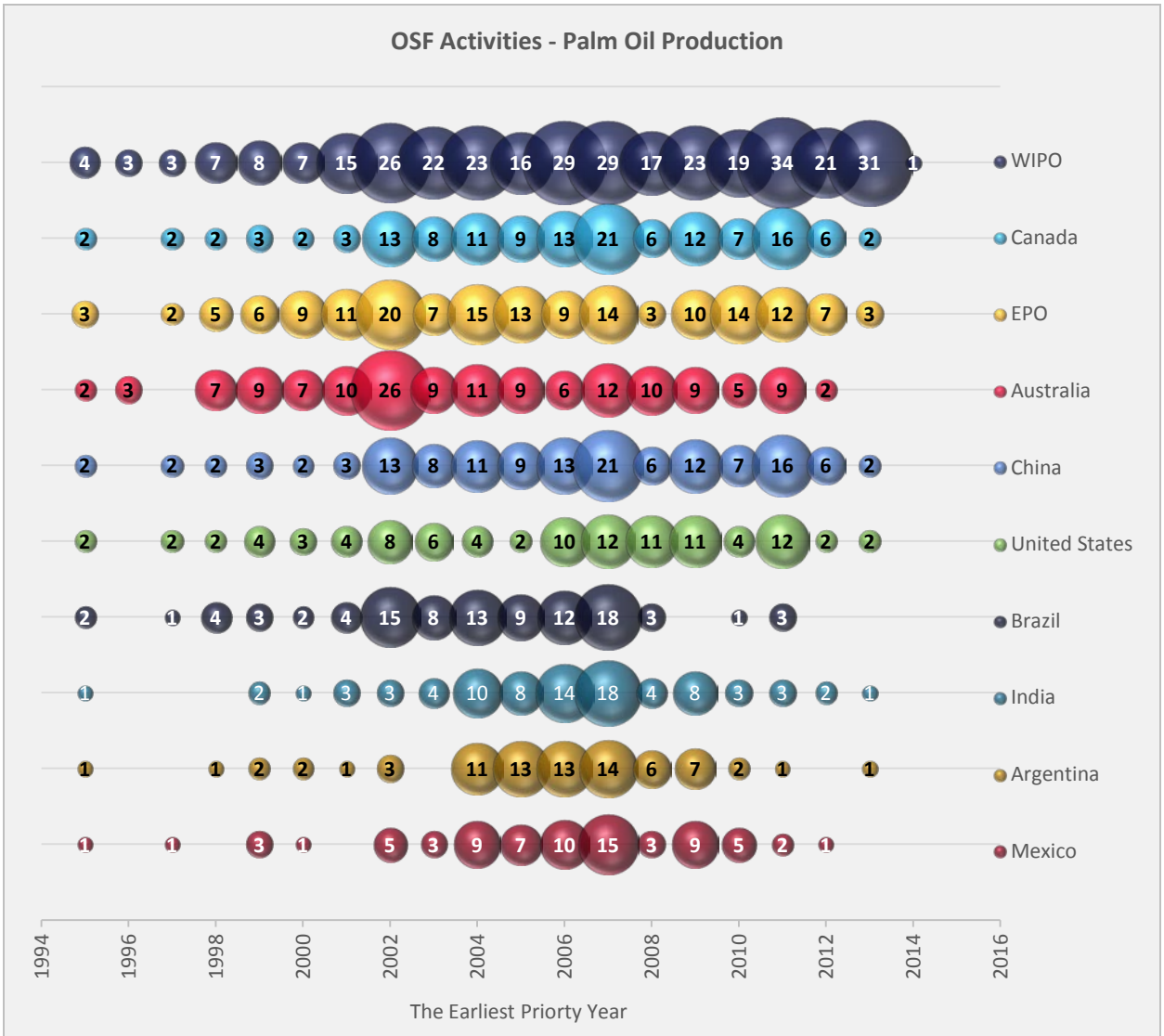


Figure 32 Patent families filed with any Office of Second Filing (OSF) in total and per (earliest) priority year, for Palm Oil Production category.

Figure 33 shows the OSF distribution in Waste Treatment and Exploitation category. There are forty-three (43) OSFs, very close to the number of OFFs, thirty-nine (39) shown in Figure 30. It approved again that the applicants in this category are less active to file abroad, comparing with those in Palm Oil Production category. PCT application is also the leading OSF, followed by United States and Europe.

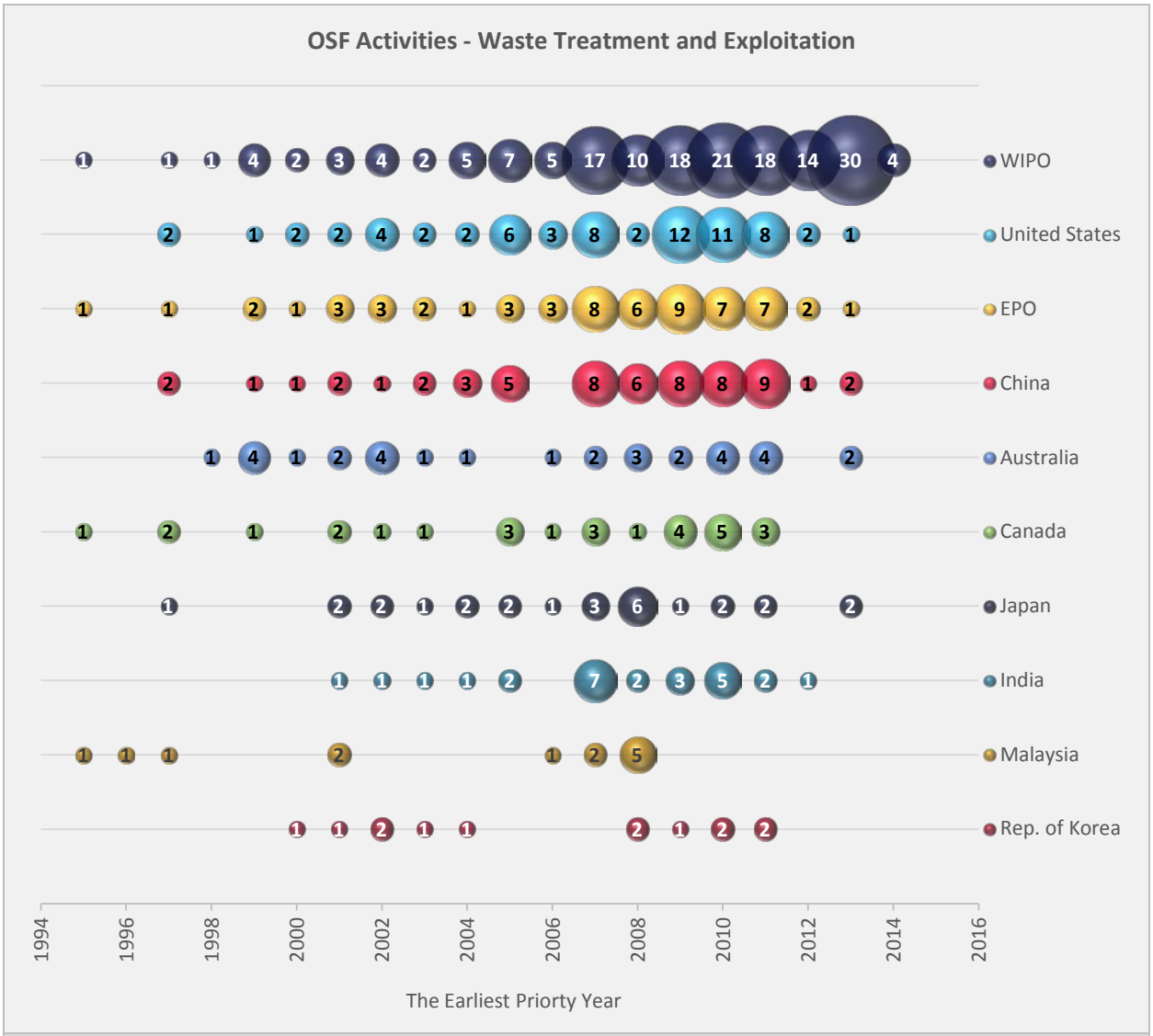


Figure 33 Patent families filed with any Office of Second Filing (OSF) in total and per (earliest) priority year, for Waste Treatment and Exploitation category.

It is also interesting to see how OSF is distributed after each OFF. In the table below the top three (3) OFFs are selected in each top category and the corresponding OSFs are compared. Only a limited number of OSF is selected. For example, United States is the leading OFF in Palm Oil Production. After the first filing (priority) filed in United States applicants tend to file heavily in Europe, Canada and Australia but very few in Colombia, Costa Rica, Malaysia and Indonesia. Quite differently, applicants who filed the first filing in Malaysia tent to file heavily in

United States, Colombia, and Indonesia. Surprisingly applicants who filed a CN priority did not file in any above OSFs.

A detailed analysis of filing activities in Malaysia is provided in a separated section later in this report.

Palm Oil Production (Office of Second Filing)													
OFF	**WO**	**EP**	**CA**	**AU**	**CN**	**BR**	**IN**	**JP**	**CO**	**CR**	**US**	**ID**	**MY**
US	186	117	115	92	73	64	52	27	6	1			1
MY	45	9	1	5	8	11	7	6	14	6	23	11	
CN													

Waste Treatment and Exploitation (Office of Second Filing)													
OFF	**WO**	**US**	**CN**	**EP**	**IN**	**CO**	**BR**	**JP**	**MY**	**AU**	**VN**	**KR**	**ID**
CN	2	1						1	3				
JP	26	9	12	9	2	1	1		9	2	2	4	2
MY	54	29	20	17	14	11	4	5		4	3	2	2

Table 1 Top 3 OFFs and the distribution among selective OSFs.

The information Office of First Filing (OFF) presented as above provided a good indication on the applicants' nationalities, as generally the first priority application (the first filing) is usually filed in the same country when an applicant is located. However there are some discrepancies between these two sets of data. A multinational corporation may file their first filings in a variety of countries. BASF, in this study, filed many first filings in United States, although it is traditionally considered as a Germany company. The Malaysian Palm Oil Board also filed some first filings in United States. For the first filings filed in PCT (WIPO) or European Patent Office (EPO), it is also worth knowing the exact nationality of an applicant. Therefore the nationality of the applicants and inventors in this study are provided in Appendix.

4.7. Most active applicants and inventors

The most active applicants (Top 20) among all relevant patent families) in this study are presented Figure 34. To reflect the recent activities only patent families since 1995 are counted. In this figure the bubble size represents the total number of patent families from each applicant. The position of the bubble along horizontal or vertical axis represents the number of patent families in the corresponding category, in a relative manner. The exact values can be found in Table 2 and Table 3. The primary focus of each applicant's patent filings, either on Palm Oil Production or on Waste Treatment and Exploitation, can be shown from this plot. As can be seen MPOB is the leading applicant overall and also in either of the two categories. It also shows MPOB and other leading Malaysian applicants, e.g. Universiti Putra Malaysia and Sim Darby all had a very balanced patenting activity between Palm Oil Production and Waste Treatment. Most of the other top applicants had their patenting activity predominantly in only one category, for example, BASF and CATAS in Palm Oil Production category, while Guizhou Daziran in Waste Treatment and Exploitation category.

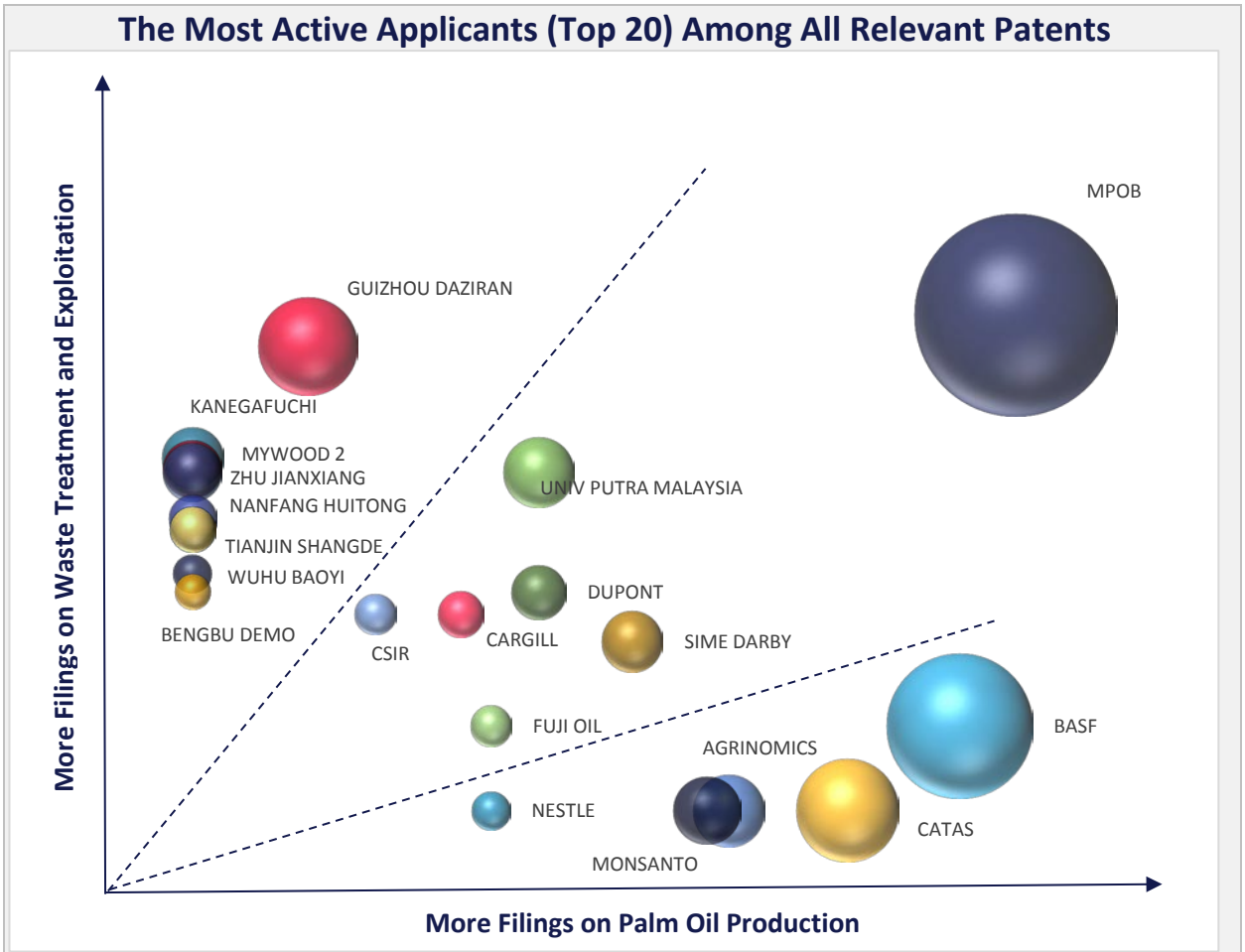


Figure 34 Most active applicants (Top 20) since 1995. Bubble size represents the total number of patent families from each applicant, while position of bubble along horizontal or vertical axis represents the number of patent families in the corresponding category, in a relative manner. The exact values can be found in Table 2 and Table 3.

The most active applicants were also presented separately in Palm Oil Production and Waste Treatment and Exploitation categories, respectively, in Table 2 and Table 3. In Palm Oil Production category MPOB and BASF are the leading two applicants, well exceeding the other applicants in patent family counts. Multinational agrochemical and agricultural biotechnology corporations are among the top list. Sime Darby and Universiti Putra Malaysia are another two Malaysian entities. Among the three Chinese applicants, the Chinese Academy of Tropical Agricultural Sciences (CATAS) is a research institute, while the other two are machinery manufacturers. The two most active Japanese applicants are both food oil makers. Applicants from the private sector are the majority.

Most Active Applicants in Palm Oil Production

Applicant	Type	Nationality	Family Counts
Malaysian Palm Oil Board	Public	Malaysia	141
BASF	Private	Germany	100
Catas-China	Public	China	51
Agrinomics	Private	United States	25
Monsanto	Private	United States	22
Sime Darby	Private	Malaysia	14
Universiti Putra Malaysia	Public	Malaysia	8
DuPont	Private	United States	8
Nestle	Private	Switzerland	6
Fuji Oil	Private	Japan	6
Zhong Yongtai	Individual	China	5
Sued Chemie	Private	Germany	5
Agrigenetics	Private	United States	5
Cargill	Private	United States	5
Ningbo Lihao	Private	China	4
Nantong Safe	Private	China	4
Nisshin Oil	Private	Japan	4
Swetree Technologies	Private	Sweden	4
Sumatra Bioscience	Private	Singapore	4
Ceres	Private	United States	4

***Table 2** Most active applicant in Palm Oil Production category, since 1995*

In Waste Treatment and Exploitation category MPOB is also the leading applicants. Nine Chinese applicants made to the top 20 list. Universities in Malaysia are very active, such as Universiti Putra Malaysia and Universiti Malaysia Pahang. Although not in the list University Malaya, Universiti Teknologi Malaysia, and University Malaysia Technology also have four patent families. Council of Scientific and Industrial Research (CSIR) of India is also among the list. Private and Public applicants are more balanced in this area as many universities are involved.

Most Active Applicants in Waste Treatment and Exploitation

Applicant	Type	Nationality	Family Counts
Malaysian Palm Oil Board	Public	Malaysia	58
Guizhou Daziran Technology	Private	China	45
Kanegafuchi Chemical Industry	Private	Japan	18
Zhu Jianxiang	Individual	China	16
Mywood 2	Private	Japan	16
Universiti Putra Malaysia	Public	Malaysia	16
Nanfang Huitong	Private	China	11
South Huiton	Private	China	10
Tianjin Shangde	Private	China	10
Universiti Teknologi Malaysia	Public	Malaysia	9
Bengbu Demo Filtration Technology	Private	China	7
Wuhu Baoyi Amusement Equipment	Private	China	6
Jinan University	Public	China	6
Arter Technology	Private	United Kingdom	6
Dupont	Private	United States	6
Guizhou Nature Science & Technology	Private	China	5
Csir-India	Public	India	5
Sumitomo	Private	Japan	5
Cargill	Private	United States	5
Sime Darby	Private	Malaysia	4

Table 3 Most active applicants in Waste Treatment and Exploitation, since 1995.

The technology profile of the most active applicants in palm oil production is summarized in Table 4. Among all the applicants MPOB has the most versatile profile. MPOB has patents filed heavily in advanced seeds, fruit growing and harvesting, pressing and refining. The other applicants tent to focus only on one category. For example, BASF, Agrinomics and Monsanto focus primarily on advanced seeds. CATAS patents also covered multiple categories, but focus on tree seeding and cultivating. Not surprisingly the leading applicants in oil refining are major food oil makers, such as Fuji Oil, Nisshin Oil and Nestle.

Table 5 summarizes the waste exploitation subcategories of the most active applicants. The most investigated category of MPOB is the extraction of phytonutrients. Many Chinese applicants filed heavily in making mattresses and cushions using palm fiber. MYWOOD 2 focuses on making composite wood materials by palm tree trunk. Obtaining fermentation products, such as sugar and alcohols, are the important technology of Du Pont, Arter and Universiti Putra Malaysia.

Technology Profile of Most Active Applicants – Palm Oil Production

	Advanced seeds	Tree seeding and cultivating	Fruit growing and harvesting	Sterilization of bunches	Threshing	Digestion	Pressing	Oil storage	Refining	Kernel recovery	Kernel cooking	Kernel oi extraction	Other process
Malaysian Palm Oil Board	33	23	38	4	1		13	2	23	2		1	
BASF	88	7					4		1				
Catas-China	4	22	8	3	2		7		2	3			
Agrinomics	25												
Monsanto	22												
Sime Darby	6	2				1			4			1	
Universiti Putra Malaysia		1	2	2					3				
DuPont	5	2	1										
Nestle									6				
Fuji Oil									6				
Agrigenetics	5												
Cargill									5				
Sued Chemie									5				
Zhong Yongtai				5									
Ceres	4												
Swetree Technologies	4												
Sumatra Bioscience Pte	4												
Nisshin Oil								1	3				
Ningbo Lihao Machinery		3	1										
Nantong Safe Machinery Equipment				1	2					1			

Table 4 Palm oil production technology categories of the most active applicants. Numbers indicate count of families.

Technology Profile of Most Active Applicants – Waste Treatment and Exploitation

	Extraction of palm oil	Phytonutrients	Other chemicals	Direct fuel	Charcoal	Biodiesel	Adsorbent	Filter	Composite material	Animal feed	Fertilizer	Cultivation structure	Fermentation product	Paper making	Waste water treatment	Mattress/cushion	Other products	Other processing
Malaysian Palm Oil Board	2	34		1	1				4	2	5		2		3	1		3
Guizhou Daziran Technology				3				1	3							32	2	4
Kanegafuchi Chemical Industry												1				6	11	
Universiti Putra Malaysia		5							3	1	2		4		1			
Zhu Jianxiang																14		2
Mywood 2									13								2	1
Nanfang Huitong								2								6		3
South Huiton												1				7	1	1
Tianjin Shangde																		10
Universiti Teknologi Malaysia					2				3				1				2	1
Bengbu Demo Filtration Technology							6	1										
Wuhu Baoyi Amusement Equipment								6										
Jinan University							6											
Arter Technology													6					
Dupont													6					
Sumitomo					1								1		3			
Guizhou Nature Science & Technology																5		
Csir-India		3									1						1	
Cargill				1					1						3			
Sime Darby			2			1							1					

Table 5 Waste Treatment and Exploitation categories of the most active applicants. Numbers indicate count of families.

The patenting activities of the most active applicants are shown in Figure 35 and Figure 36. In Figure 35 it appears MPOB have been very active since 1996. CATAS became very active after 2010. BASF, Agrinomics, Monsanto were active in 2000s, but their activities are very low now. A few applicants have activities only in a single year, such as Agrigenetics, Nantong Safe, Ningbo Lihao, and CERES.

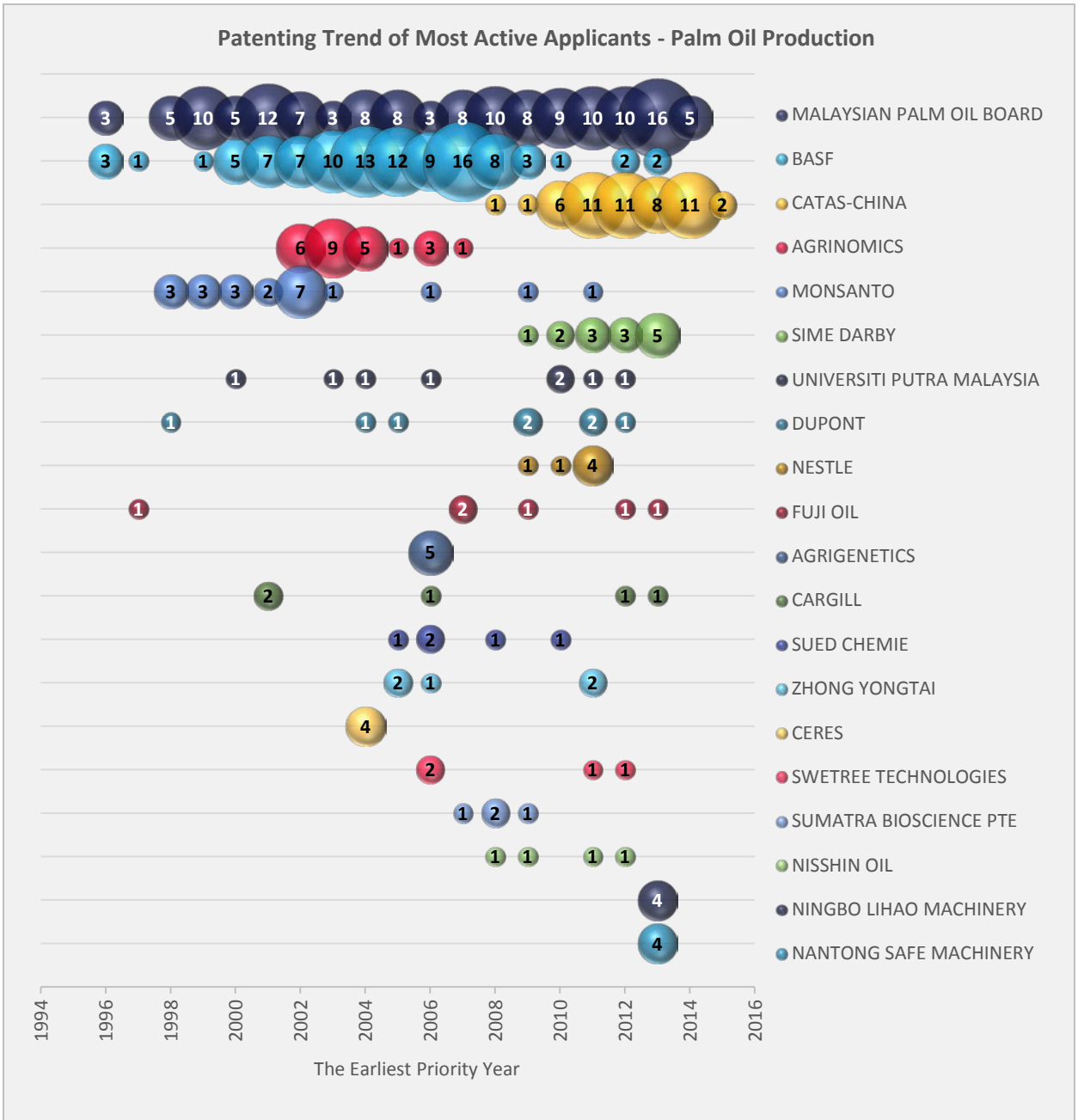


Figure 35 Filing activities from the most active applicants since 1995, by the earliest priority year, for Palm Oil Production. The bubble size and the numerical value represent the number of patent families.

Many of the applicants in Waste Treatment and Exploitation category showed activities only in a year or two. Malaysian applicants, such as MPOB and Univ Putra, have been active for the past 10 years. CSIR of India also has a long history in this field.

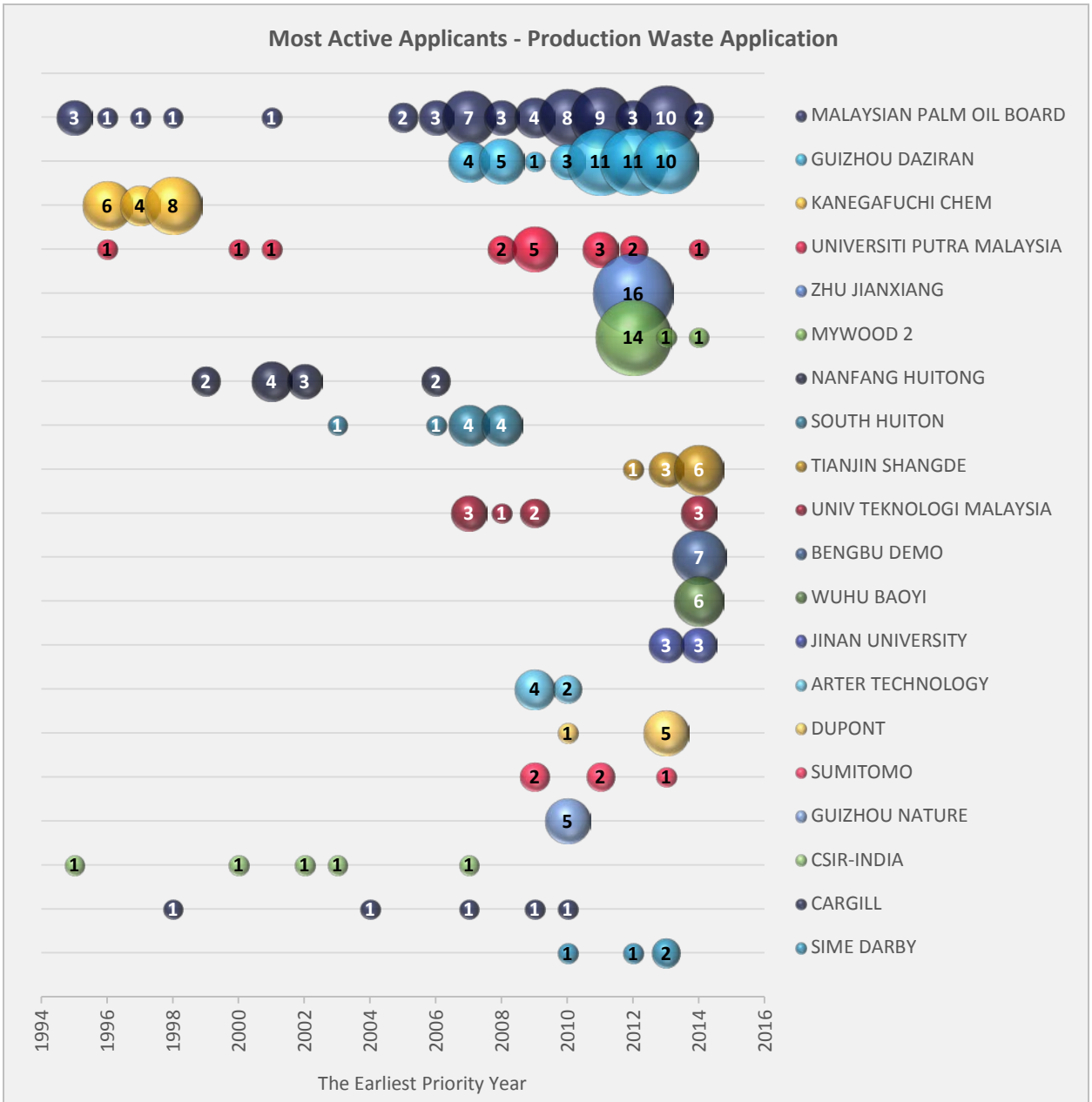


Figure 36 Filing activities from the most active applicants since 1995, by the earliest priority year, for Waste Treatment and Exploitation. The bubble size and the numerical value represent the number of patent families.

The preferred OFF of most active applicants are presented in Table 6 and Table 7. The results are not surprising that the preferred OFFs normally follow the applicants' nationalities. The preferred OFF of BASF is US because most R&D in this field was conducted in United States.

Most Active Applicants in Palm Oil Production – Office of First Filing (OFF)

	US	MY	CN	EP	TH	JP	DE	AU	GB	WO	NL	SE
MALAYSIAN PALM OIL BOARD	4	113		1	18	2		1			1	
BASF	67			21	1		7	3	1			
CATAS-CHINA			51									
AGRINOMICS	24				1							
MONSANTO	21			1								
SIME DARBY		12		1	1							
UNIV PUTRA MALAYSIA		8										
DUPONT	7		1									
NESTLE				5	1							
FUJI OIL						6						
AGRIGENETICS	5											
CARGILL	4			1								
SUED CHEMIE				3			2					
ZHONG YONGTAI			5									
CERES	4											
SWETREE TECHNOLOGIES	1									2		1
SUMATRA BIOSCIENCE PTE		1		1					2			
NISSHIN OIL					1	3						
NINGBO LIHAO			4									
NANTONG SAFE			4									

Table 6 OFFs of most active applicants in Palm Oil Production. Numbers indicate count of families.

Most Active Applicants in Waste Treatment and Exploitation – Office of First Filing (OFF)

	CN	MY	JP	US	WO	IN	TH	EP	SG
MALAYSIAN PALM OIL BOARD		51		4	1		2		
GUIZHOU DAZIRAN	45								
KANEGAFUCHI			18						
UNIV PUTRA MALAYSIA		11		1	3				1
ZHU JIANXIANG	16								
MYWOOD 2		2	11		3				
NANFANG HUITONG	11								
SOUTH HUITON	10								
TIANJIN SHANGDE	10								
UNIV TEKNOLOGI MALAYSIA		9							
BENGBU DEMO	7								
WUHU BAOYI	6								
JINAN UNIVERSITY	6								
ARTER TECHNOLOGY		2			4				
DUPONT				6					
SUMITOMO			3		2				
GUIZHOU NATURE	5								
CSIR-INDIA						5			
CARGILL				3			1	1	
SIME DARBY		4							

Table 7 OFFs of most active applicants in Production Waste Application. Numbers indicate count of families.

Table 8 and Table 9show use of OSF for extensions among the most active applicants. Surprisingly none of most active Chinese applicants filed in any OSF. MPOB filed in a broad range of OSFs, with WO and US the most important two offices. Also MPOB filed heavily in other key palm oil production countries, such as Indonesia and Colombia. Other Malaysian applicants also filed WO and US significantly. While most US and European applicants have a broad coverage of OSF, they rarely filed in Malaysia (MY) as an OSF.

Most Active Applicants in Palm Oil Production – Office of Second Filing (OSF)

	WO	CA	EP	CN	AU	BR	US	AR	IN	MX	JP	DE	ES	AT	ZA	CO	ID	DK	KR	CR	RU	NZ	PT	EA	TW	GB	IL	VN	NO	UY	CL	SG	TH	EC	AP	FR	PE	PH	NL	MY	OA	HU	UA	MA
MPOB	27	1	10	7	3	8	25		4		4	5		3		7	11			2					1	4			1			2	4			2			2	1				
BASF	86	70	51	48	55	39	25	42	38	35	13	17	16	12	9	2		3	6	2	5	4	2	6	1		3	3	3	3	2			1	1		1					1	1
CATAS-CHINA																																												
AGRINOMICS	24	7	5	11	7	12		6	1	10	1	1	2	1	10			2	1		1						1																
MONSANTO	19	14	15	11	18	11		7	5	1	3	6	4	7				3				1	3				1																
SIME DARBY	12		1	1	1		1				1		1			3		1		3											1												
UNIV PUTRA	2																																										
DUPONT	8	7	7	5	5	6		3	2	3	3	1	2		1	2						1	1					1	1								2			1	1		
NESTLE	5	1		5	1		5		1	1	4										1				1						1												
FUJI OIL	4		3	1			3												2																								
AGRIGENETICS	5	5						5																																			
CARGILL	4		1						1																																		
SUED CHEMIE	5	2	2	1			3	1	1	2	1		1			1																		1			1						
ZHONG YONGTAI																																											
CERES	4	3	2	2	2	1			2	2																																	
SWETREE TECH	2	2	3	3	3		2		1		2				1							1						1		1	2											
SUMATRA BIOSCI	3			1	1	1	1		1							1				1													1	1								
NISSHIN OIL	2		2	2			1																		2	1																
NINGBO LIHAO																																											
NANTONG SAFE																																											

Table 8 OSFs of most active applicants in Palm Oil Production

Most Active Applicants in Waste Treatment and Exploitation – Office of Second Filing (OSF)

	WO	US	EP	CN	IN	CO	JP	AU	DE	BR	MY	SG	AT	DK	KR	AP	VN	CA	ES	GB
MPOB	28	23	18	16	12	11	5	4	3	2	2	2	2	2	1		1	1	1	
UNIV PUTRA	4	3	1													1				1
CARGILL	4					1		1		1										
DUPONT	6																			
SIME DARBY	2																			

Table 9 OSFs of most active applicants in Production Waste Application

The most active inventors, with 13 families or more, and their activities are shown in Figure 37. The distribution of the most active inventors are quite as expected that they are always affiliated with the most active applicants, including MPOB, Guizhou Daziran, CATAS-China, and Mywood 2. With regard to the technologies the inventions between palm oil production and waste treatment are quite balanced (See Appendix). MPOB inventors all have spanned their activities over more than ten years, indicating the stable and dedicated effort of MPOB in promoting palm oil industry. It is also noted that Datuk Dr. Choo Yuen May, one of the most active inventors, is the current director of MPOB. For inventors associated with other applicants their patenting activities appear very much limited to several years.

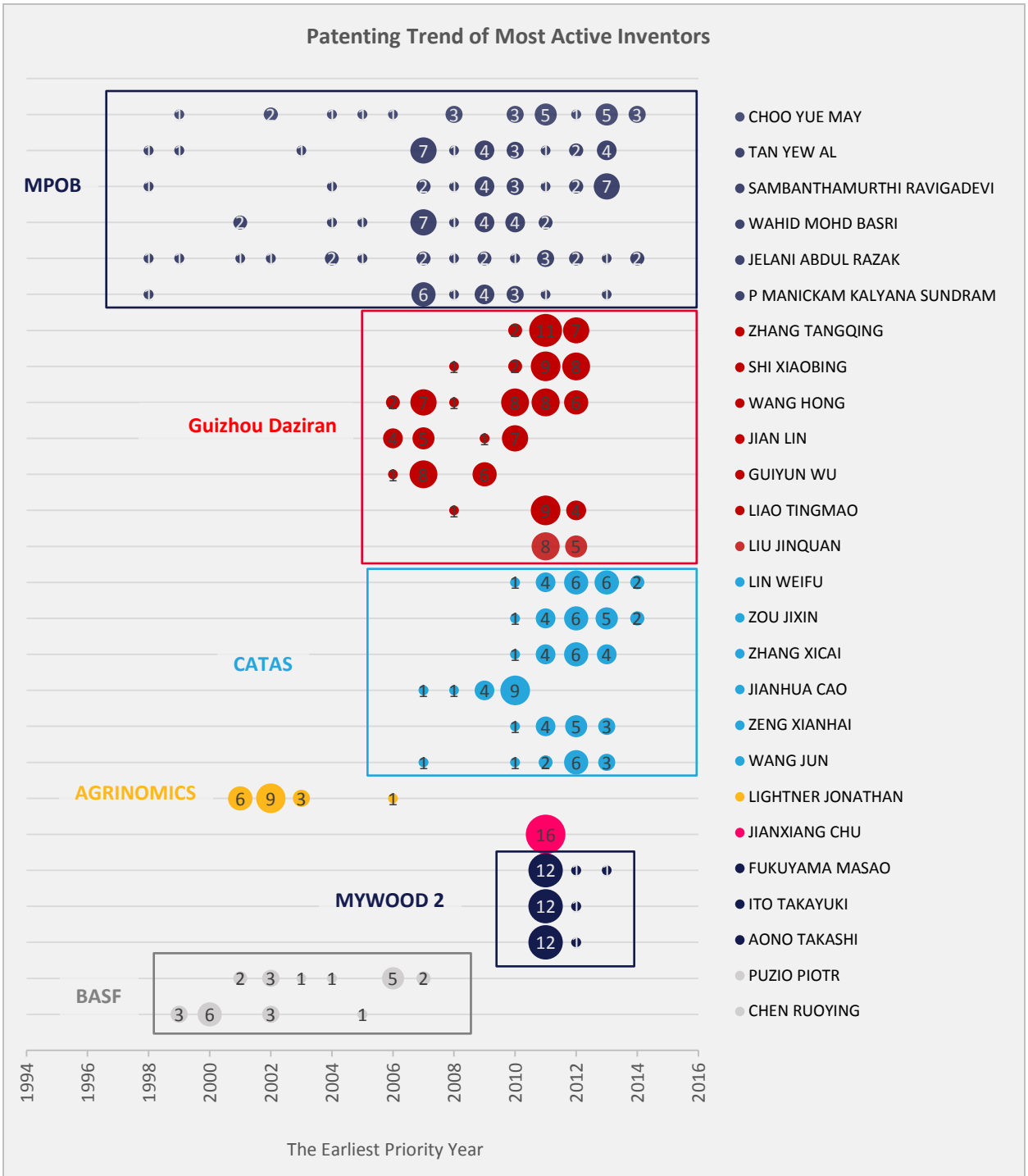


Figure 37 Filing activities from the most active inventors since 1995, by the earliest priority year. The bubble size and the numerical value represent the number of patent families.

4.8. Collaborations

Significant collaborations among applicants were observed in this study. Collaborations were judged by the co-assignment of patent families. Among the most active applicants, MPOB, Universiti Putra Malaysia (UPM) and BASF have led collaborations with many public and private entities, as shown in Figure 38. The collaboration between MPOB and UPM is the most active. The coassignment information shows MPOB is very active in collaboration with foreign entities, including, Japan: Sakamoto Yakuhin Kogyo; Japan Bioindustry; Yokohama Rubber; Tsubakimoto Bulk Systems; Germany: Fraunhofer; China: Tsinghua University; United States: Brandeis University; Australia: CSIRO; France: CIRAD.

Please note that only collaborations involving the most active applicants are shown here. More detailed information of collaborations can be found in Appendix.

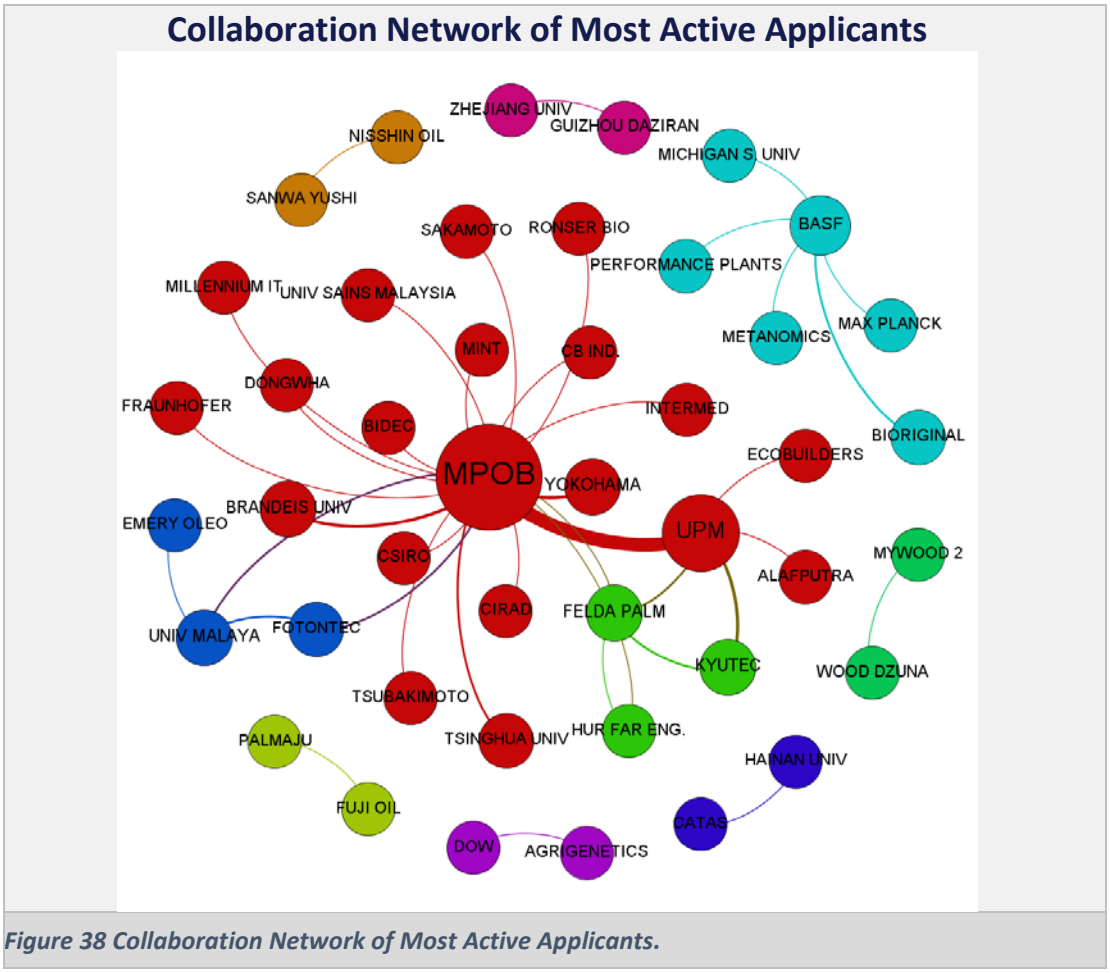


Figure 38 Collaboration Network of Most Active Applicants.

4.9. Citation frequency

Forward citation frequency, i.e. the number of times of a patent being cited in later patent applications, was determined by the data provided by Orbit. High citation frequency may indicate a patent covering key innovations. Figure 39 presented a forward citation frequency analysis of patent families filed since 1990. In the Palm Oil Production category advanced seeds and oil refining are the two categories containing patents with high forward citations. In Waste Treatment and Exploitation category, MPOB has patents in extraction of phytonutrients that received high forward citations. More description of these patents can be found in Appendix.

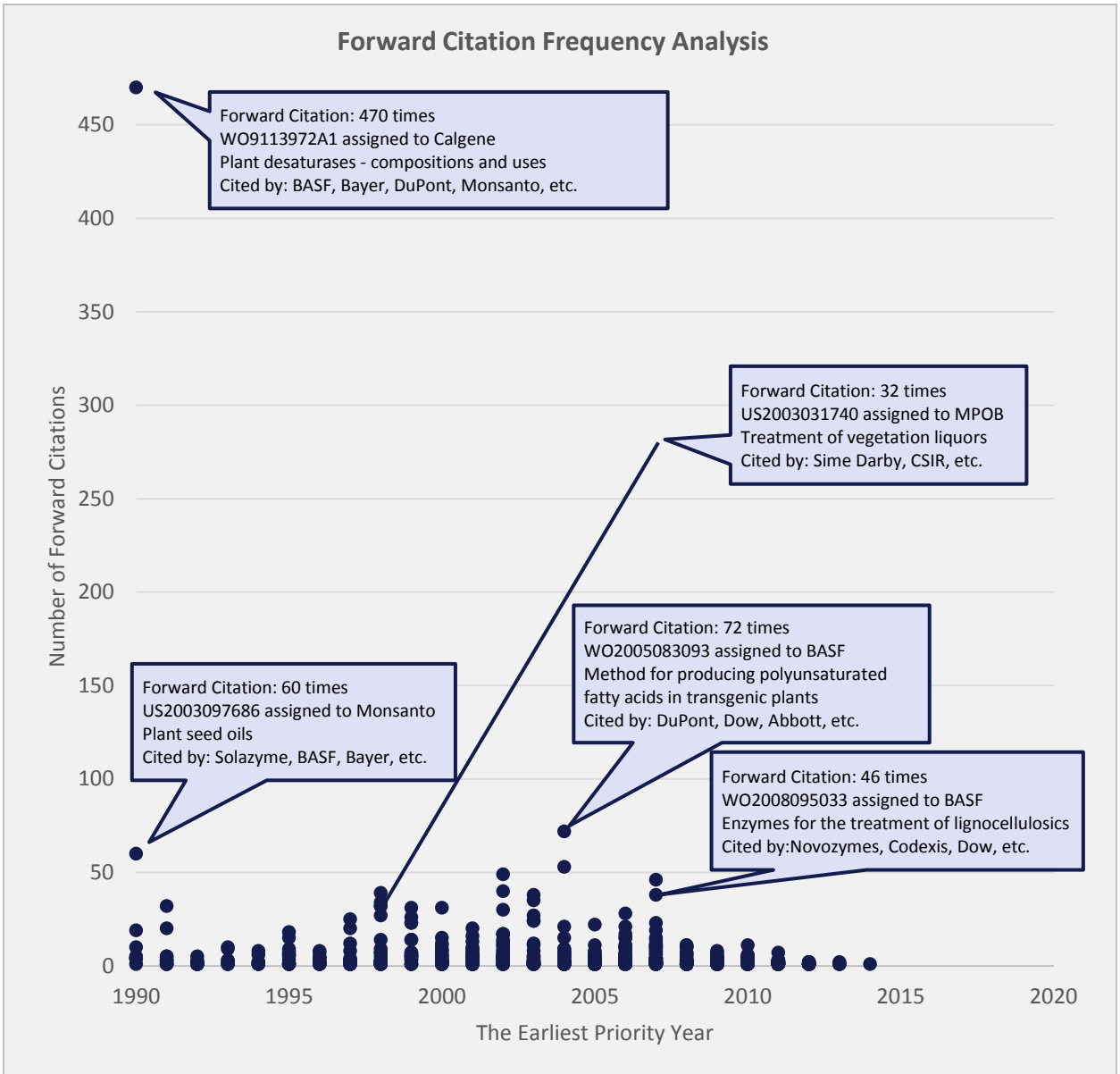


Figure 39 Forward Citation Frequency Analysis

4.10.Recent Technology Trends (2010-2015)

The patenting activity relevant to palm oil production can be traced by to early 1900s, although it is critical to review the recent filing in order to understand technology advancement. In this section we examine the patents filed since 2010 (earliest priority year in and after 2010) and present the important findings.

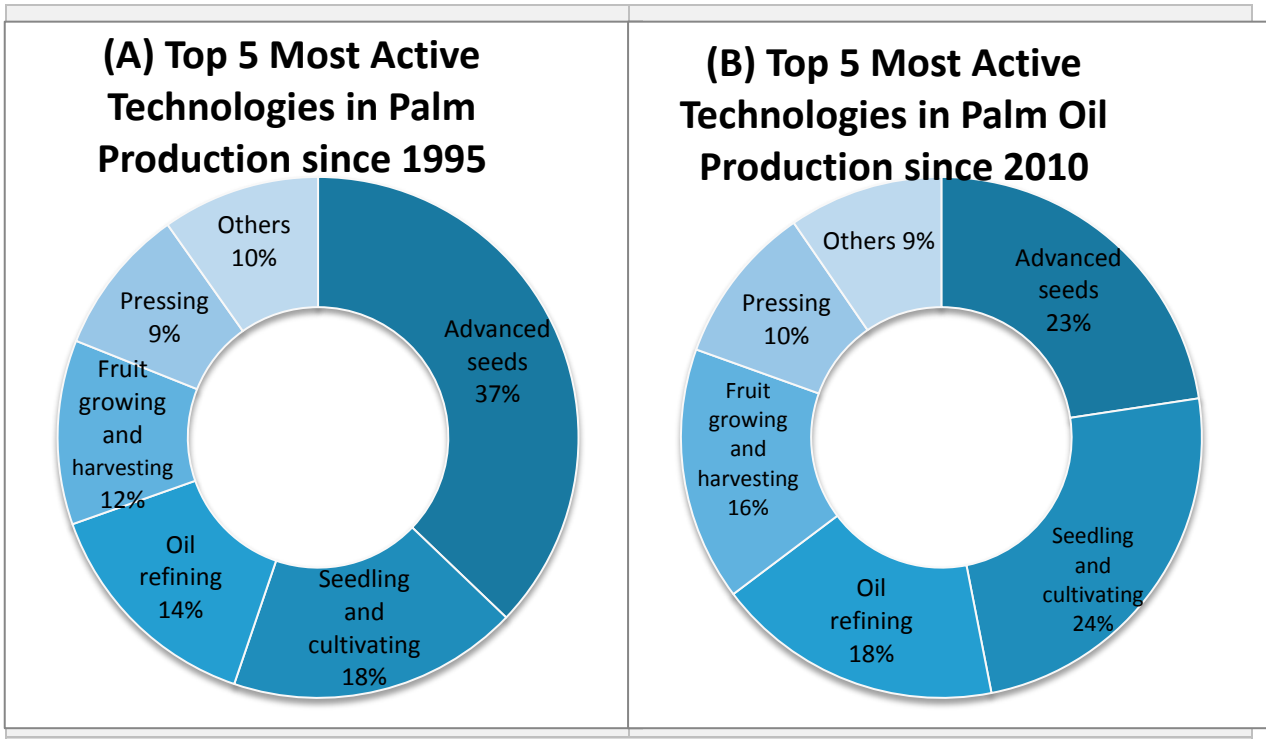


Figure 40 Top 5 Most Active Technologies in Palm Oil Production in Recent Patent Filing, (A) since 1995 and (B) 2010 to 2015.

Advanced seeds, Seedling and cultivating, Oil refining, Fruit growing and harvesting and Pressing have been the top five (5) most active technology subcategories in Palm Oil Production since 1995 and remained the most active in recent 5 years, as shown in Figure 40.

Figure 41 shows the top 5 most active subcategories within waste treatment and exploitation. Consumer products, such as mattress and cushion, composite material, and biomass fermentation have remained active in the past 20 years. Using palm fiber as filter materials have become active since 2010.

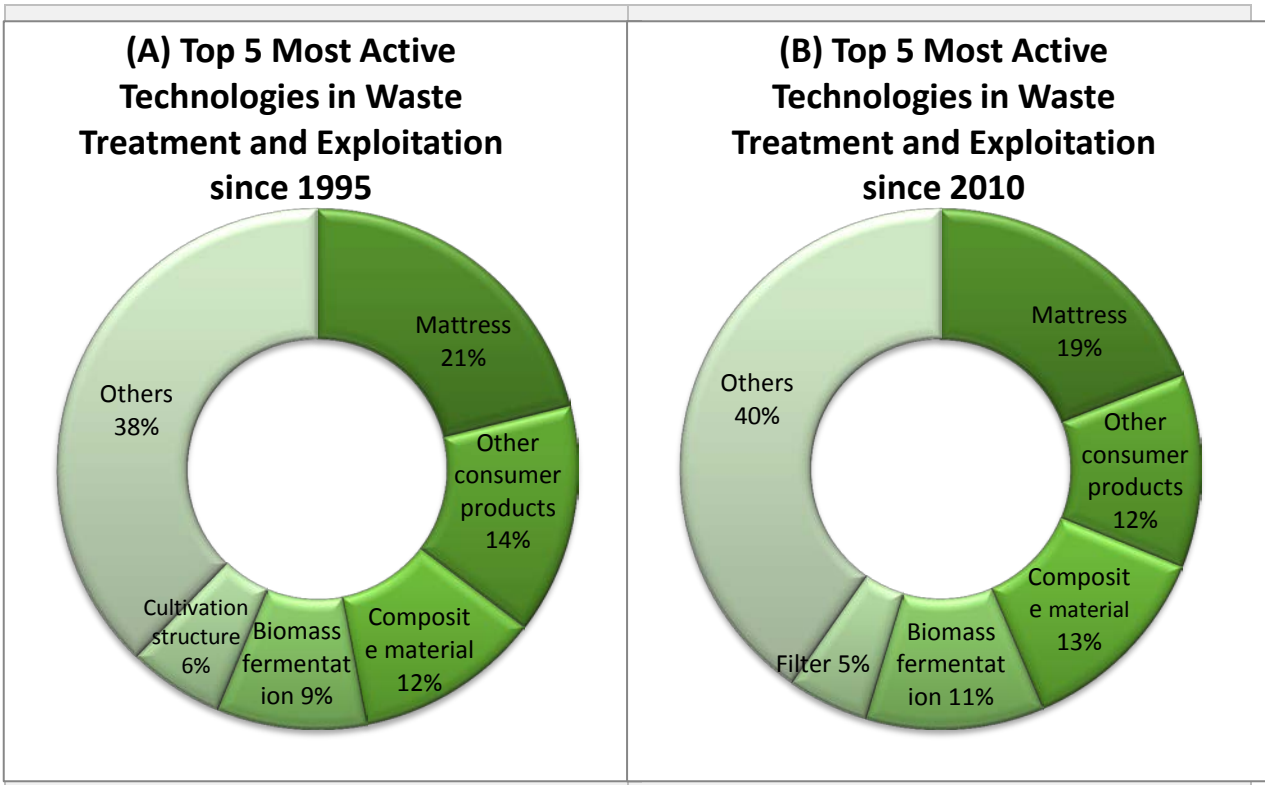


Figure 41 Top 5 Most Active Technologies in Waste Treatment and Exploitation in Recent Patent Filing, (A) since 1995 and (B) 2010 to 2015.

More detailed analysis of each technology subcategory and the important applicants are included in Section 5 and 6.

4.11. Patenting activities in MyIPO

Patenting activities in MyIPO were particularly analyzed to compare with the global trend. While some information regarding MyIPO filings, such as OFF and OSF, has been provided in the previous sections, we are adding here more analysis in order to understand the activities more comprehensively.

Figure 42 shows the patenting activity in MyIPO since 1970, using count of families. Similar to the global trend the recent increase in activity was dramatic. However a more balanced technology distribution between Palm Oil Production and Waste Treatment was noticed. This demonstrates that Malaysia has developed significant experience in the entire value chain of palm oil production.

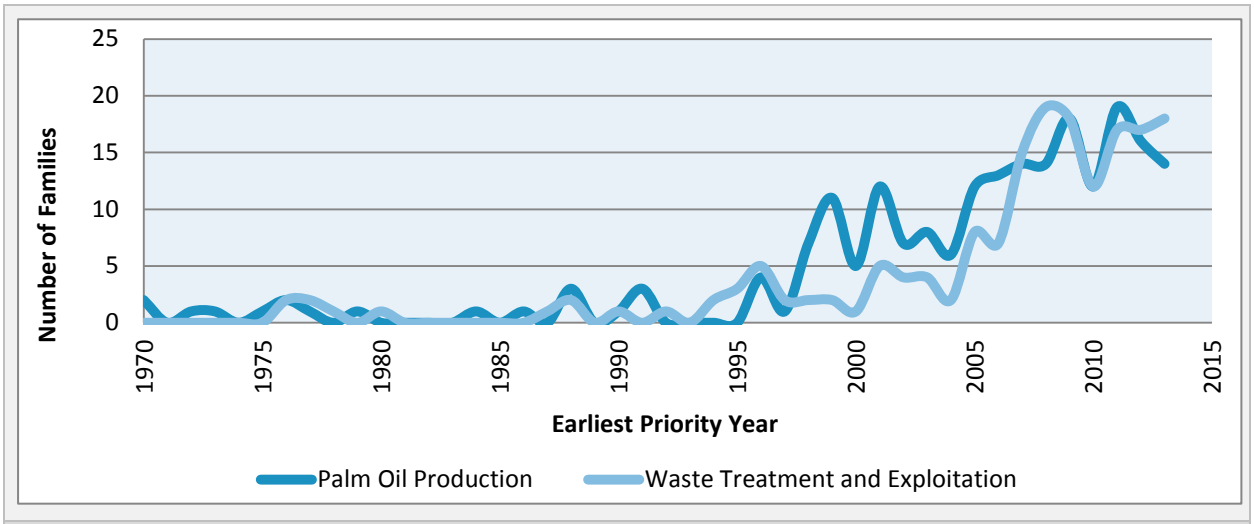


Figure 42 Patenting activity in MyIPO since 1970. (Note: 2014 and 2015 data are not shown due to incompletion from delayed publication.)

Figure 43 shows the geographic origin of the patents filed in MyIPO in this field. Filings are predominantly from Malaysian applicants, with MyIPO as the OFF. Foreign applicants are not actively filing in MyIPO.

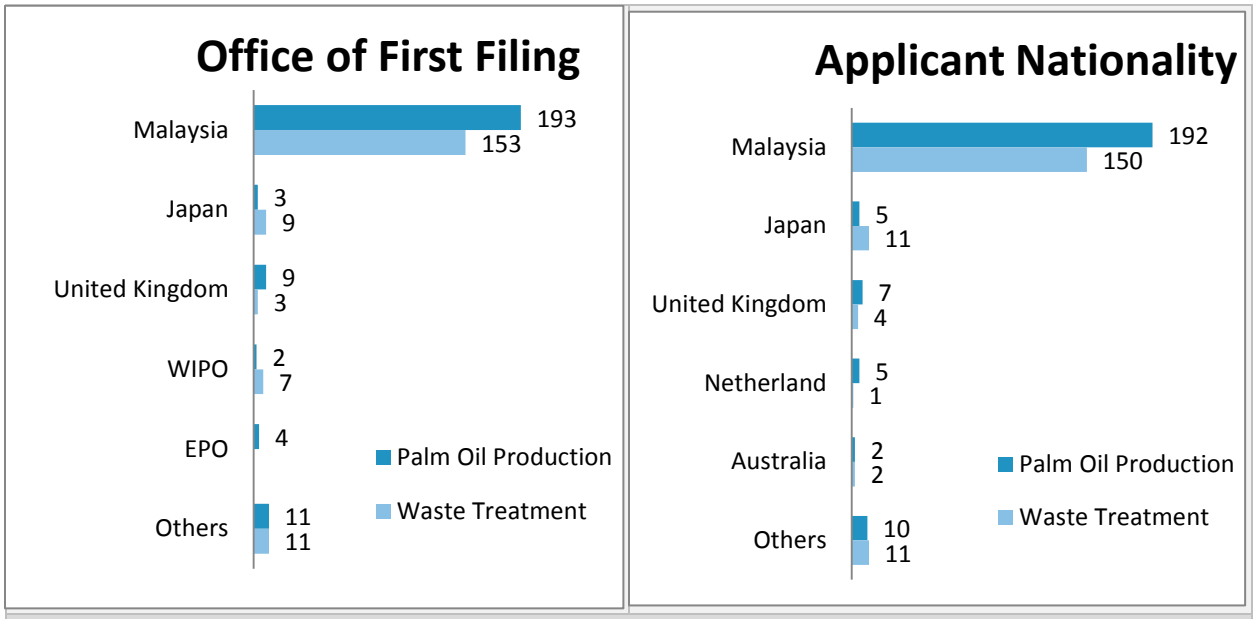


Figure 43 Geographic origin of filings in MyIPO

The most active Malaysian applicants have been shown in the global trend, such as MPOB, Sime Darby and Universiti Putra Malaysia. Figure 44 expands the coverage to more applicants. However it appears the other applicants cannot actually compete with these three top applicants in number of filings. Therefore the technologies disclosed by these three applicants very much determined the entire patent landscape in Malaysia.

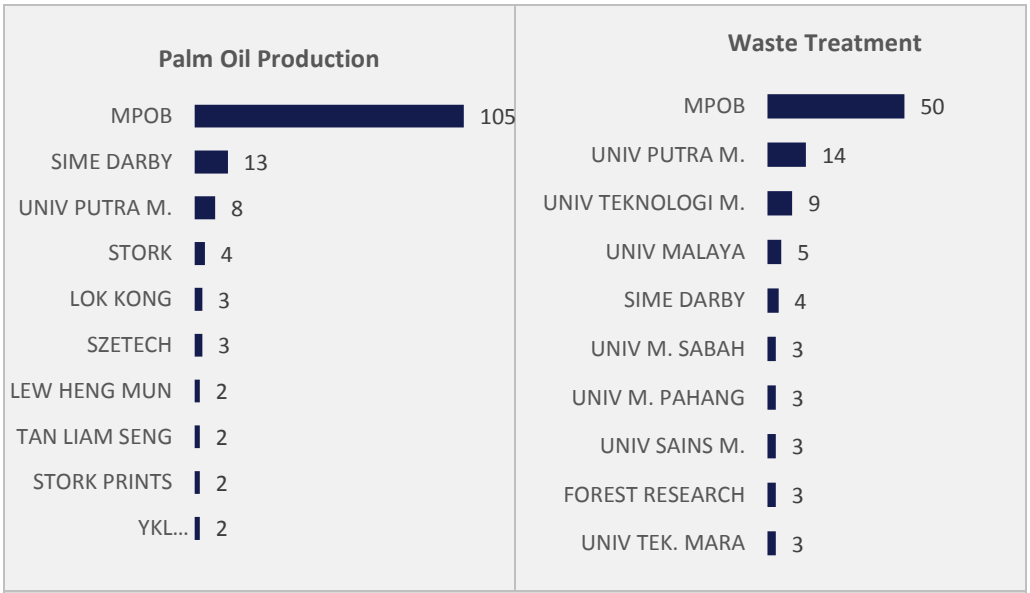


Figure 44 The most active applicants in MyIPO filings

4.12. Patenting activities in other major palm oil producing countries

Palm oil production also plays an important role in other economies in South-East Asia, Latin America and Africa. Indonesia, for example, is the leading producer of palm oil. As discussed in Section 2.2 the patent search in this study has limited coverage in many of these countries. The coverage might not be sufficient for reliable patenting activity analysis. However, from the patents collected we can still get some information of the patenting activities in other palm oil producing countries.

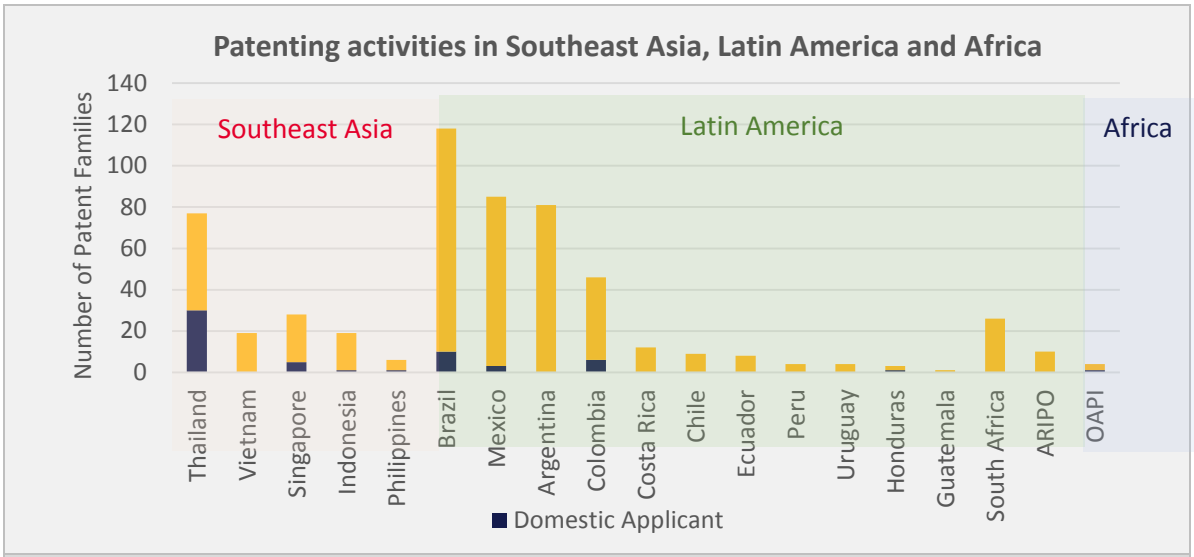


Figure 45 Patenting activities in Southeast Asia, Latin America and Africa, since 1995.

As can be seen in Figure 45 among Southeast Asian countries Thailand showed much higher patenting activities, and a significant portion of the patents were from Thai applicants. Malaysian applicants, particularly MPOB, are the most active foreign applicants Thailand. In Latin America, relevant patents were predominantly filed by foreign applicants. Brazil, Mexico, Argentina and Columbia showed high activities, primarily filed by US and European Agrochemical and agricultural biotechnology corporations, e.g. BASF and Monsanto. MPOB also filed actively in Brazil and Columbia. However there were domestic applicants filing patents relevant to palm tree seedling and cultivation. For example, Universidade Federal De Vicosa (Brazil), Roberto Gonzalez Barrera (Mexico) and Colombiana De Organicos (Columbia).

Very few patent families found in this study were originated from Africa. BASF and Agrinomics are very active in South Africa. Also foreign applicants have filed within African Regional Intellectual Property Organization (ARIPO) and African Intellectual Property Organization (OAPI)

The observation as above may not reflect the complete trend in these countries. It is recommended that searches using native languages should be conducted. A separate patent landscape report on palm oil covering the national patenting activity in the Philippines is planned to be carried out by the Philippines Intellectual Property Office (IPOPHL). The data will be compared to the global patent landscape report and can also serve stakeholders in the field of palm oil in Malaysia to identify potential partners.

4.13. Comparison between Patenting Activities of Palm Oil Production and Waste Treatment and Exploitation

As can be seen from the analysis above the patenting activities of Palm Oil Production and Waste Treatment and Exploitation shared some similar trends but also exhibited noticeable differences. In this section we summarize the key findings by comparing these two categories, with references to the figures and tables presented in the previous sections.

- More patent families were filed in Waste Treatment and Exploitation in recent years than that in Palm Oil Production (Figure 21A).
- Patents in Palm Oil Production had larger family size (Figure 20), more grant percentage (Figure 24) and more foreign/PCT filings (Figure 26), than those in Waste Treatment and Exploitation.
- Most active first-filing countries in Palm Oil Production are United States, Malaysia and China. (Figure 28).
- Most active first-filing countries in Waste Treatment Exploitation are China, Japan and Malaysia. (Figure 30).
- Malaysian patents are predominantly filed by domestic applicants, led by MPOB, Sime Darby and Universiti Putra Malaysia. Technology distribution between Palm Oil Production and Waste Treatment are very balanced among Malaysian patents. (Figure 42).

- Most active applicants in Palm Oil Production are MPOB, BASF and CATAS. (Table 3).
- Most active applicants in Waste Treatment and Exploitation are MPOB, Guizhou Daziran and Universiti Putra Malaysia. (Table 3).
- In recent patent filings (2010-2015) the most active technologies relevant to Palm Oil Production are Advanced Seed, Tree Seedling and Cultivation, Fruit Growing and Harvesting, Pressing and Refining. (Figure 40).
- For Waste Treatment and Exploitation the recent trends are Mattress/Cushion, Composite Material, Adsorbent, Filter and Biomass Fermentation. (Figure 41).

5. Palm Oil Production

Highlights of this section:

- Advanced seeds, tree seedling and cultivating, pressing and refining are the most active subcategories in the area of palm oil production.
- There are very few patent filings on palm kernel-related processes.
- In the Advanced Seeds subcategory, more than 80% of the filings are related to genetic engineering methods, for example, improving oil content for transgenic oil-producing plants, including oil palm.
- The most active applicants in Advanced Seed subcategory include, BASF, Monsanto, Agrinomics, MPOB and Sime Darby.
- Chinese Academy of Tropical Agricultural Sciences (CATAS) became very active after 2010 has sine led the filing activities in palm tree seeding and cultivating. It was reported that CATAS has conducted trial planting of oil palm for regional adaptability.
- MPOB leads the patenting activities in pressing (oil extraction) and refining. MPOB has dedicated to improving palm oil milling process, for example, to reduce the palm oil mill effluent (POME).
- Producing high purity palm oil fractions, particularly, high oleic oil fraction is the recent trend in oil refining. MPOB and Nestle are very active recently in this field.

In this section we analyze the technologies disclosed in the patents relevant to palm oil production and the corresponding patenting activity. The production subcategories, following the entire process of palm oil production in a stepwise manner, are used to track patenting activities. Figure 46 shows the patent family distribution among the subcategories and Figure 47 the patenting activities by years. Advanced seeds, oil refining, pressing and tree cultivating are the most active fields for patent filing. On the contrary, palm kernel related processes have gained very few patent filings. Some patent examples have been provided in Technology Categorization. In the following some important subcategories will be demonstrated in detail.

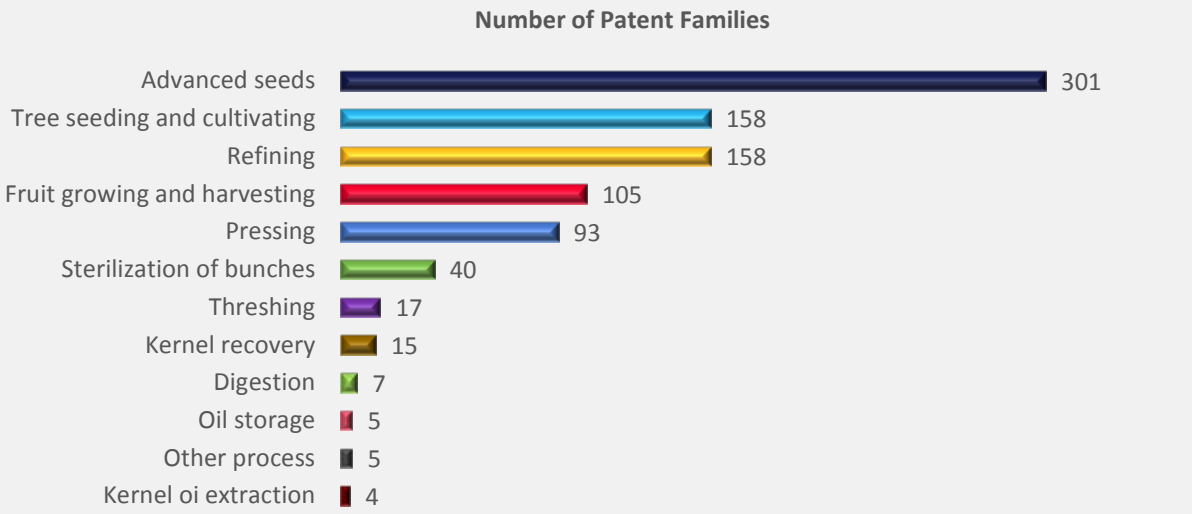


Figure 46 Patent family counts of palm oil production subcategories. Patent families with the earliest priority year since 1970.

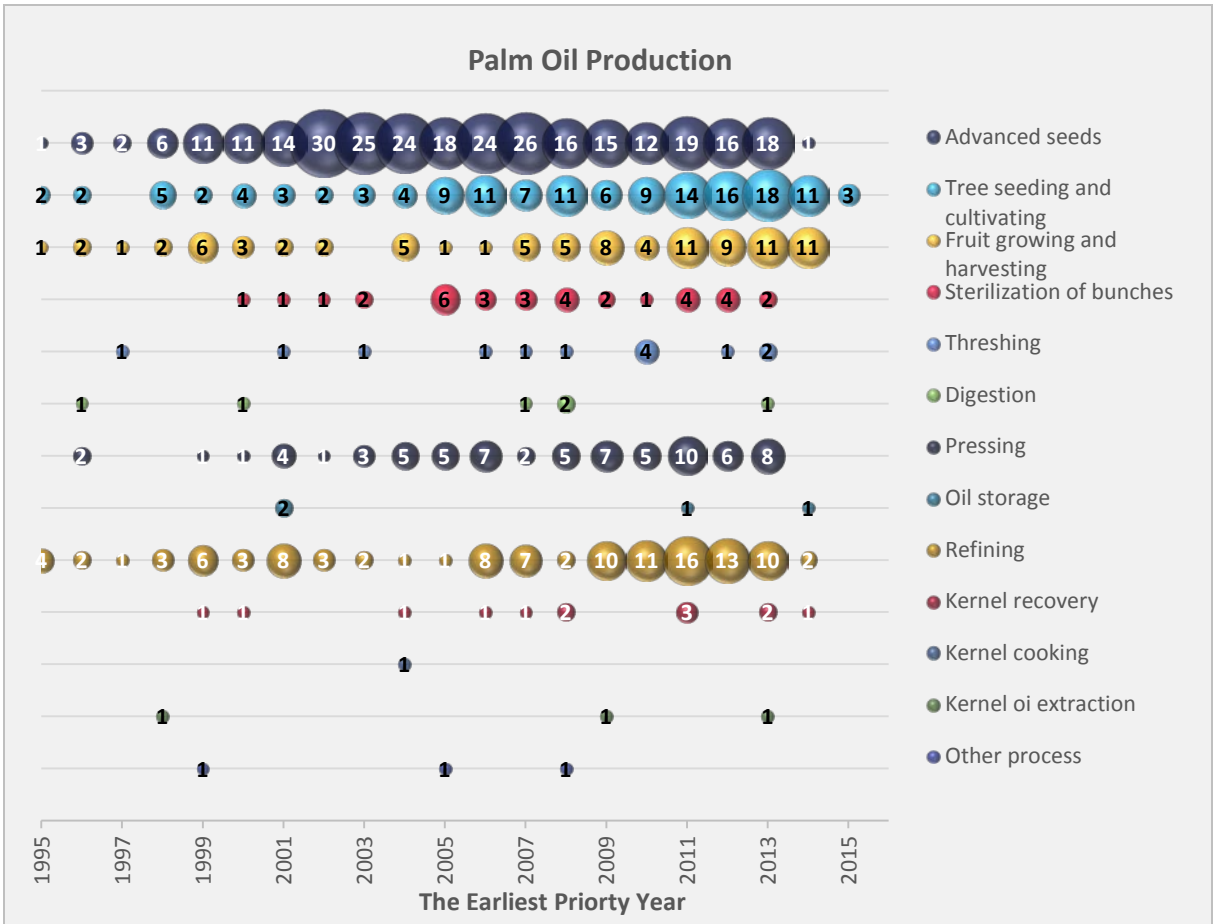


Figure 47 Filing activities in palm oil production subcategories since 1995, by the earliest priority year. The bubble size and the numerical value represent the number of patent families.

5.1. Advanced palm tree seeds (e.g. genetic engineering, seed selection, etc.)

This subcategory includes patents disclosing advanced seed technology, both seed selection and genetic engineering. The patenting activity in this subcategory has been high since early 2000s. More than 80% of the families are related to genetic engineering methods to improve certain traits. Improving oil content is an important goal for these transgenic plants. It is noted that the inventions disclosed in these patents appears to apply to a variety of oil-producing plants, judged by their broad claims, including oil palm. For example, WO2008079545 to Agrigenetics [US], titled "Generation of plants with altered protein, fiber, or oil content", had in its claims "Claim 2: The transgenic plant of claim 1, which is selected from the group consisting of plants of the Brassica species, including canola and rapeseed, soy, corn, sunflower, cotton, cocoa, safflower, oil palm, coconut palm, flax, castor, peanut, wheat, oat, and rice."

Seed selection or diagnostic technology also heavily relies on genetic information. Here patented inventions are more specific to oil palm, for example, WO201389557 to Sime Darby, titled "Methods for obtaining high-yielding oil palm plants".

The top applicants are shown in Figure 48. BASF, as the top most active applicant, has 85% of its patents in this category, making it the absolute leader here. However BASF patents usually cover a large variety of plants including oil palm. MPOB and Sime Darby are also very active and their patented inventions are always specific to oil palm. As an example, in WO2014168759A1 to MPOB, it disclosed a genetic method controlling fruit color phenotype in palm, as shown in Figure 3.

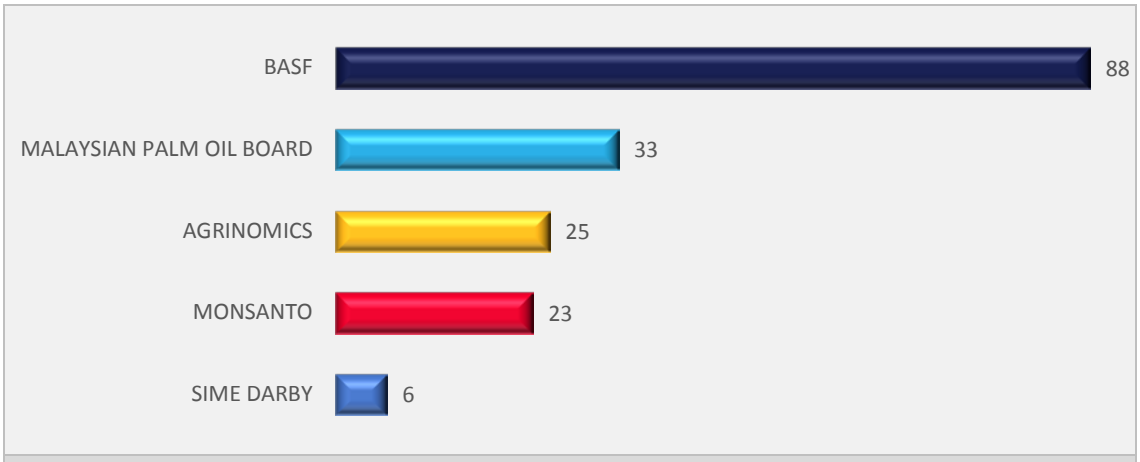


Figure 48 The most active applicants in advanced seed subcategory.

5.2. Tree seeding and cultivating

MPOB and CATAS have led the recent filing activities in palm tree seeding and cultivating. Ganoderma, a wood decaying fungus, produces enzymes that degrade oil palm tissue and gradually affects the infected oil palm xylem thus resulting to severe problems to the distribution of water and other nutrients to the top of palm tree. It causes Basal Stem Rot (BSR), a major threat particularly for oil palm cultivation. MPOB disclosed in WO2013081448 “Compositions for controlling ganoderma disease in plants and method thereof by using endophytic fungus, hendersonia ganoef1”. BASF also demonstrated its strength in agrochemical technology, for example, WO2008152096A2 “Use of fungicides for making the phenological development of oil plants more coherent”.

China CATAS became very active after 2010. Although there are no commercial oil palm plantations available in China due to failure in trial planting of oil palm introduced from abroad, the recent initiation of research is driven by a huge edible oil market in China who imported about 6 million tons of palm oil annually from Southeast Asian countries. It was reported that some accessions of oil palm collected by CATAS-RRI showed promise in yield of fresh fruit bunches and are now on trial planting for regional adaptability (Figure 4).[14]

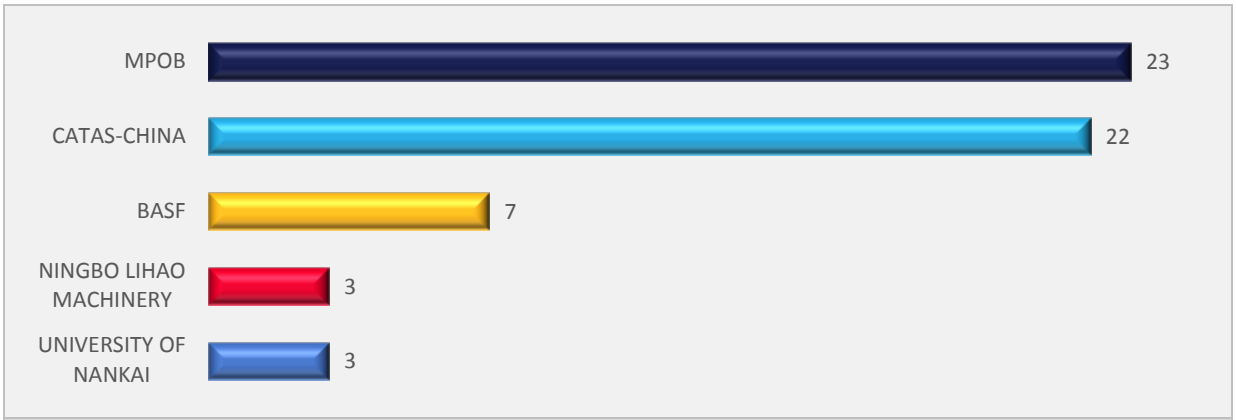
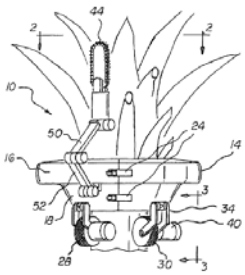


Figure 49 The most active applicants in Tree seeding and cultivating subcategory, since 1995.

There are also patents disclosing palm tree trimming devices collected in this subcategory. For example, a palm tree trimming system is disclosed in US8307865B1, by Cuffel Joe, shown below. Ningbo Lihao Machinery is also developing such tools.



5.3. Fruit growing and harvesting

The patents in this subcategory are predominantly relevant machines and tools to harvest fresh palm fruit. MPOB has a long history developing such tools, followed by Chinese applicants (CATAS, Wuxi Huaying, and Yongkong) joining recently. A recent disclosure “Cutting device for fruits and vegetables” from MPOB (WO201534346) provided a less vibration cutting head that uses a bended connecting- rod so that the line of action of the pole is in-line with the cutting action which could minimize the development of vibration of the whole tool.

There are also disclosures regarding bio-technology in fruit growing, such as MYPI2010006305 “A method of predicting oil content of oil palm fruit and a device for performing the same” to Universiti Putra Malaysia.

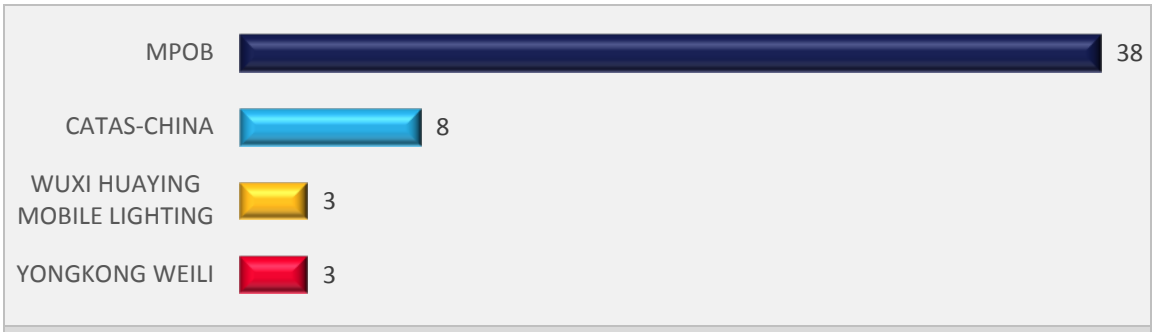


Figure 50 The most active applicants in fruit harvesting subcategory, since 1995.

5.4. Palm oil extraction/pressing

The patenting activity in pressing and extraction had an active period in 1970s but appeared to have a gap in the next twenty years. The activities increased again after 2000, as the industry tried to increase the extraction efficiency, to reduce the use of water and energy. Among the top applicants MPOB has dedicated to improving palm oil milling process. In WO2015037980A1 MPOB disclosed a system that is capable of producing zero liquid discharge palm oil clarification process (Figure 52). CATAS of China has developed oil presses at low cost. CAVITUS disclosed a method of generating cavitation bubbles inside palm fruit by a surface oscillating or vibrating at between about 16kHz and about 50kHz (WO2012106768).

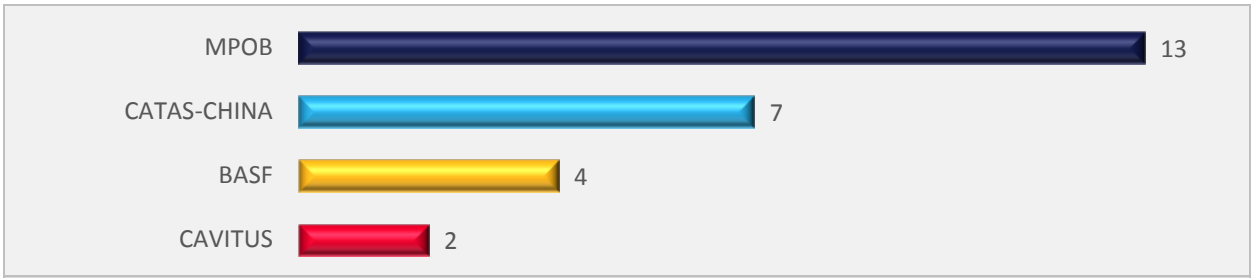


Figure 51 The most active applicants in oil extraction/pressing subcategory, since 1995.

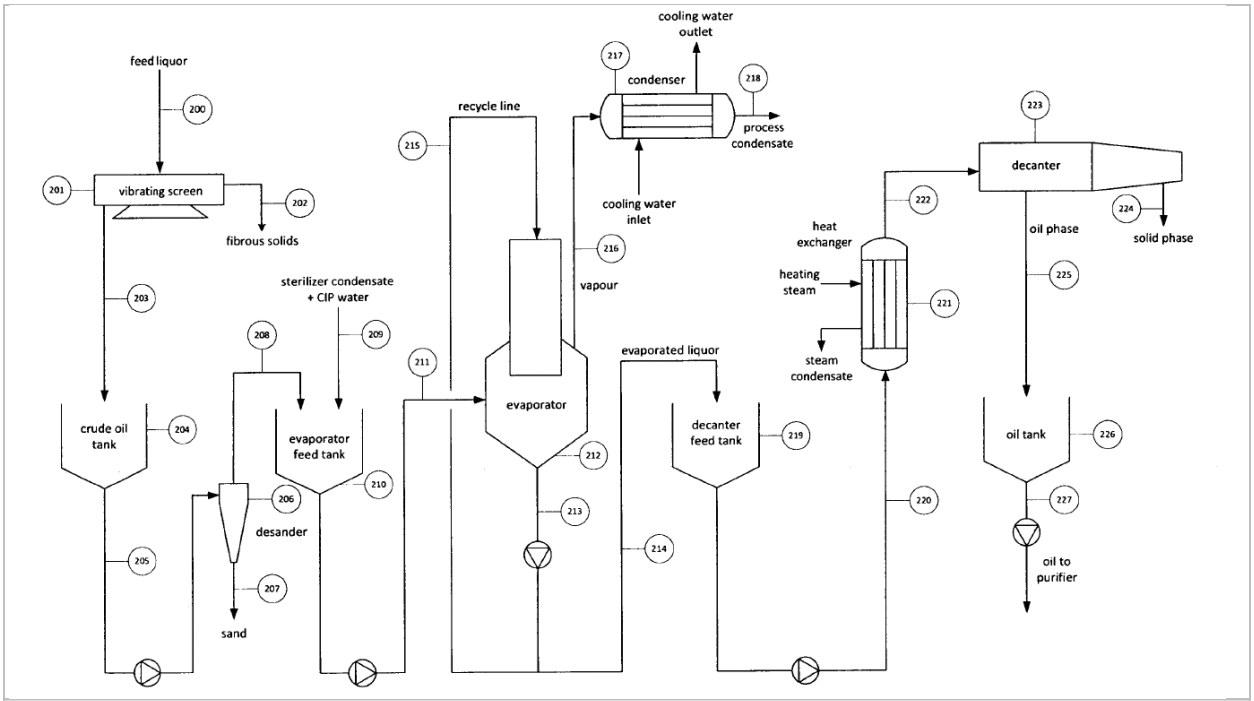


Figure 52 One preferred embodiment of the invention disclose in WO2015037980A1, wherein evaporation is carried out prior to separation using a two- phase decanting centrifuge and evaporation achieves substantially complete removal of the free water..

5.5. Palm oil refining

The refining process of palm oil is schematically shown in Figure 10. The patenting activity of palm oil refining has span more than 40 years and is still very active now. The recent filings have been led by the following applicants in Figure 53. The technology is driven by the growing demand of high quality oil free of contaminants. As an example Nestle disclosed “Refined plant oils free of glycidyl esters” in WO2012130745. Palm oil is a balanced oil with equal parts of saturated and unsaturated fatty acids. With current consumer preference for low saturated fat products, fractionation of palm oil is very often disclosed, for example, WO2014126454 to MPOB “A process for producing high oleic content liquid palm oil fraction”. High oleic oils are currently touted to be the healthiest edible fat in the human diet.

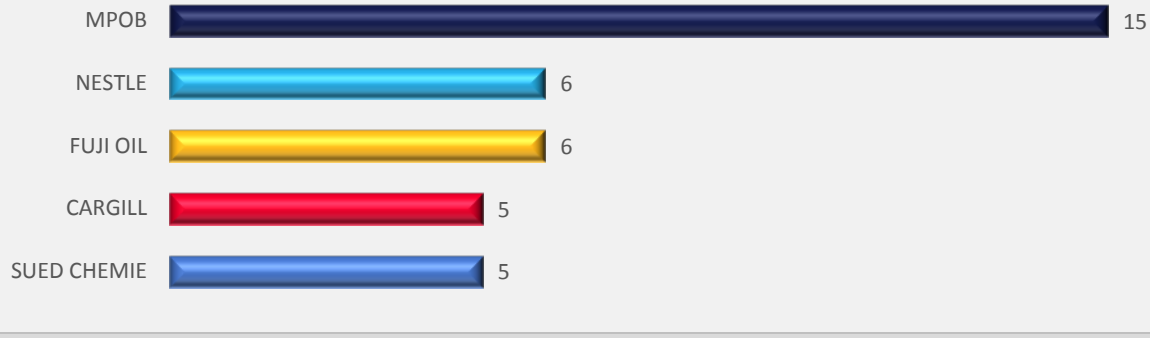


Figure 53 The most active applicants in oil refining subcategory, since 1995.

The patenting activities in the other subcategories of palm oil production appear to be low, therefore further demonstration is not included in this report. Interested readers may refer to the examples provided in Technology Categorization Section and the patent database for more details.

6. Production Waste Application

Highlights of this section:

- POME, EFB and palm fiber are the most produced waste materials during palm oil production. They are also the most disclosed materials in patents regarding waste treatment and exploitation.
- Palm fiber is the most versatile material disclosed in patents, utilized not only for consumer products, such as mattresses and brushes, but also for industrial applications, such as composite materials and filters.
- EFB are traditionally dried and burnt as energy source for oil mill. Innovative exploitation disclosed in patents includes fermentation and paper making.
- The treatment of POME, the primary liquid waste from palm oil mill, is very challenging, due to its large quantity and complex composition. So far the primary focus in patents is anaerobic and aerobic decomposition. MPOB has done a lot of work on extraction of phytonutrients from POME, as well as other palm waste materials.
- DuPont leads the fermentation process development, which can be applied to a variety of lignocellulosic biomass including that from palm oil production.

Lignocellulosic biomass which is produced from the oil palm industries include oil palm trunks (OPT), oil palm fronds (OPF), empty fruit bunches (EFB) and palm pressed fibers (PPF), palm shells and palm oil mill effluent palm (POME). Figure 54 shows the weight distribution among palm oil and the waste materials.[15] For every ton of palm oil produced, about one ton of EFB and three tons of POME are produced.

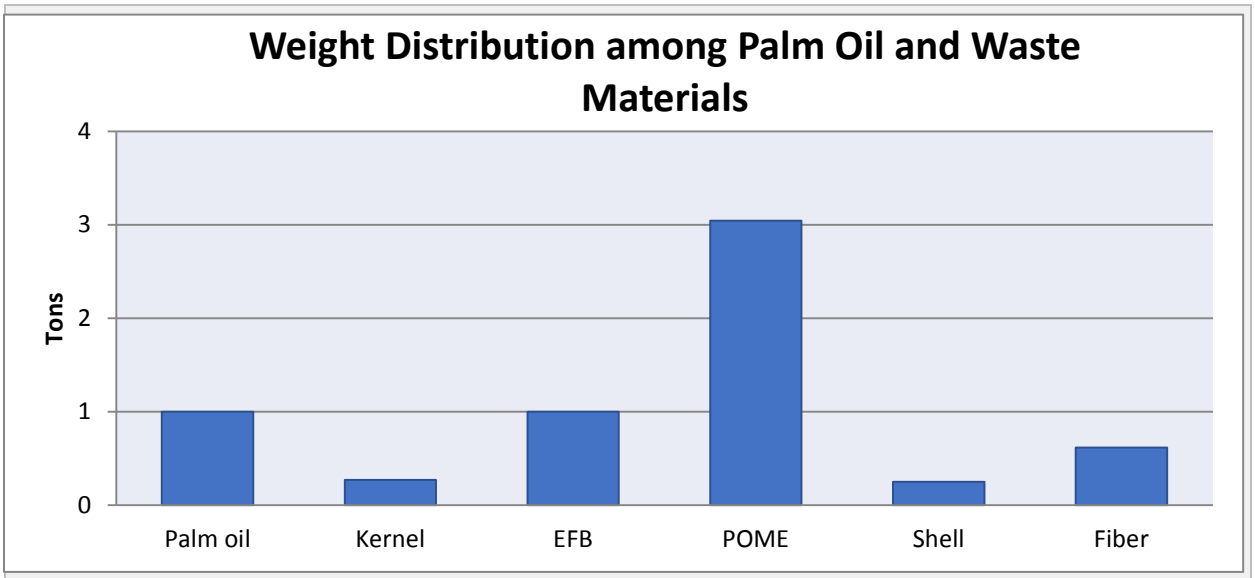


Figure 54 Distribution of palm oil and wastes by weight for every ton of palm oil produced.

The presence of these oil palm wastes has created a major disposal problem. It is simply no longer affordable to dispose the residues when there is an economically useful alternative. The fundamental principles of waste management are to minimize and recycle the waste, recover the energy and finally dispose the waste. As an example, Malaysian palm oil mills are self-sufficient in energy, using PPF, EFB and shell as fuel to generate steam in waste-fuel boilers for processing, and power-generation with steam turbines.[16]

In this section we present a more detailed analysis on what/how waste materials are used and what the potential opportunities are. During the patent search we have recorded the waste materials from palm oil production and their corresponding application. While almost all waste materials have been disclosed in patents, some of them have attracted much more investigation than the others. Figure 55 shows the top waste materials disclosed in patents. Palm fiber is the most disclosed waste material. The study of the lignocellulosic biomass from the oil palm industries is also very active. The treatment of POME, the primary liquid waste from palm oil mill, is very challenging, due to its large quantity and complex composition.

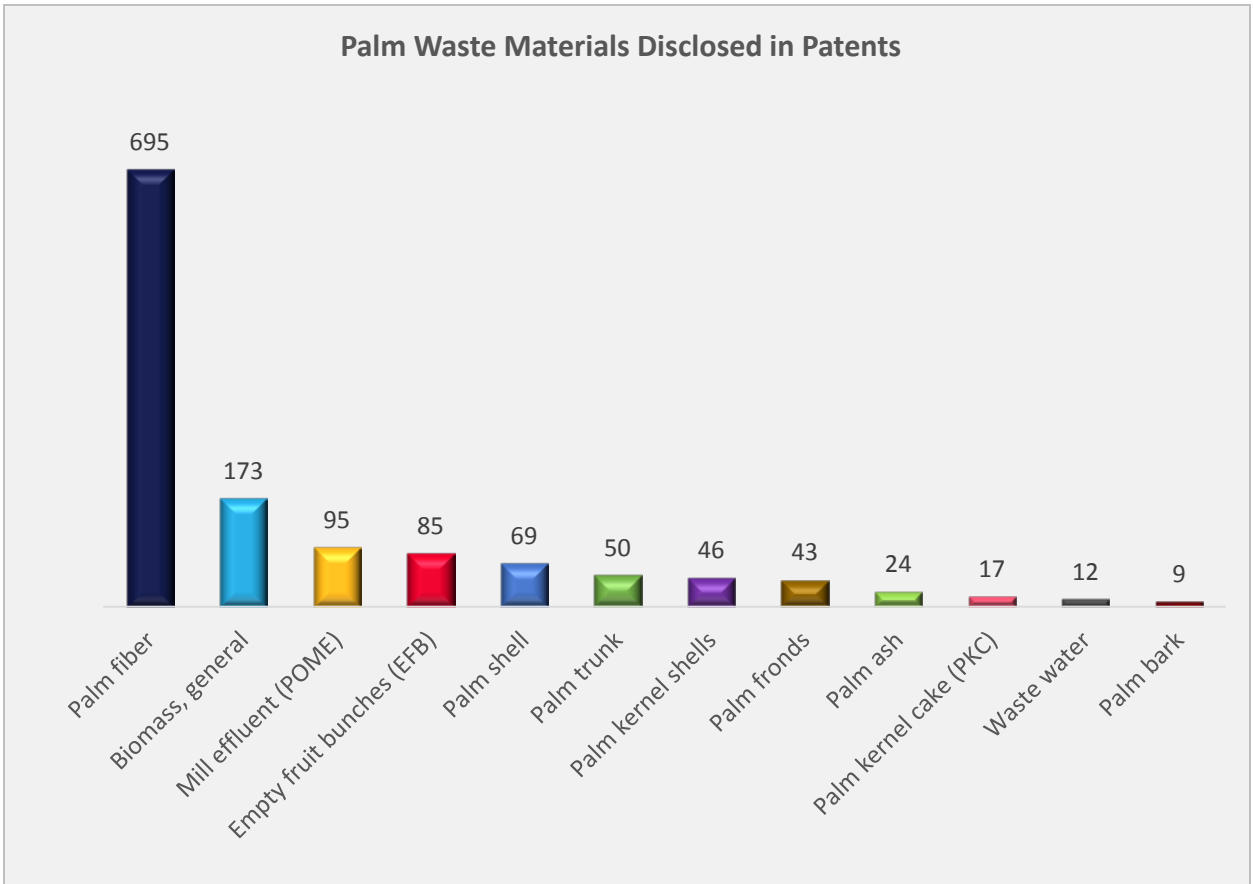


Figure 55 Patent family distribution among waste materials. Numbers indicate patent family counts.

Figure 56 shows, as a heat map, how these materials are used as disclosed in the patents. Palm fiber appears to be the most versatile materials with many popular applications. Some materials have shown a primary application, such as adsorbent for palm bark. As some exemplary patent documents for each type of application have been provided in Technology Categorization Section, we will provide detailed analysis for a few key waste materials and their applications. Also in Appendix we listed more examples for each waste material of interesting applications.

	Extraction of palm oil	Phytonutrients	Other chemicals	Direct fuel	Charcoal	Biodiesel	Adsorbent	Filter	Composite material	Animal feed	Fertilizer	Cultivation structure	Fermentation product	Paper making	Waste water treatment	Mattress/cushion	Other products	Other processing
Palm fiber	2	1		4	2		13	40	70	1	4	65	2	16	7	268	168	32
Palm trunk		2		1	1	1	2		23	1	1	1	6			1	7	3
Palm fronds		6		3	1				8	4	1	1	1	6	1	2	9	
Palm bark		1	1				7											
Empty fruit bunches (EFB)	1	6		5	2	3		1	14	2	6		21	14	1	1	4	4
Palm shell		1	2	5	13		22	2	1	3	1	2	3	3	3	2	6	
Palm oil mill effluent (POME)	3	19		1	3	2	1			2	10		13	1	37			3
Palm kernel shells		2	1	2	10	1		1	1	9	6	1	8	1			3	
Palm kernel cake (PKC)	1	2	1						1	3	1		7					1
Palm ash									7		12	2			2	1		
Biomass, general		35	2	6	6	5	5		20	3	16	6	55	7	2	1	2	2
Waste water															12			
Others	3	1								1			1					

Figure 56 Palm oil production waste materials and their applications

6.1. Palm fiber

Oil palm fiber is non-hazardous biodegradable material extracted from empty fruit bunch that are considered as waste after the extraction oil palm fruits. The fibers are clean, noncarcinogenic, and free from pesticides and soft parenchyma cells. They are such a versatile material that they are used not only in consumer products but also in industrial applications (Figure 18). Mattress and cushions made of palms fibers are popular in China, Japan and Korea, as reflected by the high number of patents filed, Figure 57. Other consumer products include brushes, shoes and fabrics. Palm fibers are often combined with other materials, such as polymers and concretes, to form composite materials. Various cultivation structures, such as plant growing bed, seedling raising bed, and vegetation mat can be made from palm fibers. Also stacked fibers are used as water and air filters.

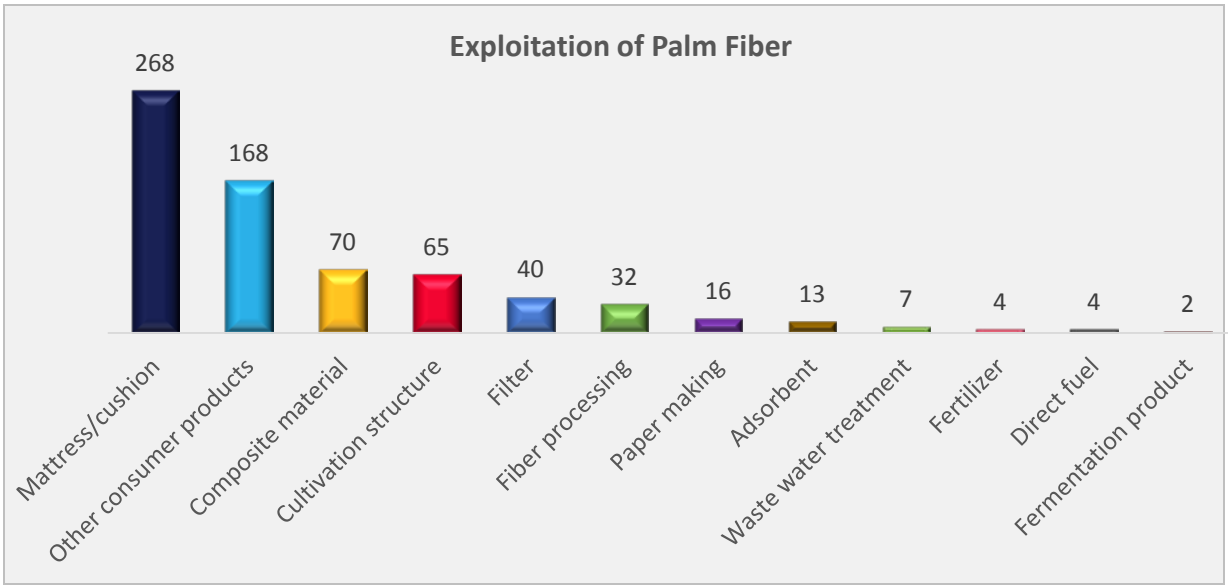


Figure 57 Patent family distribution among palm fiber exploitation technologies. Numbers indicate patent family counts.

Chinese, Japanese, Korean and Malaysia applicants dominated patent filings relevant to palm fibers (Figure 58). Guizhou Daziran (China) is the top applicant developing palm fiber mattress. Many Japanese applicants filed for cultivation structure. They all had only one or two filings, so there were not any leading applicants. Malaysian applicants focus on composite material but the filings were also evenly distributed among many applicants.

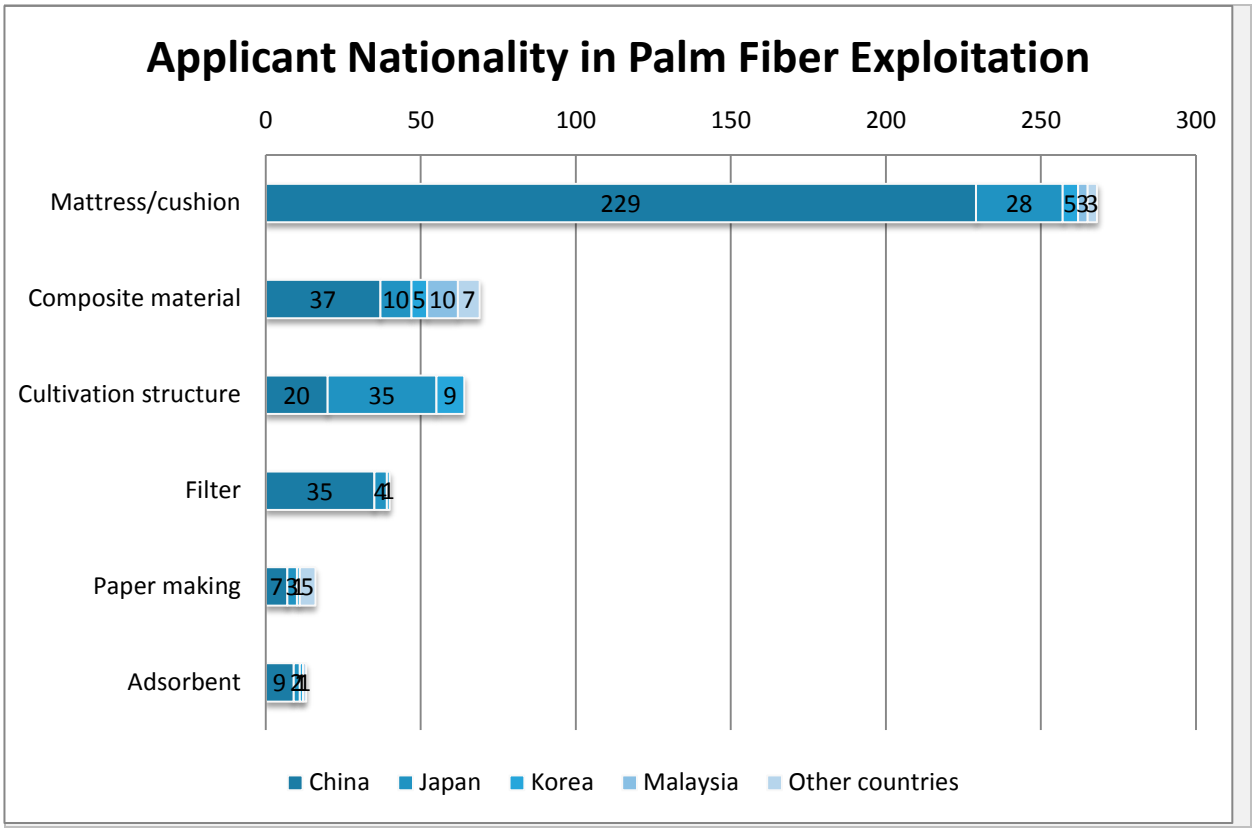


Figure 58 Applicant Nationality in Palm Fiber Exploitation.

6.2. Empty fruit bunches (EFB)

Empty fruit bunches (EFB) constitutes about a quarter (25%) of palm fresh fruit bunches by dry weight. For each kg of palm oil, roughly one kg of wet EFB is produced. The EFB are usually air dried until the moisture content reaches about 40% when it is ready to be used as fuel in the palm oil processing plant. The burnt waste is then used as fertilizer in plantations. Other than that, EFB were also used in the plantations as mulch, thus, can reduce the applied fertilizer cost. Figure 59 presents the leading methods disclosed in patents for treating EFB. It appears decomposing EFT to obtain fermentation products, pulps for paper making and composite material are the leading approaches of exploitation.

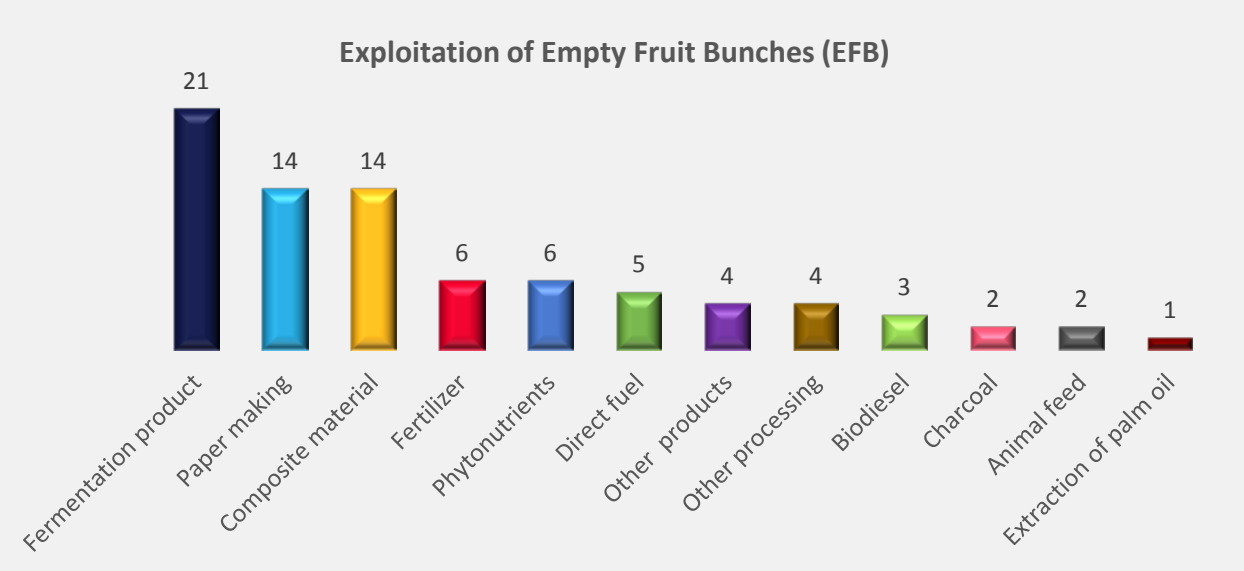


Figure 59 Patent family distribution among EFB exploitation technologies. Numbers indicate patent family counts.

As can be seen from Figure 60, applicants from United States and United Kingdom are very active in developing fermentation products from EFB. Arter Technology (UK) disclosed a method for preparation of oil palm bunches for enzymatic hydrolysis and allows accelerating enzymatic hydrolysis of polysaccharides in soluble carbohydrides (WO2011002329A1). Novozymes (Denmark) disclosed a biogas production process with enzymatic pre-treatment of EFB (WO2011092136A1). Research group from Universiti Teknologi Malaysia investigated on the fast pyrolysis of empty fruit bunches (EFB) to produce bio oil (MY148935A).

EFB had been studied to convert into paper-making pulp because EFB's high number of fibers/unit weight. Chinese applicants have actively investigated making paper pulp from EFB, for example, Shaanxi University Of Science And Technology.

Malaysian and Japanese applicants lead in developing composite materials from EFB. Universiti Malaysia Sabah disclosed a fiber-granule board comprising fibrous empty fruit bunch materials, porous oil palm shells materials and a suitable binder (WO2010013994A2). KAO (Japan) focused on producing Lignin polymers.

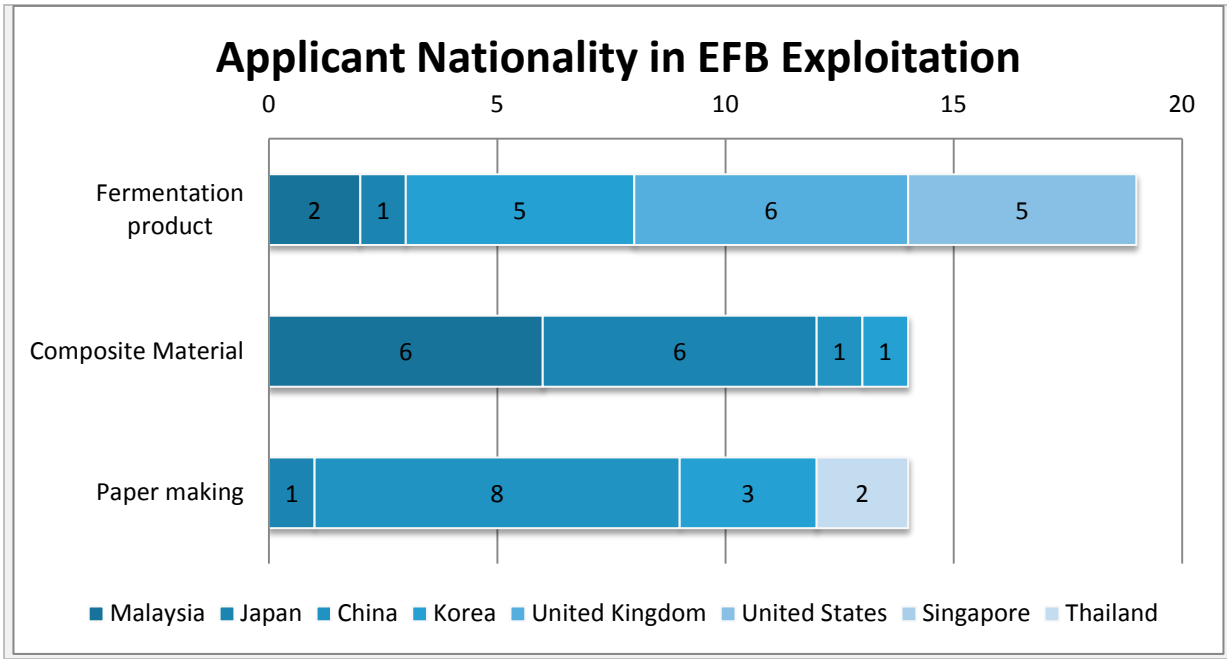


Figure 60 Applicant Nationality in EFB Exploitation.

6.3. Palm oil mill effluent (POME)

Palm oil mill effluent (POME) is the primary liquid waste from palm oil production. The conventional milling process generates about 0.6 tons of for every ton of fresh fruit bunches processed. POME is a colloidal suspension containing 95-96% water, 0.6-0.7% oil and 4-5% total solids including 2-4% suspended solids.[17] The treatment system usually consists of anaerobic and aerobic ponds to for biodegradation. Silting of ponds due to the high concentration of suspended solids reduces their effectiveness and leads to higher operating cost. POME treatment under anaerobic conditions also leads to the emission of methane a greenhouse gas. Enclosed anaerobic digestion systems are needed to capture methane (Figure 17).

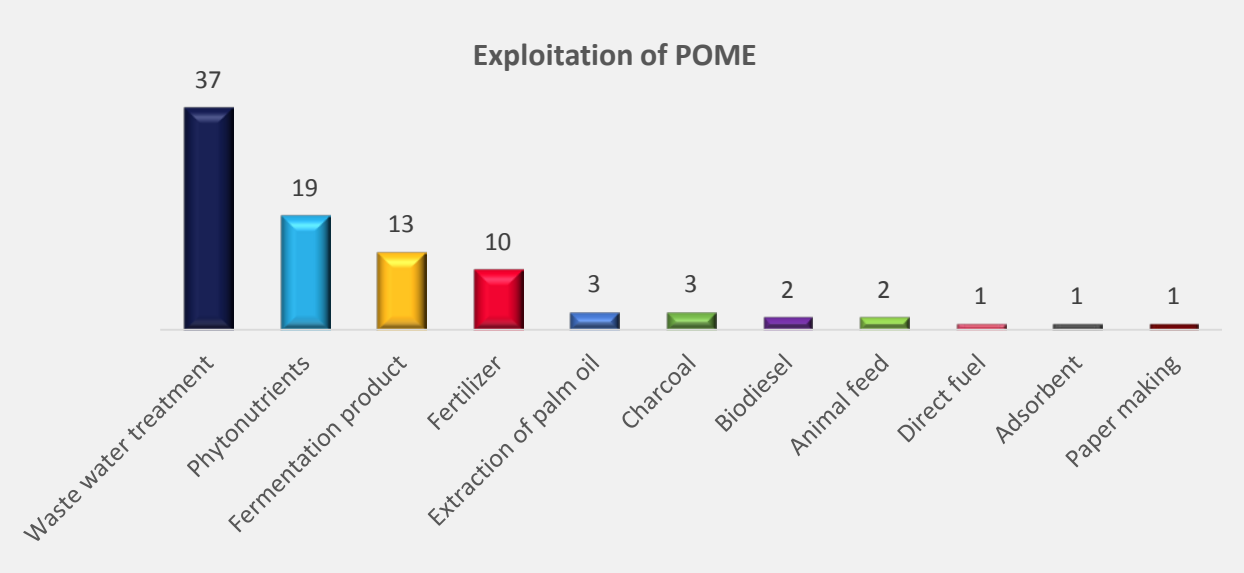
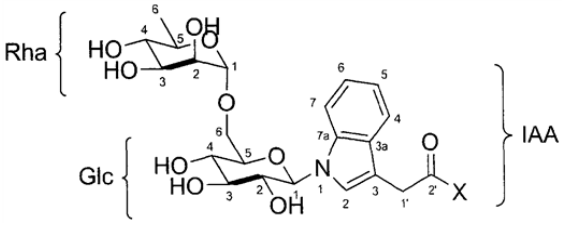


Figure 61 Patent family distribution among POME exploitation technologies. Numbers indicate patent family counts.

As shown in Figure 61 waste water treatment is the primary focus after POME is produced, although efforts have been made to utilize it for phytonutrients, fermentation products and fertilizer. MPOB leads the patenting activities in this field by a large margin (Figure 62), and has done a lot of work on extraction of phytonutrients from POME, e.g. WO2014209100A2 disclosing Isolation of bioactive indolacetic acid derivativea, with antiviral and antimicrobial effects.



It is noted that many active applicants in water treatment are not Malaysian, such as Cargill (US), Sumitomo (JP) and He Wenyuan (CN).

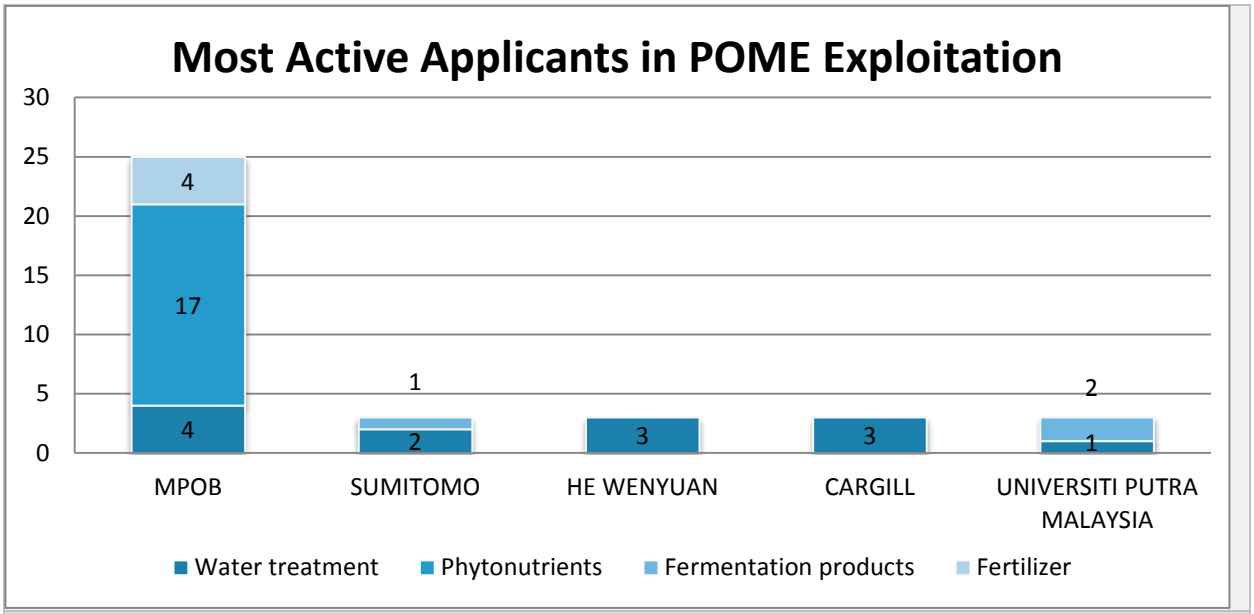


Figure 62 Most Active Applicants in POME Exploitation

6.4. Biomass (general)

Lignocellulosic biomass which is produced from the oil palm industries include oil palm trunks (OPT), oil palm fronds (OPF), empty fruit bunches (EFB) and palm pressed fibers (PPF), palm shells and palm oil mill effluent palm (POME). As the specific waste materials, when disclosed in patents, are analyzed individually, this subsection focus on general biomass waste wherein waste materials are not specified. As an example, WO2010008578A2 to MASCOMA titled "Flow-through biological conversion of lignocellulosic biomass". As shown in Figure 63, the most explored application of oil palm biomass is to produce fermentation products, to extract phytonutrients, to make composite materials and fertilizers. Top applicants in these technologies are presented in Figure 64.

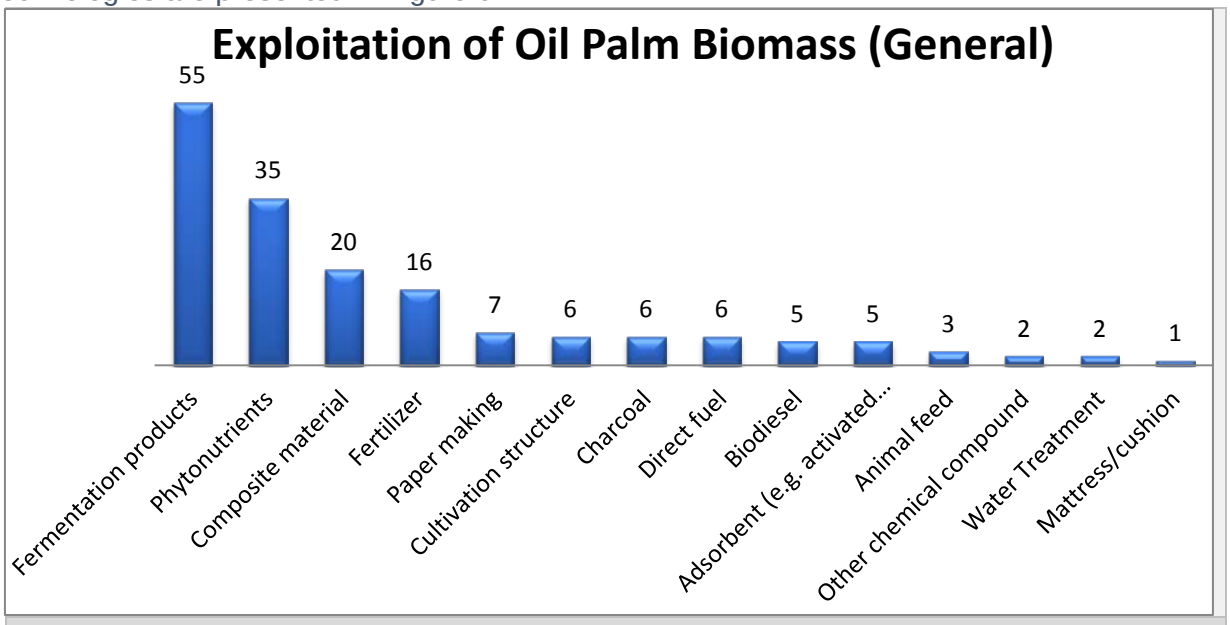


Figure 63 Patent family distribution among oil palm biomass (general) exploitation technologies. Numbers indicate patent family counts.

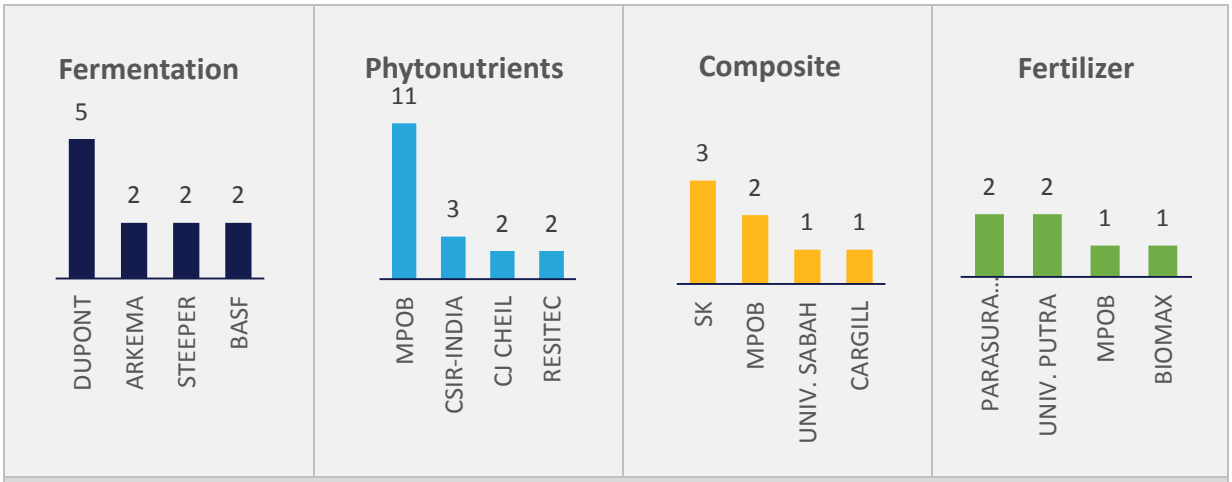


Figure 64 Top applicants in palm biomass exploitation.

In fermentation technology DuPont leads the fermentation process development. For example, in WO2014164581A1 “Gradient pretreatment of lignocellulosic biomass” it disclosed a method to pretreat lignocellulosic biomass with ammonia where the concentration of the biomass in the reaction mixture is reduced over time was found to produce more sugars following saccharification, as compared to equivalent biomass pretreated at constant concentration. Arkema developed biomass-derived methyl methacrylate to produce polymers (WO2009156648A1). BASF shows its expertise in enzyme technology, polypeptides having a lignocellulolytic activity (WO2008095033A2).

MPOB leads the extraction of phytonutrients. MPOB has collaborated heavily with public and private entities to explore the utilization of phytonutrients in healthcare, for example, with CSIRO (WO2010143936A1) on improving vascular health and with Brandeis University (WO2009146102A1) for the treatment or prevention of diabetes mellitus and other metabolic imbalances. Council of Scientific and Industrial Research (CSIR, India) also developed an improved process for the isolation of carotenes from crude palm oil (IN184306B).

In making composite materials SK INNOVATION disclosed polymer blend composition containing natural material reinforcement agent including palm oil residues (WO2012102564A2). MPOB has developed a method for producing fiberboards utilizing palm biomass (WO2013051926A2). Fertilizers can be made from decomposed oil palm biomass. Parasuraman Ramaness disclosed a process for preparing a biodegradable and/or compostable pulp composition using papain, to be used as fertilizer (WO2013141687A1).

6.5. Other waste materials

The important treatment and exploitation of other waste materials are summarized in Table 10 below, with the active applicants. More examples are provided in Appendix.

Waste Material	Most Disclosed Exploitation Methods	Active Applicant
Palm trunk	Composite material	Mywood 2
Palm fronds	Phytonutrients	Universiti Putra Malaysia
Palm bark	Adsorbent	Jinan University
Palm kernel shells	Charcoal	Nippon Steel
Palm kernel cake (PKC)	Fermentation product	Ql Agrobio
Palm ash	Fertilizer	Furuta Sangyo

Table 10 Other waste material exploitation not covered from Section 6.1 to 6.4.

7. Concluding Remarks

An extended executive summary is provided in the beginning of the report to highlight findings in this study. As concluding remarks the five (5) most important findings of the landscape are summarized below.

1. Recent filings on waste treatment and exploitation are more active than those of palm oil production. In the waste treatment and exploitation area activities are led by Chinese, Japanese, Malaysian and Korean applicants, who primarily focus on domestic market without seeking patent protection abroad. It indicates China, Japan and Korea are important markets for products using palm waste materials.
2. Genetically modified oil palm seeds may be an effective approach to further improve the oil yield, as a solution to meet the increasing global demand. US and European agrochemical and agricultural biotechnology corporations are leading in this field. Although they tend to file broad extensions globally, the data did not show their activities in Malaysia. In Malaysia MPOB has conducted active research and development in this field.
3. Chinese applicants, led by CATAS, became very active in filing inventions on palm oil production after 2010. The recent initiation of research is driven by a huge edible oil market in China. It was reported that some accessions of oil palm collected by CATAS-RRI showed promise in yield of fresh fruit bunches and are now on trial planting for regional adaptability.
4. Patenting activities in MyIPO has increased dramatically, in parallel to the global trend. Among Malaysian applicants a more balanced technology distribution between Palm Oil Production and Waste Treatment was noticed. This demonstrates that Malaysia has developed significant experience in the entire value chain of palm oil production.
5. Almost all major waste materials from palm oil production have been disclosed in patents. Palm fibers obviously have found the most applications. The study of the lignocellulosic biomass which is produced from the oil palm industries is also very active. POME might impose the most challenge of treatment. Besides decomposing approaches improved extraction processes that reduce the amount of POME discharge could be very effective.

Annex

Search queries

#	Query	Result(s)
1	((A01F011/08)/IPC/CPC OR (A01F11/08)/FI)	53
2	((A01F+)/IPC/CPC OR (A01F+)/FI)	85696
3	((OIL PALM?) OR (PALM? 5D (KERNEL? OR MESOCARP? OR PULP? OR FRUIT? OR TREE? OR PLANT+ OR STEM? OR LEAF OR LEAVES OR FLOWER?)))/TI/AB/IW/CLMS	11231
4	2 AND 3	20
5	((A01H001 OR A01H003 OR A01H004 OR A01H005)/IPC/CPC OR (A01H1 OR A01H3 OR A01H4 OR A01H5)/FI)	70819
6	5 AND 3	444
7	((C12N015)/IPC/CPC OR (C12N15)/FI)	207455
8	7 AND 3	470
9	((A01C)/IPC/CPC OR (A01C)/FI)	135378
10	((A01D)/IPC/CPC OR (A01D)/FI)	192835
11	((A01G)/IPC/CPC OR (A01G)/FI)	274073
12	(9 OR 10 OR 11) AND 3	436
13	((A23N)/IPC/CPC OR (A23N)/FI)	44281
14	13 AND 3	58
15	((C11B)/IPC/CPC OR (C11B)/FI)	37825
16	(((PALM OIL?) OR (PALM KERNEL OIL?) OR (OIL PALM?) OR (PALM? 5D (OIL? OR KERNEL? OR MESOCARP? OR PULP? OR FRUIT? OR TREE? OR PLANT+ OR STEM? OR LEAF OR LEAVES OR FLOWER?))))/TI/AB/IW/CLMS	17924
17	15 AND 16	1279
18	((B30B009/02+) OR (B30B009/04+) OR (B30B009/06+) OR (B30B009/08+) OR (B30B009/10+) OR (B30B009/12+) OR (B30B009/14+) OR (B30B009/16+) OR (B30B009/18+) OR (B30B009/20+) OR (B30B009/22+) OR (B30B009/24+) OR (B30B009/26+))/IPC/CPC	15117

#	Query	Result(s)
19	((B30B9/02+) OR (B30B9/04+) OR (B30B9/06+) OR (B30B9/08+) OR (B30B9/10+) OR (B30B9/12+) OR (B30B9/14+) OR (B30B9/16+) OR (B30B9/18+) OR (B30B9/20+) OR (B30B9/22+) OR (B30B9/24+) OR (B30B9/26+))/FI	4115
20	(18 OR 19) AND 16	25
21	((B01D009)/IPC/CPC OR (B01D9)/FI)	9474
22	21 AND 16	23
23	(((PALM OIL?) OR (PALM KERNEL OIL?) OR (OIL PALM?) OR (PALM? 5D (OIL? OR KERNEL? OR MESOCARP? OR PULP? OR FRUIT? OR TREE? OR PLANT+ OR STEM? OR LEAF OR LEAVES OR FLOWER?))) 5D (GROW+ OR GREW OR CULTIVAT+ OR SEED+ OR BREED+ OR HARVEST+ OR PROCESS+ OR PRODUC+ OR REFIN+ OR CRUDE OR PRESS+ OR EXTRACT+ OR MILL+ OR MELTING OR DISTILL+ OR FRACTION+ OR CRYSTALLI+ OR SEPARAT+ OR DEGUM+ OR BLEACH+ OR DEODOR+))/TI/AB/IW/CLMS	5414
24	(((PALM OIL?) OR (PALM KERNEL OIL?) OR (OIL PALM?) OR (PALM? 5D (OIL? OR KERNEL? OR MESOCARP? OR PULP? OR FRUIT? OR TREE? OR PLANT+ OR STEM? OR LEAF OR LEAVES OR FLOWER?))) 5D (WASTE? OR BIOMASS OR (BIO MASS) OR BYPRODUCT? OR (BY PRODUCT?) OR RESIDUE OR BIOFUEL? OR (BIO FUEL?) OR BIODIESEL? OR (BIO DIESEL?)))/TI/AB/IW/CLMS	504
25	(PALM? 2D (TRUNK? OR FROND? OR (EMPTY FRUIT BRUNCH+) OR FIBRE? OR FIBER+ OR SHELL? OR (MILL EFFLUENT+) OR RESIDUES OR ASH OR ASHES)) OR (PALM KERNEL CAKE+)	1436
26	((A23N)/IPC/CPC OR (A23N)/FI)	44507
27	((C12P)/IPC/CPC OR (C12P)/FI)	163328
28	((C02#)/IPC/CPC OR (C02#)/FI)	383610
29	((D21#)/IPC/CPC OR (D21#)/FI)	166670
30	26 or 27 or 28 or 29	751614
31	((PALM? 5D (MESOCARP? OR PULP? OR FRUIT? OR TREE? OR PLANT+ OR STEM? OR LEAF OR LEAVES OR FLOWER? OR TRUNK? OR FROND? OR (EMPTY FRUIT BRUNCH+) OR FIBRE? OR FIBER+ OR SHELL? OR (MILL EFFLUENT+) OR RESIDUE? OR ASH OR ASHES OR WASTE? OR BIOMASS OR (BIO MASS) OR BYPRODUCT? OR (BY PRODUCT?))) OR (PALM KERNEL CAKE+))/TI/AB/IW/CLMS	7487
32	30 and 31	613
33	((MALAYSIA+ AND PALM AND OIL AND BOARD)/PA/OPA/PAH/OWR/REAS)	278

Patent classifications

Class	Subclass	Class/Subclass Description
A01C		PLANTING; SOWING; FERTILISING
A01D		HARVESTING; MOWING
A01F		PROCESSING OF HARVESTED PRODUCE; HAY OR STRAW PRESSES; DEVICES FOR STORING AGRICULTURAL OR HORTICULTURAL PRODUCE
	A01F11/08	Threshing apparatus specially adapted for maize; Treshing apparatus specially adapted for particular crops other than cereals; **for palm fruit, e.g. releasing the fruit from the stalk**
A01G		HORTICULTURE; CULTIVATION OF VEGETABLES, FLOWERS, RICE, FRUIT, VINES, HOPS OR SEAWEED; FORESTRY; WATERING
A01H		NEW PLANTS OR PROCESSES FOR OBTAINING THEM; PLANT REPRODUCTION BY TISSUE CULTURE TECHNIQUES
	A01H1/00	Processes; **Processes for modifying genotypes**
	A01H3/00	Processes; **Processes for modifying phenotypes,**
	A01H4/00	Processes; **Plant reproduction by tissue culture techniques;**
	A01H5/00	Products; **Flowering plants, i.e. angiosperms**
A23N		MACHINES OR APPARATUS FOR TREATING HARVESTED FRUIT, VEGETABLES OR FLOWER BULBS IN BULK, NOT OTHERWISE PROVIDED FOR; PEELING VEGETABLES OR FRUIT IN BULK; APPARATUS FOR PREPARING ANIMAL FEEDINGSTUFFS
	A23N5/00	Machines for hulling, husking or cracking nuts
B01D		SEPARATION
	B01D9/00	**Crystallisation**
B30B		PRESSES IN GENERAL
	B30B9/02	Presses specially adapted for particular purposes; **for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material**
	B30B9/04	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; **using press rams**
	B30B9/06	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; using press rams; **cooperating with permeable casings or strainers**

Class	Subclass	Class/Subclass Description
	B30B9/08	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; using press rams; **cooperating with a rotary casing**
	B30B9/10	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; using press rams; **without use of a casing**
	B30B9/12	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; **using pressing worms or screws cooperating with a permeable casing**
	B30B9/14	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; using pressing worms or screws cooperating with a permeable casing; **operating with only one screw or worm**
	B30B9/16	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; using pressing worms or screws cooperating with a permeable casing; **operating with two or more screws or worms**
	B30B9/18	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; using pressing worms or screws cooperating with a permeable casing; **with means for adjusting the outlet for the solid**
	B30B9/20	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; **using rotary pressing members, other than worms or screws, e.g. rollers, rings, discs**
	B30B9/22	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; **using a flexible member, e.g. diaphragm,urged by fluid pressure**
	B30B9/24	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; **using an endless pressing band**
	B30B9/26	Presses specially adapted for particular purposes; for squeezingout liquid from liquidcontaining material, e.g. juice from fruits, oil from oilcontaining material; Permeable casings or strainers
C02		TREATMENT OF WATER, WASTE WATER, SEWAGE, OR SLUDGE

Class	Subclass	Class/Subclass Description
C11B		PRODUCING (pressing, extraction), REFINING AND PRESERVING FATS, FATTY SUBSTANCES (e.g. lanolin), FATTY OILS AND WAXES, INCLUDING EXTRACTION FROM WASTE MATERIALS; ESSENTIAL OILS; PERFUMES
C12P		FERMENTATION OR ENZYMEUSING PROCESSES TO SYNTHESISE A DESIRED CHEMICAL COMPOUND OR COMPOSITION OR TO SEPARATE OPTICAL ISOMERS FROM A RACEMIC MIXTURE
C12N		MICROORGANISMS OR ENZYMES; COMPOSITIONS THEREOF; PROPAGATING, PRESERVING OR MAINTAINING MICROORGANISMS; MUTATION OR GENETIC ENGINEERING; CULTURE MEDIA
	C12N15/00	Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; Use of hosts therefor
	C12N15/82	Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; Use of hosts therefor; Recombinant DNAtechnology; Introduction of foreign genetic material using vectors; Vectors; Use of hosts therefor; Regulation of expression; Vectors or expression systems specially adapted for eukaryotic hosts; for plant cells, [e.g. plant artificial chromosomes (PACs)]
D21		PAPERMAKING; PRODUCTION OF CELLULOSE

Patent data coverage

The patent data coverage in Questel Orbit particularly for major countries of palm oil production (last update: October 19, 2015).

Malaysia (MY)

Publication	Kind Codes	From	Until
Laid open patent application	A	1953/12/31	2015/08/31
Utility innovation	U	1996/03/30	1996/03/30

Indonesia (ID)

Publication	Kind Codes	From	Until
Patent application	A	1988/11/26	2002/01/03
Patent	B	1992/07/29	1996/10/30
Simple Patent	S	1996/07/22	2001/12/27

Thailand (TH)

Publication	Kind Codes	From	Until
Patent application	A	1970/01/01	2015/09/22
Patent	B	1980/01/01	2015/10/09

Philippines (PH)

Publication	Kind Codes	From	Until
Patent	A	1975/07/03	2003/03/18
	A1, B1, U1, Y1, Z	1981/12/02	2015/08/03
Utility model	U	1981/12/02	1997/12/23

Geographic distribution

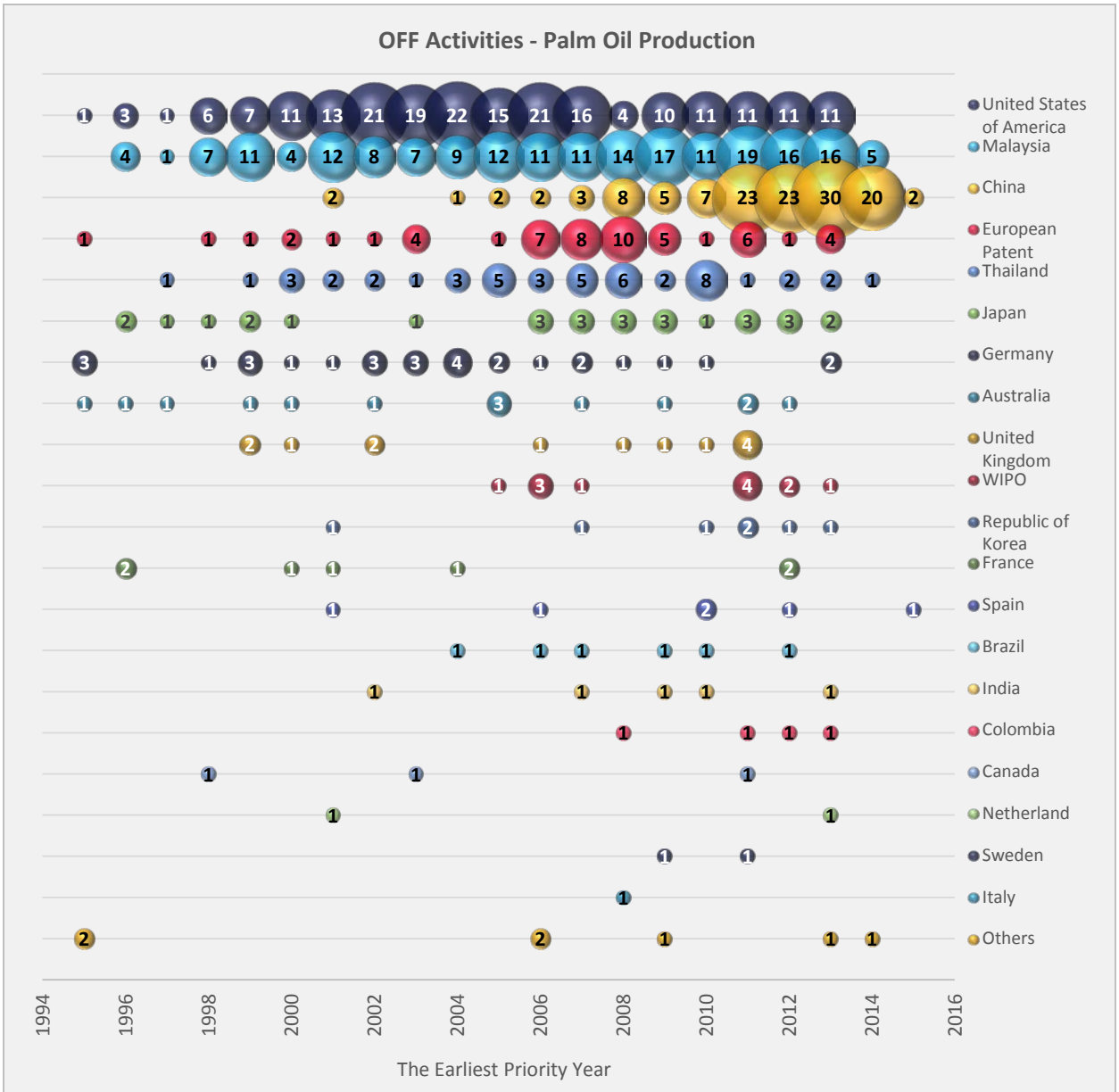


Figure 65 Filing activities from individual OFFs since 1995, by the earliest priority year, for Palm Oil Production. The bubble size and the numerical value represent the number of patent families.

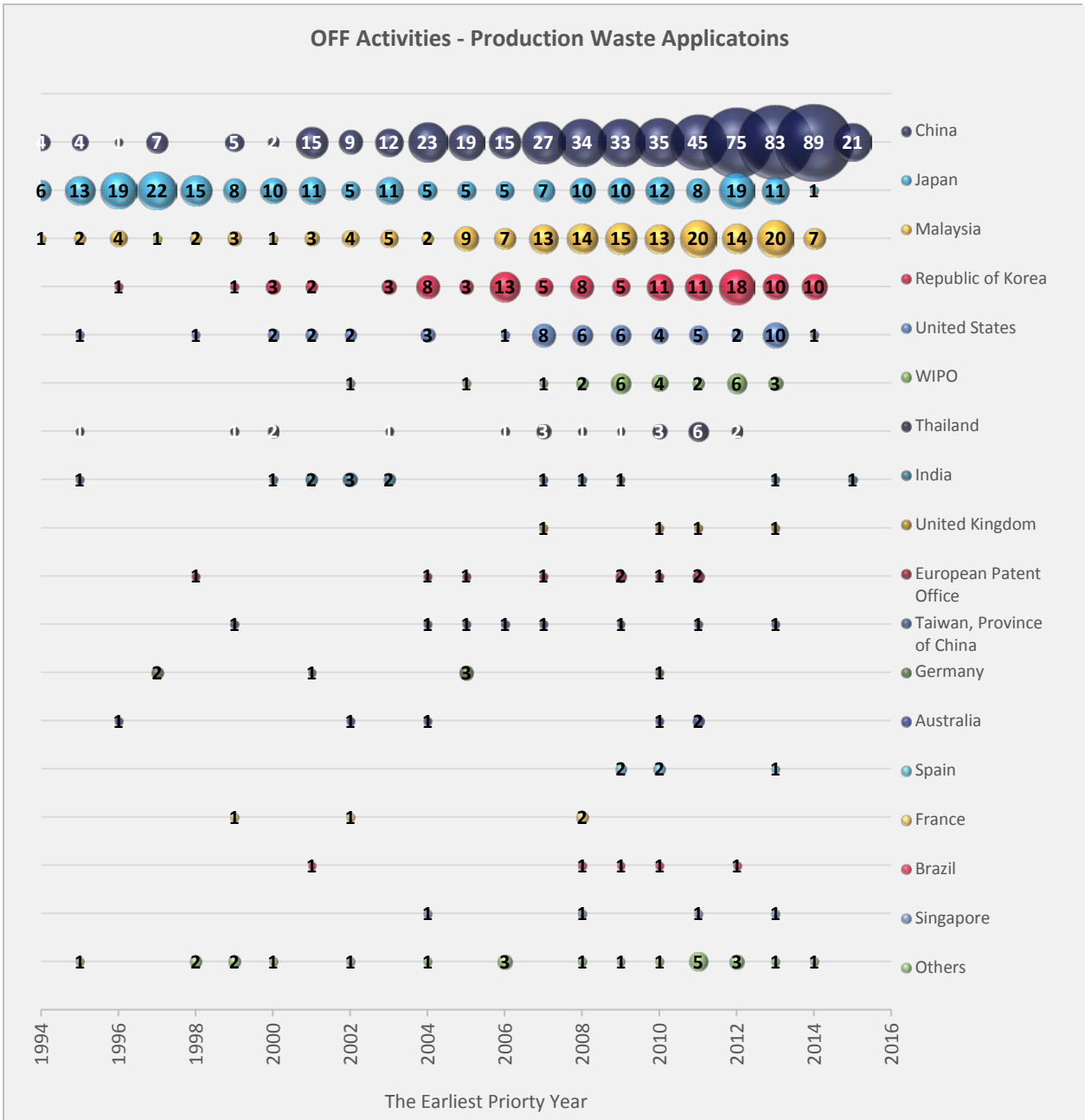


Figure 66 Filing activities from individual OFFs since 1995, by the earliest priority year, for Waste Treatment and Exploitation. The bubble size and the numerical value represent the number of patent families.

The patent family distribution of applicant nationality in Palm Oil Production is shown in Figure 67, limited to the earliest priority year since 1995. Patent families from Malaysian applicants are the largest group in this category, followed those from United States, German and Chinese applicants, with marginal differences. German applicants can make the 3rd place primarily due to BASF, an important applicant, is treated as a German corporation.

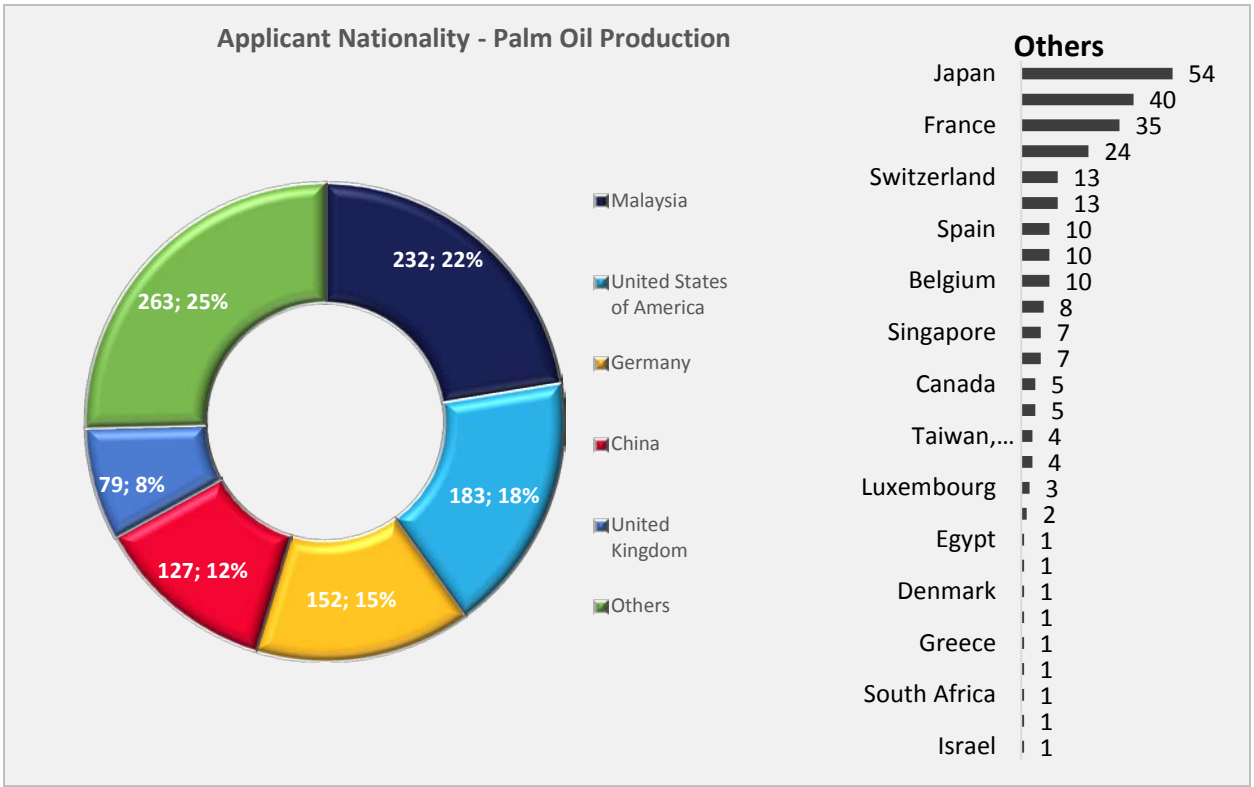


Figure 67 Family counts by applicants' nationality in Palm Oil Production category. The countries included in the slide "Others" are shown on the right. Families with the earliest priority date since 1995.

The patent family distribution of applicant nationality in Waste Treatment and Exploitation is shown in Figure 68. This distribution is quite close to Figure 30, OFF distribution. Patent families from Chinese applicants leads by a large margin, followed those from Japanese, Malaysian and Korean applicants.

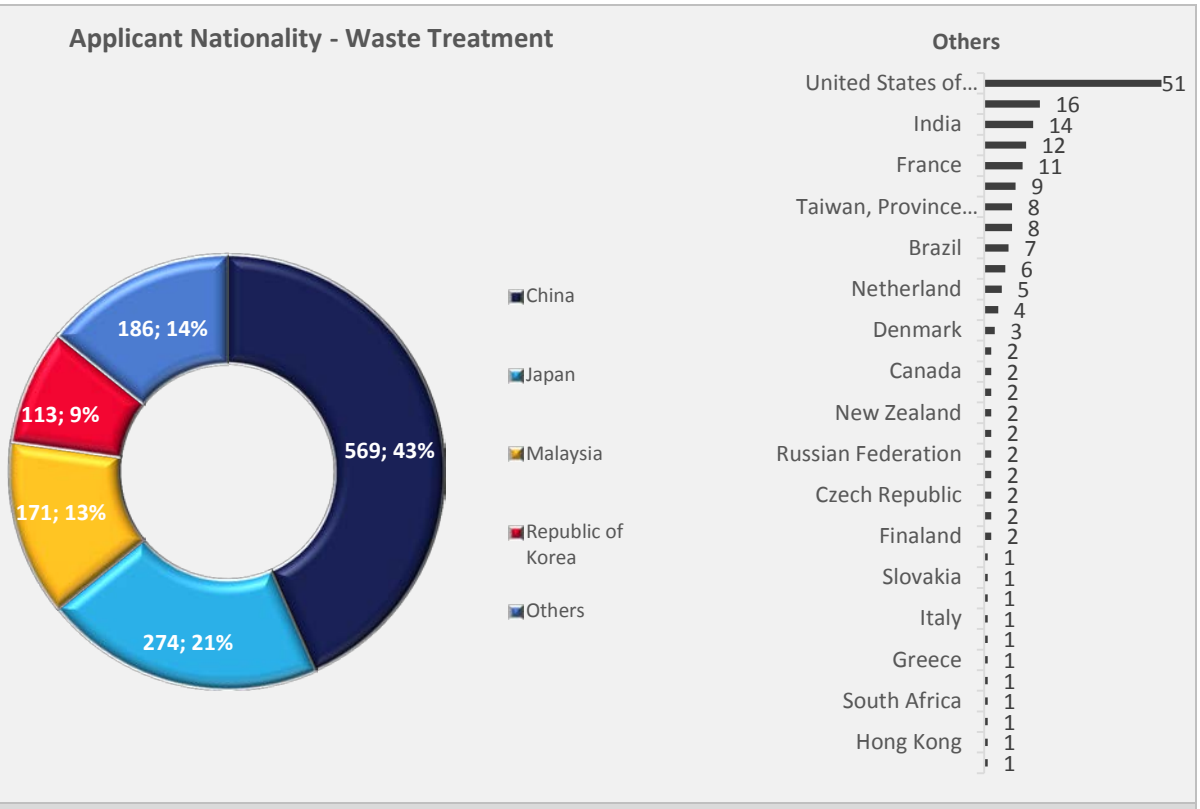


Figure 68 Family counts by applicants' nationality in Production Waste Category. The countries included in the slide "Others" are shown on the right. Families with the earliest priority date since 1995.

The analysis of patent family distribution based on inventors' nationalities produced a similar result as that based on applicants' nationalities, with a little difference. The results are presented in Figure 69 and Figure 70.

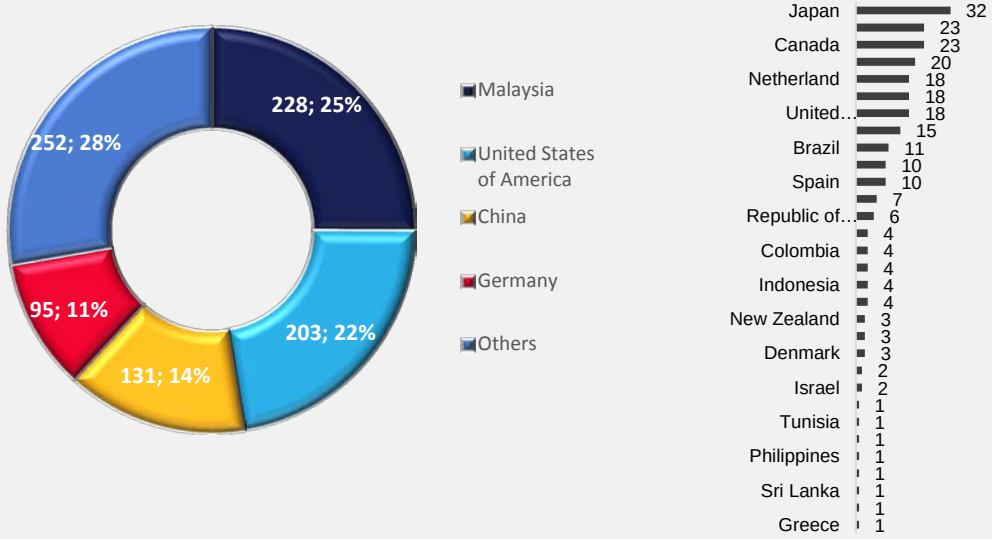


Figure 69 Family counts by inventor nationality in Palm Oil Production category. The countries included in the slide "Others" are shown on the right. Families with the earliest priority date since 1995.

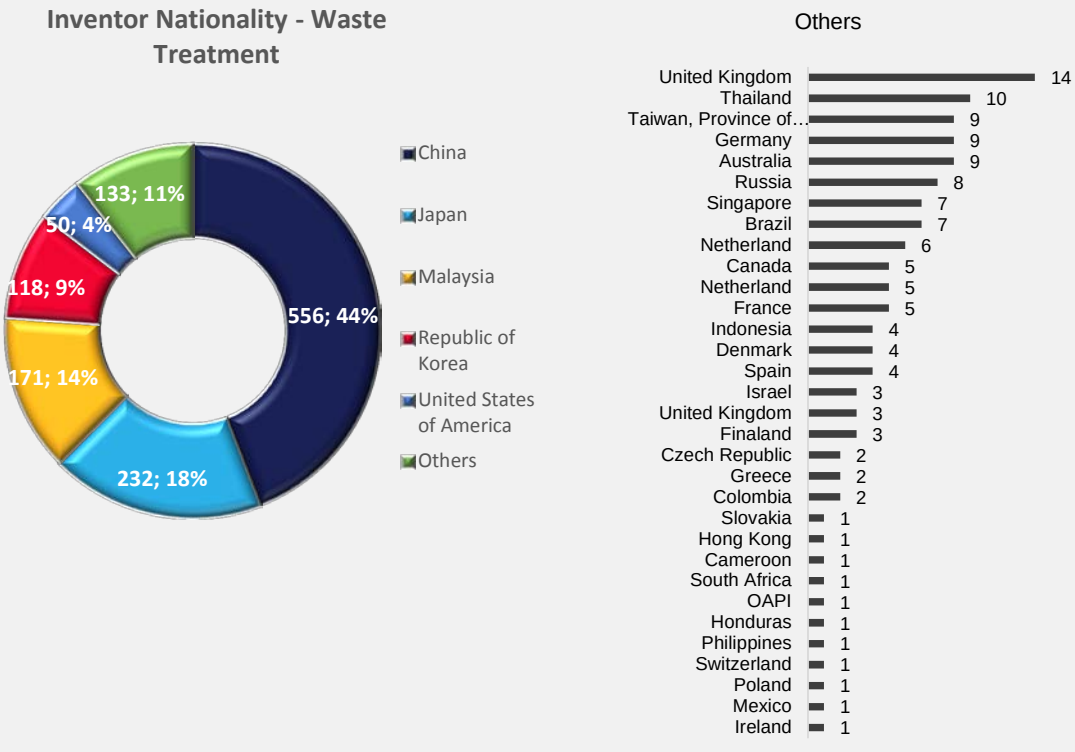


Figure 70 Family counts by inventor nationality in Production Waste Category. The countries included in the slide "Others" are shown on the right. Families with the earliest priority date since 1995.

OSF activities

Palm Oil Production Category

The Earliest Priority Year

Office of Second Filing (OSF)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
WO																	1	1			2		1	4	2	4	3	3	7	8	7	15	26	22	23	16	29	29	17	23	19	34	21	31	1		349
EP						1						1			1	1	1	1	1	1	3	1	1	1		3		2	5	6	9	11	20	7	15	13	9	14	3	10	14	12	7	3			176
CA					1	1		1				1							1	1	2			2	2	2		1	4	7	7	8	18	8	17	12	17	19	11	11	9	10	2				175
AU					1	1	1					1					1	1	1	1			1	3	2	2	3		7	9	7	10	26	9	11	9	6	12	10	9	5	9	2				160
CN																		1		1						2		2	2	3	2	3	13	8	11	9	13	21	6	12	7	16	6	2			140
US					1	1	1	1				1									2	2	1	2	1	2		2	2	4	5	4	8	6	4	3	10	12	11	11	4	12	2	2				117
BR					2	1		1	1							2	1	1		1			1			2		1	4	3	2	4	15	8	13	9	12	18	3		1	3					109
IN						1																				1				2	1	3	3	4	10	8	14	18	4	8	3	3	2	1			86
AR																										1			1	2	2	1	3		11	13	13	14	6	7	2	1		1			78
MX						1																	1		1	1		1		3	1		5	3	9	7	10	15	3	9	5	2	1				78
JP					1	1	1	2	1			2				1	1	1	1	1	1		1		1	3		1	3	4	2	2	4	3	5	1	8	3	2	4	6	8	2				77
DE					1	2	1	1	1			1								1	2	1		3	2			1	2	4	6	5	4	1	1		2	5	6	1		1					55
ES					1	1			1								1			1	1	1		2	2	2		1	2	3	2	6	3	2	3	2	7	5	1	2		1					53
AT						1						1								1	2	1		2		1		1	2	5	6	8	6	2	1		2	2									44
ZA						1	1					1					1	1		1				2	2				2	1	2		4	3	5	5	3										35
CO																									1	1									1	1	2	3	2	1	3	10	3					28
DK					1	2	1	1	1								1			1	1			2	2	1		1	1	2		1	3				2	1	1	1		1					28
KR																				1	1							1		1		1					2	3	1	5	3	2					21
MY	2		1	1		1	2	1		1												1									1	2		1			2	2		1	1						20
GB					1	1	2	1	1				1			2															1	2			1	2	1				1						17
IL					1												1			1			1					1	1	1	1		1		2		2	1	1	1	1						17
RU																																	1	3		2	1	1	5	3	1						17
NZ					1															1								1	2				1		1		3	1	1	1	2						15
OA				2	2	3	1						1				1	1		1							1								1													14
ID																											2		4	6	1																	13
PT						1											1			1			1					1	2	1		1					2	1	1									13
EA																												1		1					1		1	3	1	1	2		1					12
VN																														1			1			1	2	1		3		1	2					12
CR																																			1			3		1	1	5						11
SG							1									1														1	1			1						3	1	2						11
FR					1	2	1	2	1	1																										1			1									10
NL					1	2	2	2	1																							1			1												10
TW																																1							2	4	1		2					10
HU																	1			1					1	1			2	2																		8
NO						1	1																						1	1			1	2	1													8
CL																																					1	2			2	1	1					7
EC																																				1	2	2				2						7
PL					1												1								1	1		1		2																		7
TR						1														1				1	1	1		1																					6
AP																																					1	2				1	1					5
BE						2	1	1	1																																								5
FI						1	1										1			1					1																									5
IE					1	1	1										1			1																															5
IT					1	1	1	1	1																																										5
LU					1	1	1	1		1																																										5
MA																	1			1																						1		2								5
PH												1																																3	1						5
SE					1	1	1		1																														1											5
TH																													1	1				1								1								4
UY																																						1	1					1	1				4
CZ																									1	1				1																			3
DD					1	1											1																																	3
GR																	1			1	1																														3
HK																										1												1					1						3
PE																																						1			1	1							3
SU						1	1													1																														3
BG																				1										1																				2
CS						1														1																														2
DO																																				1						1							2
EG																				1							1																							2
HN																																			2														2
SK																				1					1																									2
TN																	1										1																							2
UA																																	1				1												2
YU						1														1																														2
CH						1																																												1
SI																																								1									1
ZW																	1																																1

Figure 71

Waste Treatment and Exploitation Category

The Earliest Priority Year

Office of Second Filing (OSF)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
WO												1		1					1	1			1		1	1	4	2	3	4	2	5	7	5	17	10	18	21	19	14	30	4		168
US												1		1					1	1							2		1	2	2	4	2	2	6	3	11	2	15	11	8	2	1			78
EP												1							1	1						1	1		2	1	3	3	2	1	7	3	8	6	9	7	8	2	1			68
CN																			1								2		1	1	2	1	2	3	5		9	6	8	8	10	1	2			62
AU														1					1									1	4	1	2	4	1	1		1	2	3	2	4	5		2			35
CA												1		1												1	2		1		2	1	1		3	1	3	1	4	5	4					31
JP																			1								1				2	2	1	2	2	1	3	8	1	2	3		2			31
IN																															1	1	1	1	2		7	2	3	5	3	1				27
MY							2	2	1		1												1		1	1	1	1			2				1	2	5									21
KR															1					1											1	1	2	1	1			2	1	2	3					16
CO																																						3		6	3	2					14
BR							1																									1	1	2	1		3		1							10
DE												1		1					1								1		1	1	2					1	1									10
MX																																			1		1			3	3					8
TW																							1							1					2			1	1			1		1			8
VN																											1								2					2	3						8
AT														1					1									1		1		2				1										7
NZ																															2	1					2		1	1						7
GB							1	1	1																					1												2				6
NO																										1		1				1			3											6
SG																											1														3	2					6
AP																																	1								1	3					5
ID																											2	1		2																	5
RU																															1			1					1	1	1					5
AR																																					1	1	1								3
DK																															1							1	1								3
EA																																									1	2					3
ES																														1		1							1								3
IL																																									1	2					3
PH									1																																	2					3
CL																																					1				1						2
HK																															1		1														2
OA									1																							1															2
PT																															1				1												2
TH																											1						1														2
BE																	1																															1
CR																																											1					1
EC																																	1															1
FR																																									1						1
PE																																										1					1
PL																																1																1
TN																														1																		1
ZA																																1																1

Figure 72

Most Active Inventors

Inventor	Family Counts	Nationality	Affiliation	Sector	Technology Subcategory (patent family counts)
Choo Yue May	27	MY	MALAYSIAN PALM OIL BOARD	Public	Extraction of phytonutrients(5) Direct fuel(1) Charcoal(1) Pressing (Extracting the palm oil)(1) Composite material(2) Palm Oil refining(6) Animal feed(2) Kernel recovery(2) Fertilizer(2) Biomass fermentation product (ethanol, sugar, etc...)(1) Waste water treatment(1) Other waste processing(3)
Tan Yew Al	25	MY	MALAYSIAN PALM OIL BOARD	Public	Extraction of phytonutrients(21) Tree seedling and cultivating(1) Pressing (Extracting the palm oil)(1) Palm Oil refining(2)
Sambanthamurthi Ravigadevi	22	MY	MALAYSIAN PALM OIL BOARD	Public	Advanced palm tree seeds (e.g. genetic engineering, seed selection, etc.)(5) Extraction of phytonutrients(16) Palm Oil refining(1)
Wahid Mohd Basri	22	MY	MALAYSIAN PALM OIL BOARD	Public	Advanced palm tree seeds (e.g. genetic engineering, seed selection, etc.)(1) Extraction of phytonutrients(13) Tree seedling and cultivating(4) Palm Oil refining(1) Kernel recovery(1) Mattress/cushion(1) Other waste processing(1)

Inventor	Family Counts	Nationality	Affiliation	Sector	Technology Subcategory (patent family counts)
Jelani Abdul Razak	21	MY	MALAYSIAN PALM OIL BOARD	Public	Tree seedling and cultivating(4) Fruit growing and harvesting(17)
P Manickam Kalyana Sundram	17	MY	MALAYSIAN PALM OIL BOARD	Public	Extraction of phytonutrients(15) Pressing (Extracting the palm oil)(1) Palm Oil refining(1)
Zhang Tangqing	21	CN	GUIZHOU DAZIRAN	Private	Mattress/cushion(13) Other waste processing(3) Direct fuel(2) Composite material(1) Filter(1) Other consumer products(1)
Shi Xiaobing	20	CN	GUIZHOU DAZIRAN	Private	Mattress/cushion(12) Other waste processing(3) Direct fuel(2) Composite material(1) Filter(1) Other consumer products(1)
Wang Hong	19	CN	GUIZHOU DAZIRAN	Private	Mattress/cushion(13) Direct fuel(2) Other waste processing(2) Composite material(1) Other consumer products(1)
Lin Weifu	19	CN	CATAS-CHINA	Public	Tree seeding and cultivating(10) Fruit growing and harvesting(6) Advanced seeds(3)
Lightner Jonathan	19	US	AGRINOMICS	Private	Advanced seeds(19)
Zou Jixin	18	CN	CATAS-CHINA	Public	Tree seeding and cultivating(9) Fruit growing and harvesting(6) Advanced seeds(3)

Inventor	Family Counts	Nationality	Affiliation	Sector	Technology Subcategory (patent family counts)
Jian Lin	17	CN	GUIZHOU DAZIRAN	Private	Mattress/cushion(12) Other waste processing(2) Composite material(1) Direct fuel(1) Other consumer products(1)
Zhu Jianxiang	16	CN	N/A	Individual	Mattress/cushion(14) Other waste processing(2)
Kurimoto Kenji	16	JP	KANEGAFUCHI CHEMICAL INDUSTRY	Private	Other consumer products(10) Mattress/cushion(6)
Zhang Xicai	15	CN	CATAS-CHINA	Public	Fruit growing and harvesting(6) Tree seeding and cultivating(6) Advanced seeds(3)
Jianhua Cao	15	CN	CATAS-CHINA	Public	Pressing(5) Kernel recovery(3) Palm Oil refining(2) Threshing(2) Tree seeding and cultivating(2) Sterilization of bunches(1)
Guiyun Wu	15	CN	GUIZHOU DAZIRAN	Private	Mattress/cushion(13) Direct fuel(1) Other consumer products(1)
Puzio Piotr	14	DE	BASF	Private	Advanced seeds(14)
Liao Tingmao	14	CN	GUIZHOU DAZIRAN	Private	Mattress/cushion(8) Other waste processing(3) Direct fuel(2) Other consumer products(1)
Fukuyama Masao	14	JP	MYWOOD 2	Private	Composite material(11) Other consumer products(2) Other waste processing(1)
Zeng Xianhai	13	CN	CATAS-CHINA	Public	Tree seeding and cultivating(6) Fruit growing and harvesting(4) Advanced seeds(3)

Inventor	Family Counts	Nationality	Affiliation	Sector	Technology Subcategory (patent family counts)
Wang Jun	13	CN	CATAS-CHINA	Public	Fruit growing and harvesting(6) Tree seeding and cultivating(4) Advanced seeds(2) Kernel recovery(1)
Hong Wang	13	CN	GUIZHOU DAZIRAN	Private	Mattress/cushion(12) Other waste processing(1)
Ito Takayuki	13	JP	MYWOOD 2	Private	Composite material(10) Other consumer products(2) Other waste processing(1)
Liu Jinquan	13	CN	GUIZHOU DAZIRAN	Private	Mattress/cushion(8) Direct fuel(2) Other waste processing(2) Other consumer products(1)
Aono Takashi	13	JP	MYWOOD 2	Private	Composite material(10) Other consumer products(2) Other waste processing(1)
Chen Ruoying	13	US	BASF	Private	Advanced seeds(13)

Table 11 The most active inventors

Collaborations

1. Public/Public Collaboration

Public Sector Applicant	Public Sector Applicant	Priority Year	Representative Patent
TSINGHUA UNIVERSITY	MALAYSIAN PALM OIL BOARD	2014	WO2015108409A1 An integrated process for fractionation of oil palm empty fruit bunch and conversion of the cellulosic solid to ethanol
FRAUNHOFER	MALAYSIAN PALM OIL BOARD	2012	WO2014027880A1 Plant regeneration from protoplasts derived from elaeis sp suspension cultures
CSIRO	MALAYSIAN PALM OIL BOARD	2009	WO2010143936A1 Composition and method for improving vascular health
BRANDEIS UNIVERSITY	MALAYSIAN PALM OIL BOARD	2008	WO2009146102A1 Methods for the treatment or prevention of diabetes mellitus and other metabolic imbalances
UNIVERSITI PUTRA MALAYSIA	MALAYSIAN PALM OIL BOARD	2009	MY146560A An oil palm electrical motorized cutter
UNIVERSITI PUTRA MALAYSIA	KYUSHU INSTITUTE OF TECHNOLOGY	2012	MYPI2014700501 Oil palm biomass powder and method for producing the same, and biomass composite molded article and method for producing the same
DONALD DANFORTH PLANT SCIENTIFIC CENTER	UNIVERSITY OF MISSOURI	2013	WO2014160862A1 Increasing the content of long chain fatty acids in seed oil
TIANJIN MARINE TRAFFIC ENGINEERING PROSPECTING DESIGN INSTITUTE	TIANJIN RESEARCH INSTITUTE WATER TRANSPORTATION ENGINEERING	2010	CN202012066U Flexible green ecological channel revetment structure

2. Private/Public Collaboration

Private Sector Applicant	Public Sector Applicants	Priority Year	Representative Patent
NEXUS TECHNOLOGY	MALAYSIAN PALM OIL BOARD	2014	MYPI2014000621 A SUBSTANTIALLY PALM OIL MILL EFFLUENT (POME) DISCHARGE THROUGH COMPOSTING OF MILL WASTES
CB INDUSTRY	MALAYSIAN PALM OIL BOARD	2013	WO2015037980A1 Zero liquid discharge palm oil clarification process
RONSER BIO-TECH	MALAYSIAN PALM OIL BOARD	2012	WO2013169091A1 Zero discharge treatment system of palm oil mill effluent (pome)
KEJURUTERAAN EMI	MALAYSIAN PALM OIL BOARD	2010	MYPI2010004885 A PROCESS AND APPARATUS FOR EXTRACTING RESIDUAL OIL FROM PALM PRESSED MESOCARP FIBER
SAKAMOTO YAKUHIN	MALAYSIAN PALM OIL BOARD	2010	JP2011195704A Division modifier of oil and fat
YOKOHAMA RUBBER	MALAYSIAN PALM OIL BOARD	1995	JPH08257545A Method for concentrating waste liquid of palm oil and concentrated liquid of waste liquid of palm oil
BAYER BIOSCIENCE	CNRS - CENTRE NATIONAL RECHERCHE SCIENTIFIQUE	2008	WO2010057620A1 Expression cassettes for seed-enhanced expression in plants
BAYER BIOSCIENCE	CNRS - CENTRE NATIONAL RECHERCHE SCIENTIFIQUE	2008	WO2010060609A1 Expression cassettes for seed-specific expression in plants
QIANNAN FENGLIN	UNIVERSITY GUIYANG	2014	CN104311321A Nuisanceless insecticidal organic fertilizer
QIANNAN FENGLIN	UNIVERSITY GUIYANG	2014	CN104355919A Botanical insecticidal bio-fertilizer

Private Sector Applicant	Public Sector Applicants	Priority Year	Representative Patent
KANEKA	TOKYO INSTITUTE OF TECHNOLOGY	2012	WO2014042076A1 Method for producing polyhydroxyalkanoate using modified fat or oil composition
STAV POLYMÉROV SAV;SKUMN ÚSTAV VODNÉHO HOSPODÁRSTVA V	CENTER VEDECKO TECHNICK CH INFORMÁCIÍ SLOVENSKEJ REPUBLIKY	2014	WO2015122856A1 A process for preparation of composite sorbent for removal contaminants from water
DOW AGROSCIENCES	BROOKHAVEN NATIONAL LABORATORY	2010	WO2011163557A2 Accumulation of omega-7 fatty acids in plant seeds
MEIDENSHA ELECTRIC MANUFACTURING	GUNMA UNIVERSITY	2008	JP2010135647A Production method of electrode for electric double layer capacitor
SEMBIOSYS GENETICS	UNIVERSITY OF ALBERTA	2007	WO2008113163A1 Transgenic expression of acyl-co-a binding proteins in plants
DUPONT	UNIVERSITY OF CALIFORNIA	2003	WO2005016504A2 Disruption of acc synthase genes to delay senescence in plants
FRONTIER AGRI SCIENCE	UNIVERSITY TORONTO	2011	WO2012159196A1 Plants having enhanced abiotic stress resistance
BEIJING AUNION NEW MATERIAL TECHNOLOGY	NANJING UNIVERSITY OF TECHNOLOGY	2012	CN103539264A River and lake water greening and purifying method and river and lake water greening and purifying device

3. Private/Private Collaboration

Private Sector Applicant	Private Sector Applicants	Priority Year	Representative Patent
JSP	MORIYA INDUSTRY	1995	JPH099778A Natural lawn with lightweight bed

Private Sector Applicant	Private Sector Applicants	Priority Year	Representative Patent
JSP	FUJIMI GREEN ENGINEERING	1997	JPH10323134A Floating mat for growing plant
NISHIMATSU CONSTRUCTION;TATEYAMA ENGINEERING	ECO GREEN	2002	JP2003199426A Vegetation base creation construction method and basis body
AGRIGENETICS	DOW AGROSCIENCES	2006	US2007220629A1 Resistance to auxinic herbicides
CENTRAL GREEN	ECOLOGY	2001	JP2002253007A Planting mat
FELDA AGRICULTURAL SERVICES	MIMOS	2013	WO2015084147A1 A method for monitoring anthesis of an inflorescence and a system for implementing the same
FUKUDA DOBOKU ZOEN	NEXCO	2008	JP2009284805A Plantation mat
FUKUKEN CHOSA SEKKEI	PENTA OCEAN CONSTRUCTION	1996	JPH09248091A Transplantation method of zostera type
HUNET	DYNIC	2003	JP2005117938A Sheet for plant raising and plant cultivation method using the same
KYOEI STEEL	STEEL PLANTECH	2008	MY150520A Arc furnace steelmaking method using palm shell charcoal
KYORITSU KOGYO	MITSUBISHI CHEMICAL	1996	JPH09187648A Active carbon for solvent refinement of dry cleaning
MAEDA TAMOTSU	SHIMONO SETSU	1995	JPH08322683A Mattress
MATSUO	JIRCAS-JAPAN	2009	WO2011045997A1 Method of tree sap extraction by squeezing, trunk shredder, and tree sap extraction system

Private Sector Applicant	Private Sector Applicants	Priority Year	Representative Patent
METANOMICS	BASF	2005	WO2007020198A2 Nucleic acid sequences encoding proteins associated with abiotic stress response and plant cells and plants with increased tolerance to environmental stress
MITSUI CHEMICALS	ITO KIYOSHI	2000	WO200153253A1 Method of purifying amide compound
NANJING JULONG ENGINEERING PLASTICS	NANJING JUFENG ADVANCED MATERIALS	2013	CN103554751A Plastic-wood composite floor and preparation method thereof
NIPPON GIJUTSU KAIHATSU CENTER	TAIHEIYO CEMENT	1996	JPH1085595A Sludge deodorizer and deodorizing method
ONNETSU KANKYO KAIHATSU	TOA SHOJI	1996	JPH108696A Plate body or compact and tatami floor or floor material using it
PLANT RESEARCH INTERNATIONAL	TIENSE SUIKKERRAFFINADERIJ	1999	AU2003246315A1 Transgenic plants presenting a modified inulin producing profile
PT ENDUGO ENZIMES INTERNATIONAL JI	HUTAPEA JAEGOPAL	2010	WO2011160192A1 Biofuel production
SANWA YUSHI	NISSHIN OILLIO	2011	WO2013014981A1 Heat-conducting material and heat-conducting member using same
SEOYEONG ENGINEERING	K C RIVERTECH	2007	KR20090051991A The Manufacturing Method for the shore-protecting item with vegetation function, using natural fiber
SHINKU	GUROOKARU	1995	JPH08302698A Mat for laying on ground and manufacture of mats

Private Sector Applicant	Private Sector Applicants	Priority Year	Representative Patent
SUNG WOON PLANT	ECO FRONTIER	2014	KR20150093892A Modular pellet manufacturing apparatus for oil palm frond
TOA SHOJI	ONNETSU KANKYO KAIHATSU	1995	WO9632251A1 Platy or molded material and method of manufacturing the same
TOKO	NIPPON GODO HIRYO	1997	JPH11117311A Method of slope greening construction
WATANABE NENRYO	KYODO SANGYO	2003	JP2005139249A Molded charcoal
KIYOMIZU KANKO;TABAI ESPEC	FUDO CONSTRUCTION;MIC	1999	JP2000328573A Vegetation unit

Most Cited Patents

Palm Oil Production

Representative Patent	**WO9113972A1**
Title	Plant desaturases - compositions and uses
Priority Year	1990
Applicant	CALGENE
Number of Forward Citation	470
Applicants of Citing patents	BASF, Bayer, Du Pont, Monsanto etc.

Representative Patent	**US4049686A**
Title	Degumming process for triglyceride oils
Priority Year	1975
Applicant	UNIVLEVER
Number of Forward Citation	77
Applicants of Citing patents	REG Synthetic Fuels, W.R. Grace, Cargill, etc.

Representative Patent	**WO2005083093A2**
Title	Method for producing polyunsaturated fatty acids in transgenic plants
Priority Year	2004
Applicant	BASF
Number of Forward Citation	72
Applicants of Citing patents	Du Pont, Dow, Abbott, CSIR, Biorginal Food, etc.

Representative Patent	**US2003097686A1**
Title	Plant seed oils
Priority Year	1990
Applicant	MONSANTO
Number of Forward Citation	60
Applicants of Citing patents	Solazyme, BASF, Monsanto, Bayer etc.

Representative Patent	**US4089880A**
Title	Process for refining fatty oils
Priority Year	1975
Applicant	ALFA LAVAL
Number of Forward Citation	60
Applicants of Citing patents	SMET, Cognis, Monsanto, P&G etc/

Waste Treatment and Exploitation

Representative Patent	**WO2008095033A2**
Title	Enzymes for the treatment of lignocellulosics, nucleic acids encoding them and methods for making and using them
Priority Year	2007
Applicant	BASF
Number of Forward Citation	46
Applicants of Citing patents	Novozymes, Codexis, Dow, etc.

Representative Patent	**US4509219A**
Title	Sleeping mattress
Priority Year	1983
Applicant	JAPAN LIFE
Number of Forward Citation	36
Applicants of Citing patents	Du Pont, Akado, Chan Hoi C, etc.

Representative Patent	**US5190618A**
Title	Production of high concentration tocopherols and tocotrienols from palm-oil by-products
Priority Year	1988
Applicant	MALAYSIAN PALM OIL BOARD
Number of Forward Citation	34
Applicants of Citing patents	Cognis, Henkel, Eastman Chemical, etc.

Representative Patent	**US2003031740A1**
Title	Treatment of vegetation liquors derived from oil-bearing fruit
Priority Year	1998
Applicant	MALAYSIAN PALM OIL BOARD
Number of Forward Citation	32
Applicants of Citing patents	Horizon Science, Sime Darby, CSIR

Representative Patent	**US2009062516A1**
Title	Lignin and other products isolated from plant material, methods for isolation and use, and compositions containing lignin and other plant-derived products
Priority Year	2006
Applicant	VERTICHEM
Number of Forward Citation	28
Applicants of Citing patents	Abengoa Bioenergy, Mascoma, Sunopta Bioprocess

Examples of Waste Material Exploitation

Palm fiber

Waste Application	Example Patent Number/Title	Applicant
Extraction of palm oil	MYPI2010004885 A process and apparatus for extracting residual oil from palm pressed mesocarp fibre	Malaysian Palm Oil Board
Extraction of phytonutrients	MY143751A Residual oil and polytonutrients concentrates from palm pressed - fibres	Malaysian Palm Oil Board
Direct fuel	CN102863999A Method and device for preparing fuel by using palm fiber waste	Guizhou Daziran Technology
Charcoal	MYPI2013700203 A method of producing lignin-based powder from oil palm fibres using pre-carbonization process	Malaysian Palm Oil Board
Adsorbent (e.g. activated carbon)	WO2006108683A1 Nanosized carbon material-activated carbon composite	Sharifah Bee Binti O A Abd Ham
Filter	JPH05237316A Filter medium using palm fiber	Suzuki Sogyo
Composite material	CN104877331A A fiber-reinforced polyurethane composite window and door profiles and its preparation method	Suzhou Hongheng
Animal feed	JPH05168417A Tropical palm useful as animal feed	Watanabe Masanaka
Fertilizer	SG186561A1 Biodegradation of oil palm fibre waste	Malaysian Palm Oil Board
Cultivation structure	JP2009284805A Plantation mat	Nexco; Fukuda Doboku Zoen

Waste Application	Example Patent Number/Title	Applicant
Biomass fermentation product (ethanol, sugar, etc...)	WO2010104371A1 A conversion of cellulosic materials into glucose for use in bioethanol production	University Malaya
Paper making	CN1737254A Pulp and paper making method by continuously boiling hollow palm fruit string fiber	Hangzhou Project & Research Institute Of Electro Mechanic Light Industry
Waste water treatment	JPH10249372A Production of waste water treating filter medium	Sekine Keizo
Mattress/cushion	CN101373118A Process of microwave heating palm fiber and production process for producing palm fiber elastic material	Guizhou Daziran Technology
Other consumer products	CN2502634Y Palm fibre cleaning towel	Fu Ximei
Other waste processing	CN1945180A Drying room for palm fiber	Nanfang Huitong

Palm trunk

Waste Application	Example Patent Number/Title	Applicant
Extraction of phytonutrients	MY143790A Method for processing oil palm dietary fiber	The Origin Foods Sdn Bhd
Direct fuel	TW200603972A Efficient reduction of botanical material into fine particles	Earth Science Industries Pte
Charcoal	JP2011094040A Production method of charcoal	Jfe Steel
Biodiesel	ES2377611A1 Procedimiento y obtencion de biocombustible solido a partir de palmaceas.	Curso
Adsorbent (e.g. activated carbon)	WO2011132675A1 Water absorbent material	Jircas-Japan

Waste Application	Example Patent Number/Title	Applicant
Composite material	WO2014057583A1 Compressed oil-palm material	Mywood 2
Animal feed	WO2014175722A1 A palm-based animal feed	Youji Organitech
Fertilizer	MY148649A Fybosoil novel biofertilizers through the bioconversion of rice bran and palm oil trunk	Universiti Islam Antarabangsa Malaysia
Cultivation structure	CN103931386A Groove-type planting method of nano-selenium chinese yam	Wei Xiaofeng
Biomass fermentation product (ethanol, sugar, etc...)	KR20120078566A Method for producing ethanol from oil palm lignocellulose wastes	Korean University Research & Business Foundation
Mattress/cushion	KR20000058414A An yellow soil mattress and yellow soil pad for an yellow soil bed	Chun In Dong
Other consumer products	TW379167B Method of making vases using palm plants	Lin He Rung
Other waste processing	JP2014126229A Lumber dryer and lumber drying method	Mywood 2

Palm fronds

Waste Application	Example Patent Number/Title	Applicant
Extraction of phytonutrients	SG184710A1 Extract from palm leaves and a method for producing the same	Universiti Putra Malaysia
Direct fuelyout	CN101088748A Compressor for producing high-density fuel block with inflammable waste	Bei Er Machinery

Waste Application	Example Patent Number/Title	Applicant
Charcoal	JPH06368A Activated carbon ceramics using strained lees of palm oil and its production	Yamahiro Toryo
Composite material	PH2006000551U Fiberboard from african palm oil(elaeis guineensis) fronds	Nelson Berson B Balopinos
Animal feed	WO2014130578A1 Palm-based animal feed	Palm Silage
Fertilizer	JPH0558767A It is low the nitrogen quality organic matter content fertilizer	Yuukishitsu Hiryo Seibutsu Kassei Riyou Gijutsu Kenkyu Kumiai
Cultivation structure	NZ506826A Methods of preserving cut plant material	Roger Kingwell Malcolm
Biomass fermentation product (ethanol, sugar, etc...)	WO2009040490A1 Method and apparatus for reducing palm stems to biomass	Palm Organics Global
Paper making	CN1715556A Method for pulping and paper-making	Yu Zuxun
Waste water treatment	US2011084029A1 Waste treatment system	Hydropress Holdings
Mattress/cushion	US1471535A Process and apparatus for producing fiber from palm leaves	Tannenberg Aubust O
Other consumer products	PH9544A Process for treating palm leaf stems and product produced thereof	Cuneta E

Palm bark

Waste Application	Example Patent Number/Title	Applicant
Extraction of phytonutrients	CN104127690A Chinese prickly ash-containing traditional chinese medicine compound hemostasis powder for treating wounds	Hancheng Qinlong Pepper Technology
Other chemical compound	JPH1121764A Application of extract from burned ash of oil palm bark	Santou Kagaku Kogyo
Adsorbent (e.g. activated carbon)	CN104174387A Palm tree bark adsorbent with good desorption property	Qingdao Hua Cheng Tian Machinery Manufacturing

Empty fruit bunches (EFB)

Waste Application	Example Patent Number/Title	Applicant
Extraction of palm oil	MY137926A Palm fibre extraction apparatus	Chen Ah Chong T A Better Engineering Works
Direct fuel	EP1990399A1 Method for the treatment of the empty fruit bunch (efb) material of palm oil trees, particulate torrefied efb product and use of such product as auxiliary fuel in a power plant	Cox Constantijn W H H
Charcoal	MY147340A Method of producing oil and bio charcoal from oil palm empty fruit bunches	Nasmech Technology
Biodiesel	MY142853A A process for converting empty palm fruit bunch (epfb) to biodiesel, gas fuel and char	Univ Malaysia Tech
Filter	CN203613057U Multi-level purification device for tap water	Qujing Hongcheng Industry & Trade

Waste Application	Example Patent Number/Title	Applicant
Composite material	WO2010013994A2 A fiber-granule board and production thereof	Universiti Malaysia Sabah
Animal feed	WO2015020347A1 Equipment and method for producing fiber feed by using palm-processing by-products	Il Sung Construction
Fertilizer	WO2011160278A1 Preparation method of organic fertilizer from empty fruit bunch of oil palm	Fujian Dade Invest & Development
Biomass fermentation product (ethanol, sugar, etc...)	WO2015108409A1 An integrated process for fractionation of oil palm empty fruit bunch and conversion of the cellulosic solid to ethanol	Malaysian Palm Oil Board
Paper making	CN101503867A Method for producing wrapping paper by oil palm empty fruit bunches mechanical pulping	Shaanxi University Of Science And Technology
Waste water treatment	WO2014192046A1 Oil palm byproduct processing method and edible substance	Nogami Kazutoshi
Mattress/cushion	GB2162554A Oil palm fibre and rubberised oil palm fibre, process for their production and articles made therefrom	Miyata Yoshio
Other waste processing	AUPO044096D0 Empty fruit bunch (efb) processing equipment for the oil palm industry	Williames Hi Tech International

Palm shell

Waste Application	Example Patent Number/Title	Applicant
Extraction of phytonutrients	GB700400A Method of producing high-value carotene-containing palm oil from palm-tree waste products	Institute Recherche S Pour Les Huiles
Other chemical compound	TH63972A The use of liquid smoke for the production of natural rubber.	Pt Jaya Baru Treatment
Direct fuel	TH135867A Solid fuels and methods and machines for the production of solid fuels.	Ube Industries
Charcoal	WO2009047927A1 Arc furnace steelmaking process using palm shell charcoal	Steel Plantech
Adsorbent (e.g. activated carbon)	CN103213983A Catalytic activated palm shell activated carbon preparation method	Institute Chemical Industry Forest Products Cas
Filter	JPH09313861A Improved waste gas deodorizing device	Mitsubishi Materials
Composite material	WO2015076665A1 Method of producing heat treated plant-based coarse aggregate for concrete	University Malaya
Animal feed	CN104489379A Palm fruit shell contained fermented feed for crucian and preparation method thereof	Suzhou Wanhe Bait
Fertilizer	JPH05211818A Compost	Tsurumi Soda
Cultivation structure	JPS61151321A Vegetation method of preventing weed growth on face of slope	Goto Ichita; Yoshimura Osamu

Waste Application	Example Patent Number/Title	Applicant
Biomass fermentation product (ethanol, sugar, etc...)	JP2011010617A Cellulose-containing raw material for producing sugar	Kao
Paper making	KR20130084926A Manufacturing method of the pulp which uses the palm fruit shell	Kwon Eo Kaun
Waste water treatment	JP2008055374A Water purifier	Fujiyama Hisami; Fujiyama Setsuko; Hayashi Koji
Mattress/cushion	KR20150085345A Eco mat made from palm shell	Ecopia
Other consumer products	RU2005065C1 Method of manufacturing wood flat articles	Kotov Stanislav Dmitrievich

Palm oil mill effluent (POME)

Waste Application	Example Patent Number/Title	Applicant
Extraction of phytonutrients	WO2008130216A1 Compounds extracted from palm oil mill effluent for the treatment of cancer, compositions thereof and methods therewith	Malaysian Palm Oil Board
Direct fuel	CN104930499A Hearth a palm waste boiler staged combustion	Tianjin Jidian
Charcoal	MY149399A Carbon form palm oil waste	Ir.S.Prabhakaran Pillai, M.Sc., A.M.I.E.T
Biodiesel	MY147972A Method for reducing free fatty acid content of sludge palm oil for producing biodiesel	Sime Darby
Adsorbent (e.g. activated carbon)	BR102012032479A2 Coal activated from the [endocarpo] of the fruit of palm [macauba] ([acrocomia] aculeata), process of attainment and uses	Universidade Federal De Minas Gerais
Animal feed	CN104222599A Pig feed with concentrated protein	Wuhu Xiangrong Food

Waste Application	Example Patent Number/Title	Applicant
Fertilizer	MY136982A Fertilizer from palm oil mill effluent	Malaysian Palm Oil Board
Biomass fermentation product (ethanol, sugar, etc...)	WO2011002270A1 A novel bacterium producing polyhydroxyalkanoates from palm oil mill effluent	Universiti Putra Malaysia
Paper making	WO2015083903A1 Method for manufacturing pulp using palm sludge	Sky Global
Waste water treatment	GB1529934A Treatment of palm oil effluents	Ici
Other waste processing	MYPI20071650 Bioplastic raw materials production from palm oil waste	Universiti Teknologi Malaysia

Palm kernel shells

Waste Application	Example Patent Number/Title	Applicant
Extraction of phytonutrients	MY128648A Method for producing myo-inositol from palm kernel pellet	Malaysian Palm Oil Board
Other chemical compound	MY145094A Process for preparing natural oil-based polyesters and polyamides	Universiti Kebangsaan Malaysia
Direct fuel	KR101442769B1 Fuel pellet for powdered coal boiler and it's manufacturing process by using palm oil byproduct	Nam Moon Sik
Charcoal	WO2011142001A1 Method and device for producing pelm kernel shell charcoal	Steel Plantech
Biodiesel	CN102703135A Method for producing biodiesel	Beijing Guoliyuan Polymer Technology Research Development Center

Waste Application	Example Patent Number/Title	Applicant
Filter	CN103159160A Manufacturing method and functions of palm corn fillers	Guizhou Daziran Technology
Composite material	TH137356A Soil processing of solid waste from the manufacture of rubber and latex. Products derived from this process	University Department Of Research National Rubber
Animal feed	CN102038113A Duck feed containing palm kernel meal and preparation method thereof	Tongwei
Fertilizer	NL1021833C2 Plant growth substrate or fertilizer comprises uncarbonized hard shell parts of oil palm nuts	Bas Van Buuren
Cultivation structure	CN103922847A Pleurotus eryngii culture medium containing rubber tree sawdust and preparation method of pleurotus eryngii culture medium	Saas-China
Biomass fermentation product (ethanol, sugar, etc...)	WO2012047430A1 Processing of palm kernel waste using mannanase and pectinase	Dupont
Paper making	JP2010090487A Production method of paper, production method and paper make container of paper make container	Crown Package

Palm kernel cake (PKC)

Waste Application	Example Patent Number/Title	Applicant
Extraction of palm oil	WO2014084718A1 A process for extracting residual oil from oil bearing waste feedstock	Eonchem Technology
Other chemical compound	WO2014189357A1 A process for extracting phenolic compound	Sime Darby
Composite material	MYPI2012002069 Natural based adhesive	Universiti Malaysia Pahang
Animal feed	MY149881A Protein enrichment of palm kernel cake	Universiti Putra Malaysia
Fertilizer	MY148391A Method of making compost from oil palm harvest refuse material	Biotop Organic Waste Management Sdn. Bhd.
Biomass fermentation product (ethanol, sugar, etc...)	WO2006137807A1 Production of fermented palm kernel cake (pkc)	Ql Agrobio
Other waste processing	MYUI90001762 Process for the simultaneous manufacture of phytin acid from palm kernel cake	Karim B. Yaacob

Palm ash

Waste Application	Example Patent Number/Title	Applicant
Composite material	CN103102517A A palm ash-natural rubber composite material preparation method	Agricultural Products Proc Research Institute Catas
Fertilizer	JP2010120814A Palm ash potassic fertilizer	Furuta Sangyo
Cultivation structure	JP2001286221A Organic quality raising of seedling ridging for paddy rice	Kanto Nosan

Waste Application	Example Patent Number/Title	Applicant
Waste water treatment	MYPI2011001290 Oil palm ash for treating industrial wastewater	Universiti Malaysia Pahang
Mattress/cushion	CN101601542A Method for manufacturing palm-bamboo charcoal mattress	Yuejian Wang

Biomass, general

Waste Application	Example Patent Number/Title	Applicant
Extraction of phytonutrients	WO2012050425A2 A process for extracting antioxidants from oil palm biomass	MPOB
Other chemical compound	WO2014042509A1 Extracting lecithin from palm agro-waste	Sime Darby
Direct fuel	CN103952205A Biomass compact briquette fuel and preparation method thereof	Mengcheng Shengyan Straw
Charcoal	JP2012046729A Manufacturing method of carbide from fibrous biomass	Nippon Steel
Biodiesel	CN101260312A Method for producing biological diesel oil	Deng Chubai
Adsorbent (e.g. activated carbon)	WO2015038965A1 Catalytic activated carbon structures and methods of use and manufacture	Meadwestvaco
Composite material	CN101224965A Biomass composite material wall modules and processing technology thereof	Beijing Creatvow Invent

Waste Application	Example Patent Number/Title	Applicant
Fertilizer	CN102976870A A method of producing a large dedicated slow-release fertilizer particles of oil palm	Zhengzhou University
Cultivation structure	CN103910584A Palm sawdust-containing pleurotus eryngii culture material and preparation method thereof	Saas-China
Biomass fermentation product (ethanol, sugar, etc...)	WO2014164581A1 Gradient pretreatment of lignocellulosic biomass	Du Pont
Paper making	MY145164A Process for pulp and paper-making from oil palm biomass	Eko Pulp & Paper Sdn. Bhd.
Waste water treatment	WO2014193466A1 Wastewater treatment for the production of microbial biomass	Oberon Fmr
Mattress/cushion	US2011024318A1 Bottle shipping system	Fibercel Packaging
Other consumer products	WO02064337A2 Resin-impregnated substrate, method of manufacture and system therefor	Mdf
Other waste processing	CN101074496A Method for decomposing oil-palm into fibre filament and fibre filament therefrom	South Huiton

Other waste materials

Waste Application	Example Patent Number/Title	Applicant
Extraction of palm oil	US2003201228A1 Recovery of oil from spent bleached earth	Ecoprocessors International
Extraction of palm oil	IN1344/DEL/2003A A process to recover oil and bleaching earth from spent bleaching earth	Kewalram Oils Sdn Bhd
Extraction of phytonutrients	US5190618A Production of high concentration tocopherols and tocotrienols from palm-oil by-products	Malaysian Palm Oil Board
Animal feed	MY100050A A method for the preparation of livestock feed from oil palm leaves.	Daiichi Engineering Co., Ltd.
Biomass fermentation product (ethanol, sugar, etc...)	CN102808003A Carbon source combination for increasing microbial oil yield	Fengyi Shanghai Biotechnology Research & Development Center

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[1] A patent family is a set of either patent applications or publications taken in multiple countries to protect a single invention by a common inventor(s) and then patented in more than one country. A first application is made in one country – the priority – and is then extended to other offices. For more details see WIPO Guidelines for Preparing Patent Landscape Reports, 2015, Section 4.4.5 Patent Families, p. 25, available at http://www.wipo.int/edocs/pubdocs/en/wipo_pub_946.pdf , and http://www.epo.org/searching/essentials/patent-families/definitions.html

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