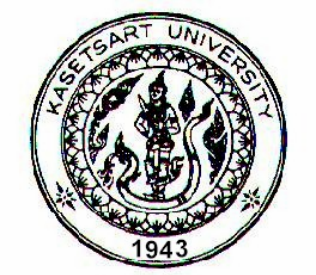

THESIS

THE MARKETING OF AGARWOOD (*Aquilaria* spp.) OIL IN THAILAND

SERI NANTA

Graduate School, Kasetsart University

2008

THESIS APPROVAL

GRADUATE SCHOOL, KASETSART UNIVERSITY

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THESIS

THE MARKETING OF AGARWOOD (*Aquilaria* spp.) OIL IN THAILAND

SERI NANTA

A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of
Doctor of Philosophy (Forestry)
Graduate School, Kasetsart University
2008

Seri Nanta 2008: The Marketing of Agarwood (*Aquilaria* spp.) Oil in Thailand. Doctor of Philosophy (Forestry), Major Field: Forestry, Interdisciplinary Graduate Program. Thesis Advisor: Associate Professor Wuthipol Hoamuangkaew, Ph.D. 101 pages.

Objectives of the study were to determine the present situation of agaroil industry in Thailand, production process, cost – benefit analysis, production, market structure, market conduct, market performance, and marketing channel of agaroil. The 24 sampled agaroil factories were purposive random sampling from the total 49 agaroil factories of the country or the percentage of cruise was 48.98. The data using for the study was gathered by employing the designed questionnaire interviewed the entrepreneurs of the sampled agaroil factories.

Results of the study indicated that in 2006 the agarwood shortage was the severe problem of Thai agaroil industry, their demand for agarwood at full capacity was much higher than the available quantity, it was 357,777.42 kg or the total quantity of the available agarwood was only 52.34 percent of the total demand at the full capacity. This mainly due to the difficulty of agarwood importation and the existing *Aquilaria crassna* plantation was still too young to harvest. In addition, the price of agarwood with a high price and a low price showing an upward tendency, increasing from 311.46 and 166.25 Baht/kg in 2002 to 341.25 and 175.63 Baht/kg in 2006 respectively. The high agarwood price provided an average profit per lot of agaroil production (using 15 kg of dried agarwood) was higher than the low agarwood price, they were 2,512.35 and 662.35 Baht per lot respectively. Furthermore, the market structure of agaroil was oligopoly. The marketing margin, producer's share and pricing efficiency were 246.67 Baht/Tora (1 Tora = 12gm), 93.97 and 1,659.10 percent respectively. Moreover, the profit cost ratios at average price were 52.67 and 28.28 percent, these belong to the high and low agarwood price respectively. This indicated that the performance of agaroil was good enough. The total agaroil production in 2006 was 45,318.47 Tora and the average price of agaroil was 3,845.83 Baht/ Tora, the most of this in amount of 35,261.61 Tora or 77.81% was distributed to the retailer at Soi Nana Market, Klongtoey Nua sub district, Wattana district, Bangkok by the entrepreneurs of 27,037.78 Tora (59.66%) and local middlemen of 8,223.83 Tora (18.15%), and then selling out to the foreign consumers in Bangkok. The rest of 10,056.86 Tora (22.19%) sold to the foreign middlemen at factories and then was exported to Dubai, Saudi Arabia and others in proportion of 11.40, 8.16 and 2.63 percent respectively.

In order to strengthen the agaroil industry for playing an important role in the Thai economy, the extension program for *Aquilaria crassna* plantation should be implemented for mitigating the raw material shortage. Moreover the standardization agaroil product is also needed for creating the reliability.

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Student's signature Thesis Advisor's signature

ACKNOWLEDGEMENT

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Seri Nanta

February 2008

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INTRODUCTION

Agarwood is an economical forest product of Thailand. It plays an important role in Thai economy because it is the principle raw material for agaroil production, this will create the agaroil industry to be a source of employment. In 1966, there were 8 agaroil factories in the whole country and this increased to 49 factories in 2006, and they distributed in the Central, North and South region in number of 43, 4 and 2 respectively (Industrial Factory Department, 2007). Moreover the price of agaroil that is the product of agaroil factory was quite high, it was 200,000 Baht/ litre (Siripattanadilok, 1982; Manimuang and Niranpakorn, 1999). However, there was no problem about the market for absorbing all of the produced agaroil, and almost all of the agaroil production was exported to the rest of the world which could earn a lot of foreign currencies in each year.

It is recognized that marketing system is very important for Thai economy development because it comprises a various relevant enterprises starting from plantation, timber transportation, agaroil integrated factories, retail, wholesale, exportation and importation of agarwood and agaroil. In addition, agaroil is multi-purpose product, it could be used in many different forms such as medicine and cosmetic, this will create more source of employment in such integrated enterprise which used agaroil as their raw material as well as the ones who come to engaged in the relevant marketing activities of each enterprises, this will generate much more income to distribute in the Thai economy.

Nowadays agarwood shortage was become severe problem of agaroil industry and most of agarwood using for agaroil production was imported from the neighboring country, this loss a lot of foreign currencies in each year. In order to mitigate this problem the agarwood plantation has been established, however the area of existing agarwood plantation is still less. In 1992 there was only about 1,000 rai of agarwood plantation in the country (Chaiwongkiat, 1994). Moreover, the information about the total demand for agarwood at full capacity, the quantity of available

agarwood, and the quantity of agarwood shortage of the agaroil industry, sources of agarwood, agarwood and agaroil price, cost and benefits from agaroil production as well as the marketing system of agaroil were not available.

Thus, in order to ensure the ones who were interested in the investment of agarwood plantation and agaroil distillation factories as well as the integrated agaroil industries to have the rational decision making, as well as the related agencies that govern such enterprise to have the necessary information for formulating the development plan for agaroil industry of Thailand. Thus, the study on the marketing of agaroil in Thailand will be needed.

The study was emphasized to determine the marketing system of agaroil in Thailand, this including in market structure, market conduct, market performance and marketing channel.

OBJECTIVES

1. To determine the present situation of agaroil industry in Thailand.

2. To determine problems and opinions of the entrepreneurs of agaroil factories on the cause of problems and the means for mitigation.

3. To determine the production process and cost – benefit analysis of agaroil production.

4. To analyze the marketing system of agaroil in Thailand, including market structure, market conduct, market performance and marketing channel of agaroil.

LITERATURE REVIEWS

1. Agarwood

Kritsana tree is the medium up to large evergreen perennial tree. It is generally called several names such as Mai Hom, Mai Paungmaprao, Kayudupu, Turadubu, Karayugaru, Kayugaru, Lookkaen, Lookput, Kaenkritsana, or Kritsana and many foreign names as Aloe wood, Agar wood, Eagle wood, Lignum aloes wood, Calambac, Kaharu wood, Agila, Aquila wood, Agallochum, Timhia, Timeao, Timpang and so on, found evergreen forest include with another wood (Chaiwongkiat, 1994), like Mai Yang (*Dipterocarpus* spp.), Yom Horm (*Toona ciliata*), Yom Hin (*Chukrassia velutina*), Wa (*Eugena* spp.), Korduai (*Castonopsis acuminatissima*), Sisiadetes (*Choerospondias axillaris*), Kradongdaeng (*Lincociera* spp.) etc. (Troup, 1921; Siripattanadilok, 1982; Subansenee *et al*., 1983)

Agarwood is classified to be in Family Thymelaeaceae, and its scientific name is *Aquilaria* spp. There are totally 15 species (Whitmore, 1973) distributed Northeast of India, Myanmar, China, Malaysia, and covered Southeast Asian up to the Phillipines (Troup, 1921; Whitmore, 1973; Baruah *et al*., 1982). Moreover, it is found in some parts of Bengal, and Assam of Pakistan (Bhattacharryya *et al.,* 1952; Siripattanadilok, 1982; Prachakul, 1989).

Agarwood is mostly found in moist evergreen forest at upper 1,100 metres above mean sea level such as Khao Khieo in Khao Yai national park (Siripattanadilok, 1982) with it's height ranging from 10-21 metres for medium and 25-50 metres for large tree, and with girth of 150-180 cm (or with diameter at breast height of 70-80 cm). (Thongjiam, 1992; Chaiwongkiat, 1994)

1.1 Thymelaeaceae

The characteristic of plant is this family is woody plants with tenacious bark. Leaves are simple, alternate or opposite, entire, without stipules. It has inflorescences spikes, racemes, umbels or heads. Flowers is bisexual, polygamous or dioecious. Calyx (hypanthium) is campanulate, cylindric or tubular, including 4-5 lobed. Petals (petaliod appendages) is scale-like, inserted in the throat of the calyx-tube, 4, 5 or 10, often reduced to fleshy glands or absent. Disc hypogynous, annular, scale-like or lacking. Its Fruit is a berry or drupe, sometimes is a loculicidal capsule.

This family has 50 genera and 720 species and found in, cosmopolitan with centers in Australia and Africa. There are 5 genera with 15 species in Thailand. The five genera of Thymelaeaceae which occurring in Thailand are placed under two different subfamilies. The genus *Aquilaria* is a member of the subfamily Aquilarioideae. The genera *Enkleia* and *Linostoma* of the tribe Dicranolepideae and *Wikstroemia* and *Daphne* of the tribe Dephneae belong to the subfamily Thymelaeoideae.

1.2 Aquilaria

The characteristics of the plants in Aquilaria family are shrubs or tree; its branches is pubescent, later glabrescent. Leaves are alternate, simple, entire, elliptic to slightly ovate, penninerved, nerves sometime branched, margins undulate, often slightly recurved and thickened. Inflorescence axillary, terminal, umbelliform, rarely with small bracts. The flowers has 5-merous, articulate and pedicelled. Its calyx-tube is campanulate or tubura, persistent, often splitting on one side in fruit; calyx-lobes is reflexed or erect, puberulous outside and often inside. There is 10 petals, free or connate at the base, elliptic or ovate, pilose or villous, inserted in the throat of the tube opposite the calyx-lobes. There is 10 stamens and located at the same level as the petal or attached slightly below them, sessile or filamentous, those alternating with the sepal sometimes is slightly longer than the episepalous ones, anthers are linear, dorsifixed. Ovary subsessiles is elliptic or ovate, puberulous, there is 2-loculed which

is style obscure or distinct; stigma is globose or oblong, disc none. Fruit characteristic is a locuiicidal capsule, elliptic to suborbicular, compressed contrary to the dissepiment and puberulous. Seeds are elliptic to ovoid, testa crustaceous, with a caruncle-like appendage at the base, endosperm is very thin or none; cotyledons thick and planoconvex.

There are about 15 species found in India, Myanma, Thailand, Laos, Cambodia, Vietnam, Malaysia and China (Hongkong, Hainan) and four species form in Thailand (Peterson, 1997). Exclusively for Thailand, there are only 4 species of agarwood namely *Aquilaria malaccensis* Lamk, *Aquilaria crassna* Pierre ex Lec., *Aquilaria subintegra* Hou., *and Aquilaria hirta* Ridl, (Peterson 1977), while the first 2 species are the commercial ones.

1.3 Situation of Agaroil Industry in Thailand

Agaroil industry was initiated in Thailand since 1966, during that time agarwood using for agaroil production was mostly come from natural forest. The domestic demand for agarwood has been increased over time this mainly due to the high price of both agarwood and agaroil, and these also caused the increasing in the rate of agarwood cut illegally from the natural forest. The high quality of agarwood core which having a very high price was mostly imported to Arab countries, the exported value was about 1,000 Million Baht per annum (Royal Forest Department, 2002). In addition, Klampaibul (2002) revealed that agarwood of Thailand was mostly used for distillation and exportation. The quantity of domestic use was a rather small. The agaroil produced from Thailand is the desirable product of the consumers, this because of the high quality, which created the reliability between exporters and importers. The agaroil price is directly related to the quality. The agaroil price was ranging from 2,500 – 3,000 Baht per Tora (1 Tora = 12.5 cc). The demand for agarwood and agaroil were unlimited, however this mainly due to their quality.

The agaroil production per lot (15 kg of agarwood) is varied to the quality of agarwood. The quality of agarwood in Thailand was divided into 4 grades as follows:

Grade 1: The best quality of agarwood which contains a large proportion of agaroil, and having a very high price, the price was ranging from 40,000 to 60,000 Baht/ Kg. The weight is 1.01 time of water.

Grade 2: The fragrance level as well as the weight of agarwood grade 2 are lower than agarwood grade 1. The weight is lighter than water. The price was ranging from 20,000 to 40,000 Baht/ kg.

Grade 3: The fragrance level and accumulation oil are lower than agarwood grade 2. The weight is lighter than water and the price was ranging from 15,000 to 20,000 Baht/kg.

Grade 4: The fragrance level and oil proportion were a rather low, this only suitable for distillation. The weight is 0.3 time of water and the price was ranging from 5,000 to 15,000 Baht/kg (Klampaibul, 2002).

Due to the natural agarwood is become scarce, and the agarwood shortage is the severe problem of the agaroil industry. In order to mitigate the problem, the extension program for *Aquileia crassna* Pierre ex. Lecomte reforestation is necessity. Nowadays the agarwood was wildly grown, and mostly found in Trat, Chanthaburi, Nakhon Nayok and Prachin Buri province. In 2006, the *Aquilaria crassna* Pierre ex. Lecomte. has been grown by the members of Thai Agarwood Assembly for 12 million trees (Sommung and Lilamanit, 2006).

1.4 Agaroil Utilization

Agaroil is the multi-purpose product, it could be used in many different forms such as medicine and cosmetic. Agaroil usable for curing stomachache,

moreover the smoke from agarwood burning usefully be cured the heart illness, as well as the smell will fix deeply in the skin of users and could prevention from the disturbance of desert insects. Furthermore, based on the Muslim religion, the use of alcoholic cosmetic is prohibited for all Muslims, thus agaroil is the indispensable product for the Central East Muslims. In addition, based on the Central East Muslim culture, in order to honour the guests, the agarwood burn will be performed (Klampaibul, 2003). In addition, agarwood could be used for rehabilitating the healthiness of heart blood, liver, and lung, curing headache and rheumatism. Furthermore, the agaroil could be used for perfume and cosmetic production (Siripattanadilok, 1994).

Naturally, the fragrant agarwood is a rare occurrence. Normally the most proportion or totally of agarwood is colourless which having no fragrant substance, while the agarwood which having brown to dark colour having more and more fragrant substance, this indicated that the quality of agarwood with dark colour is higher than the light ones. Thus, the proper technique for stimulating agarwood to originate the fragrant substance is needed. Based on the study of Siripattanadilok (1991) the fragrant substance in agarwood was originated by making scar on the trunk of *Aquilaria crassna* Pierre ex Lecomte. The tree will develop the chemical substance and accumulating at the scar. The scar could be made by chopping with knife or axe. In addition, the fragrant substance in agarwood could be originated by application the chemical substance, biological substance or some species of fungi in to the sapwood of *Aquilaria crassna* Pierre ex Lecomte. trunk (the holes were already prepared). (Rusmeetheemavong, 1994)

2. Marketing System

The most popular framework used for marketing system are market structures analysis, and approaches to marketing problems. Market structures analysis consists of market structure, market conduct, and market performance (Cave, 1982). Market structure consists of the relatively stable features of the market environment that influence the rivalry among the buyers and sellers operating within it. Market conduct

consist of the policies that participants adopt toward the market with regard to their price, the characteristics of their product, and other terms that influence market transactions. Market performance is our normative appraisal of the social quality of the allocation of resources that result from a market's conduct. Approaches to marketing problems consists functional, institutional, and commodity approach (Richard, 1961). All three are merely ways of breaking down a complex marketing problems.

3. Marketing Structural Analysis

3.1 Market Structure

The main elements of market structure are:

1. Seller concentration. The indicator of concentration of an industry is the concentration ratio. The compute a concentration ratio, it rank firm in order of size, starting from the largest in the industry (size is usually measured in term of either sales or employees). Then, starting from the top of the list, it add up the percentages for the top x firms published statistics usually give concentration ratios for the largest 4, the largest 8, and sometimes the largest 20 firms in an industry. If the concentration ratio of a firm is 100 percent, the market structure is monopoly. If the concentration ratio of the four largest firm is very low (5-10 percent), the industry is competitive. If the concentration ratio is between the two proportions as mentioned above, the industry is an oligopoly.

2. Product differentiation. The difference between products could be considered in various ways. These included quality, brand, size, packing and services. If consumer can not detect a different between products, the market is competitive. Change in price of product will lead to increase or decrease in quality of buying and selling of all products. If consumer difference between products, the market is imperfect. A change in price in one product will not cause gain or loss of the entire market shares.

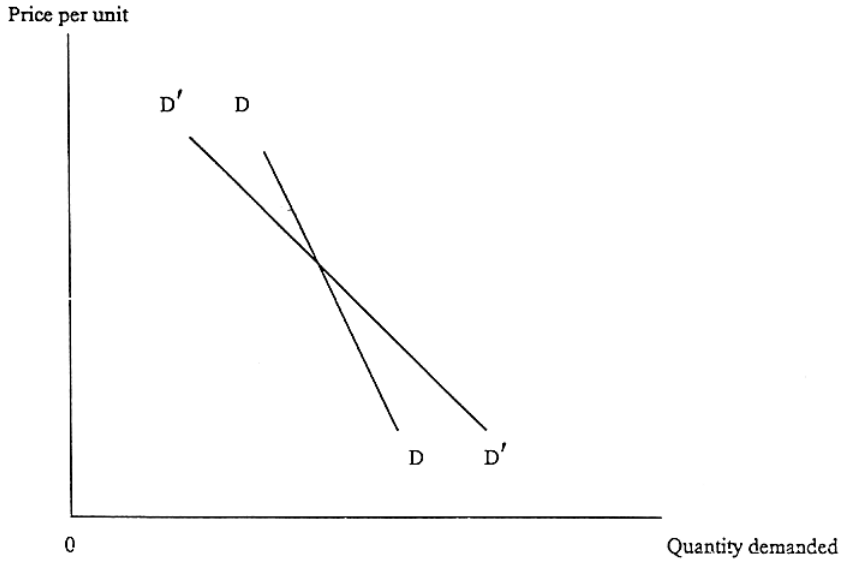

Figure 1 Demand curve facing individual seller of differentiated and undifferentiated product.

Source: Cave (1982)

DD is firm demand curve facing seller of differentiated product D′ D′ is firm demand curve facing seller of undifferentiated product (Figure 1).

3. Barriers to entry. Barriers to entry comprise another major segment of the firm's economic environment. Just as concentration reflects the number of actual market, rivals of a firm, so the condition of entry tells the story about potential rivals. To see the potential importance of the condition of entry, imagine a monopolist who has no actual rivals, but well know that raising its price above the level which a security yields normal profits will draw a horde of rivals into competition with it. To preserve of life, the firm may choose to set a "competitive" price, earning on excess profits but attracting no rivals. In this case, it would say that entry is "easy". New firms can produce at a lower cost than those of the going firm. This monopolist has no long-run monopoly power at all. Take the opposite case, a monopolist who controls patents, could avoid completely from rivals, actual or potential. Thus, the entrance of the new comer is blockaded, and the monopolist's position becomes perfectly protected. The firm can change whatever price will maximize profits in the short run and still remain its entire market in splendid isolation in the long run.

Figure 2 gives a more specific interpretation to these ideas. It shows average cost (AC) and marginal cost (MC) curves for a monopolistic producer, along with the demand (D) and marginal revenue (MR) curves faces. The firm gains maximum short-run profits by setting price Pm, by supplying to quantity of output for which the marginal cost equals marginal revenue. Pc is the competitive price. In a perfectly competitive industry, price is equal to both marginal and average costs. The competitive price would yield just enough profit to keep the firm in the business. The condition of entry are low barriers to entry will permit a price not much above Pc, if rivals are not to be tempted into the industry, and high barriers to entry, on the other hand, will permit a price at or near the which maximizes short-run profits without attracting new competitors. In between high and low barriers are located moderate barriers to entry, allowing a price yielding some profit above and beyond the competitive level, but not the short-run monopoly maximum indicators of barriers to entry are as follow.

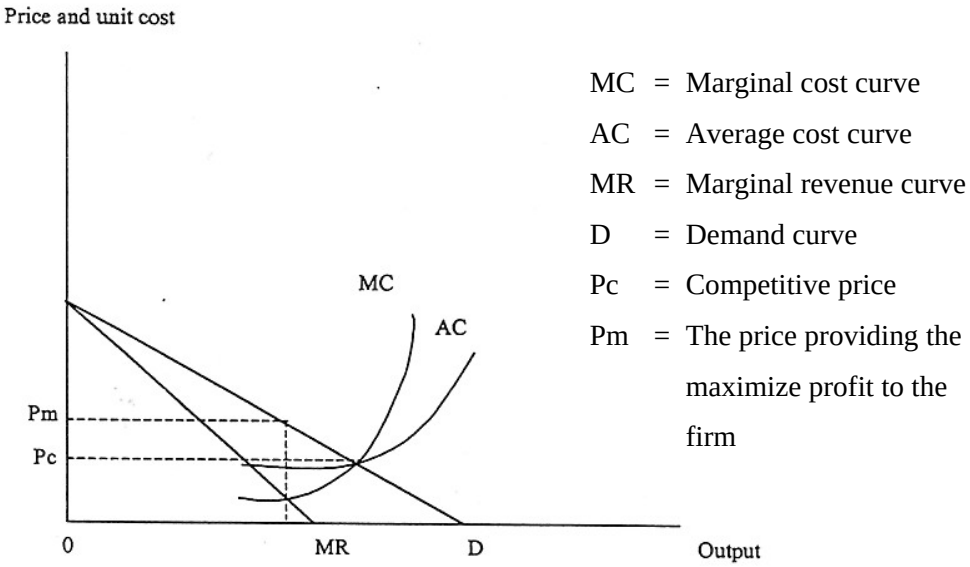

Figure 2 Measurement of barriers to entry**.**

Source: Cave (1982)

3.1 Scale – economy barriers to entry. Achieve the lowest possible cost until they have grown to occupy a large portion of the national market. Figure 3 offers an illustration. It shown the average unit cost curve any firm, new or old, in some industry. The firm would enjoy economics of scale as it grows from any small output toward output OB, for average unit costs decline over this range. Now, suppose the output OB would supply a large portion of the national market. Output OM, which is three times output OB, equal sales in the national market at the going price.

Consider the dilemma that faces any new firm entering this industry. The existing firms, each producing OB, can supply the entire market. If the newcomer also builds a plant big enough to achieve the available scale economics, OB, the firm has to wrest from the existing firms a substantial part of their market. To sell as much as they do, on the average, the firm would have to cut each of them back from a third to a fourth of the national market. The firm would probably have to come early heavy bases to do this.

The new firm has another alternative. The firm can build a small plant, with a capacity such as OA, and sell its whole output without waking a sizable dent is the market of the going firm. But the firm must pay the penalty of inefficiency due to small scale. As illustrated in Figure 3, a firm producing output OA, half the output OB which just gains all the available scale economics, incurs cost haft again as high as the larger firm. Either way, the new firm faces disadvantages, which the older rivals avoid.

3.2 Absolute – cost barrier to entry. Cost barriers are anything which causes the production cost curve of a new firm to be higher than that of a going concern. Figure 4 shows the new firm's cost curve placed above the old firm's by a constant amount. Notice the distinction from scale-economy barriers to entry. Here the new firm faces cost disadvantage over the old one at any output level it chooses to produce.

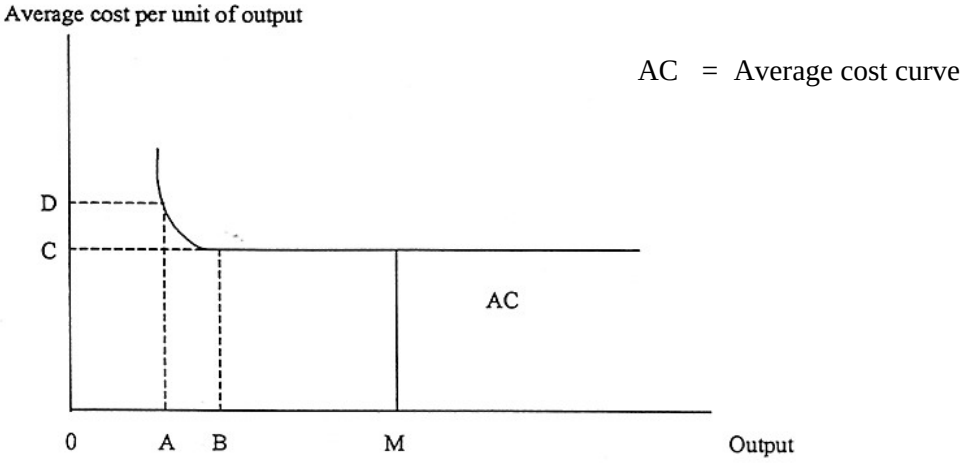

Figure 3 Entry barriers due to scale economics.

Source: Cave (1982)

3.3 Product – differentiation barrier to entry. Differentiation is one of these major features of market structure. It exists when consumers form different preferences among the individual brands of a product. It removes the pressures on producers all to sell at single market price. Each can set its own price policy, and the form of price competition is changed.

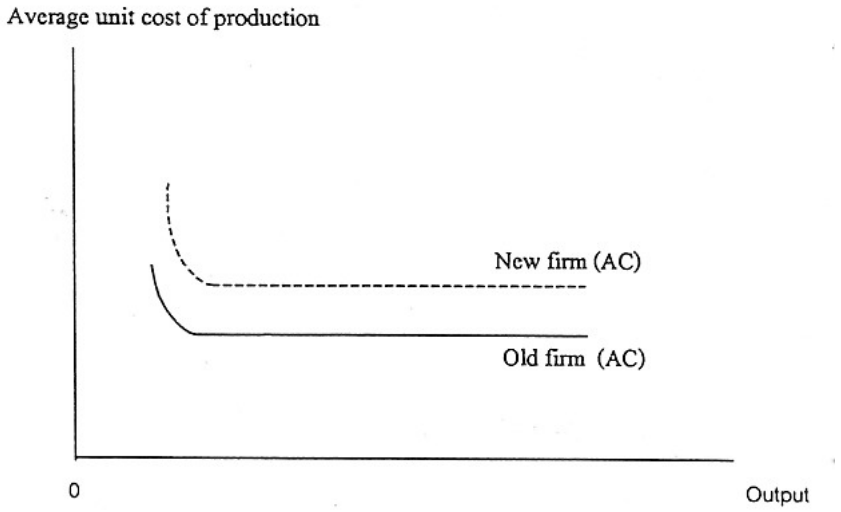

Figure 4 Barriers to entry due to absolute cost disadvantages.

Source: Cave (1982)

3.2 Market Conduct

Market conduct consists of a firm's policies toward its product market and toward the moves by its rivals in that market (Cave, 1982).

1. Conduct under pure competition. Consider the industry which matches the model of pure competition. In term of the elements of market structure, it would exhibit very low concentration, insignificant barriers to entry, and no product differentiation. It is the environment of the individual firm has no significant freedom of choice. The market sets the price for its product, and it cannot meaningfully ask a different one. Pure competition permits a firm on choice in deciding how efficient it will be. If the many rivals firm keep costs as low as possible, the firm can only do likewise or else be forced out of business as a result of subnormal profits.

2. Conduct under pure monopoly. The pure monopolist is almost as limited in playing and independent hand. One particular combination of price and output is optimal for profit maximizing monopolist. There will be some optimal level for advertising budget, and quality level. The monopolist's demand and cost curve many shift from time to time in response to changing prices and incomes in the economy, but these shifts merely call for routine corrective actions. It responds only to general economic current, not to the challenge of some particular business rival.

3. Conduct under oligopoly. The essence of oligopoly is that firm are few enough to recognize the impact of their actions on their rivals and thus on the market as a whole. When one firm cuts its, it considers the possibility that sales snatched from its rivals may cause them to their price too. This is a new and distinctive element of market conduct found only on oligopolies industries.

General principles to study market conduct are as follows:

1. Price policies. In a competitive market, the market sets the price. In an oligopolies market, individual firm set list price. Firms adjust prices in response to changing market conditions or to change introduced by their rivals. When the product is differentiated, this process of adjustment a response goes on very quickly and sensitively. When one seller initiates a price change in such a market, the response usually occur immediately, or else the sellers' market shares would undergo great changes. The means and countermoves lead quickly to a new market price. By contrast, the product is heavy differentiated, oligopolies are less sensitive to one another's price changes.

2. Product policies. If the product is differentiated, firm will make decisions on quality and cost of product. Each firm will consider that they can increase profit by improving quality or reducing cost. These decisions affect rivals. Rivals are forced to improve their products or let other firms have a large market share.

3. Coercive conduct. Coercive conduct is the behavior of firm, which seeks to increase concentration by driving some of rivals out of business.

Coercive conduct generally cuts in one or both of two directions; (1) taming, weakening, or eliminating existing business rivals; (2) raising the barriers to entry to curtail the supply of potential rivals. In both cases the likely outcome is more monopoly or oligopoly excess profits for the least some of the existing firms. Coercive actions can take pluck only in market where concentration is high enough 50 that each firm takes specific account of at least some of its rivals.

Rival elimination method

Predatory price cutting is the most of the coercive devices would appeal primarily to a financially strong firm seeking to waken, tame, or eliminate its

current market rivals. If a rival has acted independently, trying to capture a larger market share, a predatory firm may discipline the firm by driving the market price down to unprofitable levels for a period of time. The predator much have several assets to allow this alternative lower cost than the victim; greater financial reserves from post profits; sustaining source of profit from sales in other market.

3.3 Market Performance

Market performance is the measurement of how far the economic results of an industry's behavior fall short of the best possible contribution. It could make to achieve efficiency in the use of resources, progressiveness in enlarging and improving the flow of goods and services, stability of prices and employment, and full employment and equity of income distribution.

4. Approaches to Marketing Problems

4.1 The Functional Approach

The main elements of marketing function are: (Richard, 1961)

1. Exchange functions. The exchange functions are those activities, which are involved in the transfer of title to goods. They represent the point at which the study of price determination enters into the study of marketing. These functions are never performed in our economy without a judgment of value, usually express at least partially as a price, being place on the goods. Both the buying and selling functions have as their primary the negotiation of favorable terms of exchange.

The buying function is largely one of seeking out the source of supply, assembling of products, and the activities, which are associated which purchase. This can either be the assembling of the raw products from the production areas or the assembling of finished products into the hands of other middlemen in order to meet the demands of the ultimate consumer.

The selling functions must be broadly interpreted. It is more than merely passively accepting the prices offered. In this function can be grouped all of the various activities which sometimes are called merchandising. Most of the physical arrangements of display of good are grouped here. Advertising and other promotional devices to influence or create demands are also part of the selling function. The decisions as to the proper unit of sale, the proper packages, the best marketing channel, the proper time and place to approach potential buyer.

2. Physical functions. The physical functions are those activities, which involve handling and movement of the actual commodity itself. They are involved solving the problems of when and where in marketing.

The storage function is primarily concerned with making goods available at the desired time. It may be the activities of elevators in holding large quantities of raw material until they needed for further processing. It may be the holding of supplier of finished goods as the inventories of processors, wholesalers, and retailers.

The transportation function is primarily concerned with making goods available at the proper place. Adequate performance of this function requires the weighing of alternatives of routes and types of routes and types of transportation as they might affect transportation costs. It also includes the activities involved in preparation for shipment such crating and loading.

3. Facilitating functions. The facilitating functions are those which make possible the smooth performance of the exchange and physical functions. These activities are not directly involved in either the exchange of title or in the physical handling of products. However, without them the modern marketing system would not be possible. They might aptly be called the grease that makes the wheels of the marketing machine go round.

The standardization function is the establishment and maintenance of uniform measurements. These may be measurements of both quality and quantity. This function simplifies buying and selling, since it makes the sale by sample and description possible. It, therefore, is one of the activities which make possible mass selling, which is so importance to a complex economy. Effective standardization is basic to an efficient pricing process. A consumer – directed system assumes that the consumer will make his wants knows largely through price differentials. These differentials must then be passed back through the marketing channel so that marketing agencies and producers can know what is wanted. Only if a commodity is traded in well-defined units of quality and quantity can a price quotation do this job effectively. Standardization also simplifies the concentration process, since it permits the grouping of similar lots of commodities early in movement from the producing points. Besides their establishment, the use of standards must be policed. Such activities as quality control in processing plants and inspections to maintain the standards in the marketing channel can be considered part of this function

The financing function is the advancing of money to carry on the various aspects of marketing. To the extent that there is a delay between the times of the first sale of raw products and the sale of finished gods to the ultimate consumer, capital is tied up in the operation. Anywhere that storage or delay takes place, someone must finance the holding of goods. The period may be one of a year or more, as in the operations of the canning industries, or a relatively short time as in the marketing of perishables. Financing may take the easily recognizable from the advances from various lending agencies or the more subtle from typing up the owner's capital resources.

The risk-bearing function is the accepting of the possibility of loss in the marketing of a product. These risks can be largely classified into two broad classification – physical risks and market risks. The physical risks are those which occur from destruction or deterioration of the product itself by fire, accident, wind, and earthquakes. Market risks are those which occur because of the changes value of a product as it is marketed. An unfavorable movement in prices might result in high

inventory losses. A change in consumer taste might reduce the desirability of the product. A change in the operation of competitors might result in a loss of customers. All of these risks in varying degree must borne in the marketing of a product.

The marketing information function is the job of collecting, interpreting, and dissemination the large variety of data which are necessary to the smooth operation of the marketing processes. Efficient marketing cannot operate in an information vacuum. An effective pricing mechanism is dependent on well-informed buyer and sellers. Successful decisions have how much to pay of commodities or what kind of pricing policy to use in their sale require that large amount of market knowledge be assembled for study. Adequate storage programs, an efficient transportation service, and adequate standardization program all depend to a considerable extent on good information. Much of the market research which is carried on to evaluate the possible alternative marketing channels which may be used, the different ways of performing other functions, the market potentialities for new products, may be classified as part of the board function of market information.

4.2 The Institution Approach

The institution approach considers the nature and character of various middlemen and related agencies and also the arrangement and organization of the marketing machinery. Middlemen are those individuals or business concerns that specialize in performing the various marketing functions involved in the purchase and sale of goods as they are moved from producers to consumers.

4.3 The Commodity Approach

Commodity analysis helps focus attention of the differences in marketing which arise because of differences in either the commodity or its production. Perish ability, seasonally, and the size of the basic production unit may influence the way functions are performed and the type and organization of institutions which performed them. The separate study of a large number of commodities also will often help point

up the similarity of the marketing problems, which exits. For example a commodity-by-commodity analysis point out that retailing usually is the most costly single step in marketing. The finding helps emphasize the importance of a critical evaluation of the retailer as a middleman and performed functions and why some are more efficient than others.

All three approaches functional, institution, and commodity are necessary to obtain the most complete understanding of marketing. Functional analysis may have meaning only when combined with institutional and commodity analysis. Thus, it may be simplifying procedure to think of the functions of storage or financing in the abstract. However, a complete grasp of a particular problem may not be possible until the characteristics of the various business organizations and the product itself which are specifically involved are considered.

4.4 Economic Analysis of Costs

The major elements of a firm's costs are its fixed costs (which do not vary at all when output changes) and variable costs (which increase as output increases). Total costs are equal to fixed plus variable costs: TC = TFC + TVC.

Where : TC = Total cost; TFC = Total fixed cost; and TVC = Total variable cost

Fixed cost sometimes called "overhead" or "sunk costs", they consist of items such as and they will not change if output changes. While variable costs are those which vary as output rent for factory or office space, contractual payments for equipment, interest payments on debts, salaries of tenured faculty, and so forth. These must be paid even if the firm produces on output, changes.

By definition, TVC begins at zero when q is zero. It is the part of TC that grows with output; indeed, the jump in TC between any two outputs is the same as the jump in TVC.

Thus, this could be concluded that total cost represents the lowest total expense needed to produce each level of output, total cost increase when output increase.

Whereas fixed cost represents the total expense that is paid out even when no output is produced; fixed cost is unaffected by any variation in the quantity of output.

Variable cost represents expenses that vary with the level of output such as raw materials, wages, and fuel and includes all costs that are not fixed.

Hence:

$$TC = TFC + TVC$$

Where:

TC = Total cost
TFC = Total fixed cost
TVC = Total variable cost

In addition, marginal cost (MC) of production is the additional cost incurred in producing one extra unit output. While average cost (AC) is the total cost divided by the total number of units produced.

$$\text{So, AC} = \frac{TC}{Q}$$

Where : Q = Output

from $TC = TFC + TVC$

so $$\frac{TC}{Q} = \frac{TFC}{Q} + \frac{TVC}{Q}$$

or; $AC = AFC + AVC$

Where: AC = Average cost
AFC = Average fixed cost
AVC = Average variable cost

Hence, the average cost is equal to average fixed cost plus average cost. Thus, we can apply cost and production concepts to understand a firm's choice of the best combination of factors of production. Firms that desire to maximize profits will want to minimize the cost of producing a given level of output. In this case, the firm will follow the least-cost rule: different factors will be chosen so that the marginal product per dollar of input is equalized for all inputs. This implies that $MP_L/P_L = MP_A/P_A = ...$ (Samuelson and Nordhaus, 1998).

4.5 Marketing Channel

Marketing channel is the chart represent the routes of distribution channel consists of the set of people and firms involved in transfer of title to a product as it moves from producer to ultimate consumer or business user (Etzel *et al.*, 1997) (Figure 5).

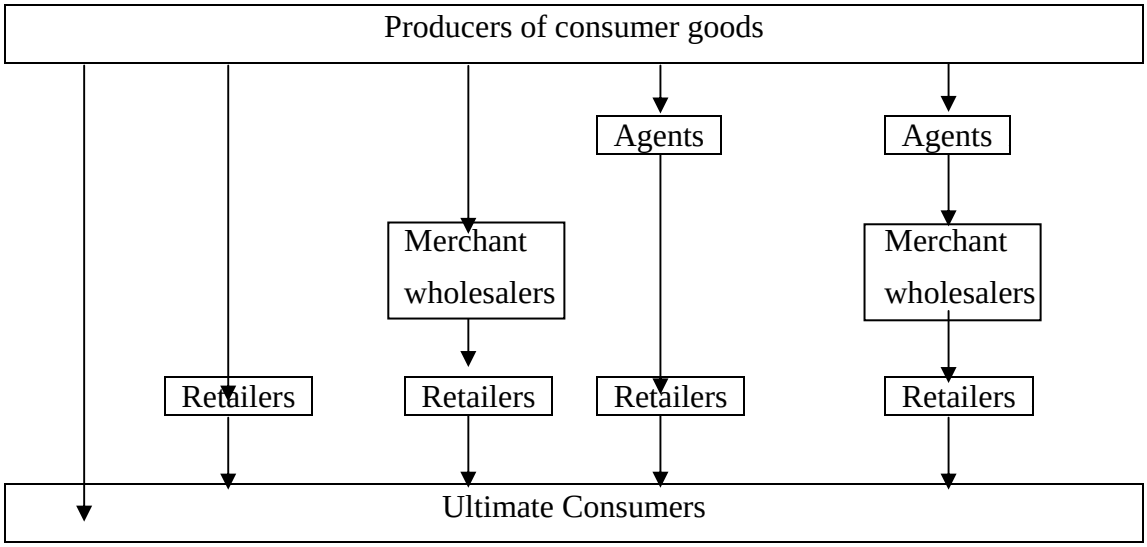

Figure 5 Marketing channel of agaroil.

MATERIALS AND METHODS

Materials

1. Designed questionnaires for interviewing the sampled agaroil distillation entrepreneurs in Thailand.

2. Computer and software for data analysis.

Methods

Data collection

To meet the mentioned objectives, the 2 types of data are needed for the study namely:

1. Secondary data. This type of information could be gathered from Royal Forest Department, library of Faculty of Forestry, Ministry of Industry, Klong Yai Customs House, Trat province, and Aranyaprathet Customs House, Sa Kaeo. The needed information included the general knowledge about agarwood, quantity of imported agarwood and its price.

2. Primary data. This type of data will be obtained by using the designed questionnaires to interview the entrepreneurs of the sampled agarwood oil distillation factories. The information including the total demand for agarwood at full capacity, quantity of available agarwood, agarwood price, source of agarwood, production of agarwood oil and it's price, marketing of agarwood oil, cost of agarwood oil production including material cost, labor cost, machinery cost and problems occurred in agaroil industry as well as the opinions of the entrepreneurs of agaroil factories on the cause of problems and the means for mitigation. In addition the agaroil retail price at Nana market was gathered by interviewing the sampled retailed seller.

The using data was collected by employing the designed questionnaires (Appendix A) interviewed the entrepreneurs of sampled agaroil factories. The number of sampled agaroil factories using for the study were 24 which were purposively sampling from the totally 49 agaroil factories of the country (Appendix B) or the percentage of cruise was 48.98. The distribution of sampled agaroil factories by region and province was represented in Table 1.

Table 1 Distribution of the number of sample and total agaroil factories by region and province in 2006

Region	Total number of factories	Number of sampled factories	Percentage
Central:	43	18	42.00
Nakhon Nayok	15	7	46.67
Prachin Buri	9	5	55.56
Trat	18	5	27.78
Chanthaburi	1	1	100.00
North:	4	4	100.00
Chiang Mai	3	3	100.00
Lampang	1	1	100.00
South:	2	2	100.00
Krabi	1	1	100.00
Narathiwat*	1	1	100.00
Total	49	24	-
Average	-	-	48.98

Remark: *Non-registration factory.

From Table 1 indicated that the number of sampled agaroil factories using for the study was 24 which sampling from the total number of 49 or the percentage of cruise was 48.98 percent. The most agaroil factories were found in the central region with the number of 43 or 88 percent of the total number of the agaroil factories of the country, this mainly due to the *Aquilaria crassna* plantations which were the main

source of raw material for this enterprise were mostly established in this regional areas especially in Trat province. In addition, this indicated that there was no agaroil factories in the northeast region because the agaroil factories had been located in Nong Khai province and Khon Kaen province in the former time had been closed, and currently resettled in Chiang Mai province in the present. This mainly was due to the scarce of raw material. Moreover, the most agaroil factories were located in Trat province, this because of their location were closed to Cambodia which was the main source of the raw material.

Data Analysis

There were 2 statistical analysis methods employed for the data analysis namely:

1. Descriptive analysis. The general information representing the present situation of agaroil industry including age of agaroil factor, the total quantity of demand for agarwood, quantity of available agarwood, source of agarwood, agarwood price, agaroil production and agaroil price (Appendix C) each of them was tabulated and representing with statistical values namely percent, maximum, minimum, mean and standard deviation. Moreover, problems occurred in the agaroil industry were classified into items and showed the frequency of each item in term of percentage.

2. Quantitative analysis. This was including cost-benefit analysis of agaroil production and agaroil marketing analysis.

2.1 Cost-benefit analysis of agaroil production. The agaroil cost-benefit analysis was carried out for determining the profit per lot of agaroil production (using 15 kg for agaroil distillation). In addition the average cost per 1 Tora of agaroil was computed (1 Tora = 12 gm). Furthermore, the average profit per 1 Tora of agaroil was computed by the following formula:

$$\pi = P - AC$$

Where:

π = profit per 1 Tora of agaroil

P = agaroil price (Baht/ Tora)

AC = Average cost of agaroil production (Baht/ Tora)

The cost of agaroil production was including fixed and variable cost. The detailed of each cost type was as follows:

Fixed cost: The fixed cost of agarwood oil production comprise of asset capital price, which are used in working more than 1 year and regard to expenditure each year for used asset. Thus, the depreciation cost or machinery cost per day of each kind of machine or instrument using for agaroil production was calculated. The method for computing machinery cost per day was represented in Appendix D.

Variable cost: Variable costs of agarwood oil production consist of:

2.1.1 Labor costs is the expenditure spending to workers practicing in various activities of agaroil production including cutting, grinding and agarwood water soaking, agaroil distillation, fuel refill and agaroil collection.

2.1.2 Material costs include the cost for agarwood, fuel, and electricity.

2.1.3 In addition, there are some of other costs namely transportation cost, opportunity cost of household labours.

2.2 Revenue from agaroil production: The revenue from agaroil production per lot could be computed by multiplying the production per lot with it’s price.

So,

Profit per lot = Total revenue/ lot – Total cost/ lot

Total revenue per lot = Agaroil production/ lot (Tora) x Agaroil price (Baht/ Tora)

Total cost per lot = Total fixed cost/lot + Total variable cost /lot

2.3 Marketing analysis of agaroil in Thailand was divided into 4 parts namely:

2.3.1 The marketing structure analysis. The agaroil market structure could be determined by concentration ratio. The concentration ratio could be done by comparison between the total agaroil production of the top 4 largest agaroil factories and the total agaroil production of all agaroil factories in the country.

2.3.2 Market conduct: The general principles to study market conduct are 1) to determine the price policy of agaroil in order to adjust prices in response to changing market condition or to change which was introduced by their rivals. 2) to formulated products policy in case of the quality of agaroil is differentiated, firm will make decisions on quality and cost of agaroil production. Each firm considered that they can increase profit by improving quality or reducing cost and 3) to determine coercive conduct which is the behavior of firm, seeking to increase concentration by driving some of rivals out of business.

2.3.3 Market performance. Market performance is the measurement of how for the economic results of an agaroil industry behavior fall short of the best possible contribution, it could make to achieve in the use of resources, progresses in enlarging and improving the flow of agaroil, stability of prices and employment, and full employment and equity of income distribution. In order to determine the performance of agaroil marketing, the analysis of marketing margin, producer's share, pricing efficiency and profit cost ratio are carried out. The formula employing for calculating such 4 technical terms were as follows:

1) Marketing margin : $M = Pr - Pf$

Marketing margin (%) = $100(M)/Pr$

Where:

M = Marketing margin

Pr = Agaroil retailed price

Pf = Agaroil factory price (Baht/ Tora)

2) Producer's share (%) = $100\frac{(Pf)}{Pr}$

3) Pricing efficiency (%) = $100\frac{(Pr)}{M}$

4) Profit cost ratio (%) = $100\frac{(Pf - AC)}{AC}$

Where:

AC = Average cost of agaroil production (Baht/ Tora)

2.3.4 Marketing channel of agaroil. Marketing channel will show the distribution of agaroil from factories in each region from local regional market to Bangkok and oversea market. The product distribution was shown in term of quantity and percentage.

RESULTS AND DISCUSSION

Results of the study which harmonized with the objectives of the study were divided into parts the present situation of agaroil industry in Thailand, problem and opinions of agaroil factory entrepreneurs on the cause of problems and the means for mitigation, production process and cost – benefit analysis of agaroil production, market structure and agaroil marketing channel. They were as follows.

1. The Present Situation of Agaroil Industry in Thailand.

1.1 Factory Size, Quantity of Demand for Agarwood at Full Capacity, the Quantity of the Available Agarwood and Age of Agaroil Factory

1.1.1 Factory size

The size of sampled agaroil factories by region in Horse Power (HP) were ranged from 11 to 263.47 HP, and with the mean of 65.28 HP. The largest factory was located in Lampang province while the smallest one was located in Krabi province. The plant size of the most (41.67%) was over than 50 HP (Table 2). Due to the most agaroil factories were a rather large plant size, thus the available agarwood to be used as their raw material is the most important issue to be determined. Hence the comparison between the demand for agarwood at the full capacity and the available agarwood were carried out and presented in the next sections.

Table 2 Distribution of the sample agaroil factories by plant size and region in 2006

Plant size of agaroil factory classified by (HP)	Number and percentage of agar-oil factory by region:				
	Central	North	South	Total	
10 -20	4 (16.67)	1 (4.17)	2 (8.33)	7 (29.17.)	Max. 263.47 Min. 11.00 Mean 65.28 S.D. 66.46
20 – 50	6 (25.00)	1 (4.17)	0 (0.00)	7 (29.17)	
> 50	8 (33.33)	2 (8.33)	0 (0.00)	10 (41.67)	

Remark: The figures in the parenthesis are percentage.

1.1.2 Quantity of demand for agarwood at full capacity

The study indicated that the total quantity demand for agarwood at full capacity of the most agaroil factories in all studied regions (66.67%) were ranging from 801 – 6,800 kg/annum. Moreover, there was only one factory in central whose demand for agarwood was over than 24,801 kg/annum. The maximum, minimum, mean and standard deviation (S.D.) of the quantity of demand for agarwood at full capacity were 90,000, 1,500, 13,951.25 and 17,680.45 kg/annum respectively. Based on the obtained mean of the demand for agarwood at full capacity could be converted to the total quantity of demand at full capacity of the country by multiplication with the total number of agaroil factories in the country of 49 factories. Hence, the total quantity of demand for agarwood at full capacity of the agaroil factories in the country were become 683,611.25 kg/annum (Table 3).

Table 3 Distribution of agaroil factories by quantity of demand for agarwood at full capacity in 2006

Quantity of demand for agarwood at full capacity (kg/ annum)	Number and percentage of agar-oil factory by region:				
	Central	North	South	Total	
801 – 6,800	11	3	2	16	
	(45.83)	(12.50)	(8.33)	(66.67)	
6,801 – 12,800	3	1	0	4	
	(12.50)	(4.17)	(0.00)	(16.67)	Max. 90,000
12,801 – 18,800	2	0	0	2	Min. 1,500
	(8.33)	(0.00)	(0.00)	(8.33)	Mean 13,951.25
18,801 – 24,800	1	0	0	1	S.D. 17,680.45
	(4.17)	(0.00)	(0.00)	(4.17)	
>24,801	1	0	0	1	
	(4.17)	(0.00)	(0.00)	(4.17)	
Total	18	4	2	24	
(%)	(75.00)	(16.67)	(8.33)	(100.00)	

Remark: The figures in the parenthesis are percentage.

1.1.3 The quantity of the available agarwood

The study indicated that all of the studied agaroil factories could purchase agarwood to be used as their raw material in a lower quantity than their full capacity. The most factories in all studied regions (75%) could allocate agarwood for their agaroil production in amount of 601 – 4,100 kg/annum. In addition, the maximum, minimum, mean, and S.D. of the available agarwood for agaroil production were 54,000, 600, 7,301.58 and 10,537.80 kg/annum respectively (Table 4). In the same manner, the total quantity of agarwood available for the total agaroil factories in the country could be carried out, it was 357,777.42 kg/annum which was quite lower then their total quantity of demand for agarwood at full capacity or the available agarwood was only 52.34 percent of their full capacity. So this will be the

good opportunity for the investors in *Aquilaria crassna* plantation to having a large market for absorbing their products.

Table 4 Distribution of agaroil factories by quantity of the available agarwood in 2006

Quantity of available agarwood (kg/annum)	Number and percentage of agar-oil factory by region:				
	Central	North	South	Total	
601 – 4,100	13 (54.17)	3 (12.50)	2 (8.33)	18 (75.00)	Max. 54,000 Min. 600 Mean 7,301.58 S.D. 10,537.80
4,101 – 7,600	3 (12.50)	0 (0.00)	0 (0.00)	3 (12.50)	
7,601 – 11,100	0 (0.00)	1 (4.17)	0 (0.00)	1 (4.17)	
11,101 – 14,600	1 (4.17)	0 (0.00)	0 (0.00)	1 (4.17)	
>14,601	1 (4.17)	0 (0.00)	0 (0.00)	1 (4.17)	
Total (%)	18 (75.00)	4 (16.67)	2 (8.33)	24 (100.00)	-

Remark: The figures in the parenthesis are percentage.

In addition, the additional demand for agarwood to meet the full capacity at agaroil factory by region and province was also determined and representing in Table 5.

Table 5 The additional demand for agarwood to meet the full capacity of the agaroil factory by region and province 2006

Region/ Province	Full capacity (kg)	Available capacity of agarwood (kg)	Percentage of available agaroil	The additional demand for agarwood (kg)	Percentage
Central	555,802.92	286,139.45	51.48	269,663.47	48.52
Nakhon Nayok	78,461.25	42,058.31	53.60	36,403.94	46.40
Prachin Buri	185,383.33	86,974.96	46.92	98,408.37	53.08
Trat	271,541.67	146,897.85	54.10	124,644.82	45.90
Chanthaburi	20,416.67	10,208.33	50.00	10,208.34	50.00
North	99,225.00	53,671.31	54.09	45,553.69	45.91
Chiang Mai	89,833.33	46,729.65	52.02	43,103.68	47.98
Lampang	9,391.67	6,941.66	73.91	2,450.01	26.09
South	28,583.33	17,966.66	62.86	10,616.67	37.14
Krabi	18,375.00	10,208.33	55.56	8,166.67	44.44
Narathiwat	10,208.33	7,758.33	76.00	2,450.00	24.00
Total	683,611.25	357,777.42	-	325,833.83	-
Average	-	-	52.34	-	47.66

Table 5 indicated that the raw material shortage problem of agaroil factories in the Central region was much more severe than the other regions, the additional demand for agarwood to meet their requirements was rather high with amount of 269,633.47 kg or 48.52 percent of the full capacity. Trat was the province in this region which having the most demands for the additional agarwood in amount of 124,643.82 kg or 45.90 percent of the full capacity. While, the agaroil factories in the north and south region the additional demand for agarwood to meet their requirement were rather low, they were 45,553.69 and 10,616.67 kg or 45.91 and 37.14 of their full capacity respectively.

Moreover, the comparison between the available agarwood in 2002 and 2006 was carried out, as shown in Table 6.

Table 6 Comparison between the available agarwood in 2002 and 2006 by region and province

Region/ province	The available agarwood			
	2002 (kg)	2006 (kg)	Decrease kg	Decrease %
Central	374,441.50	286,139.45	88,302.04	23.58
Nakhon Nayok	59,820.81	42,058.31	17,762.49	29.69
Prachin Buri	145,774.93	86,974.96	58,799.97	40.34
Trat	153,533.26	146,897.85	6,635.41	4.32
Chanthaburi	15,312.49	10,208.33	5,104.16	33.33
North	57,983.31	53,671.31	4,312.00	7.44
Chiang Mai	51,041.64	46,729.65	4,312.00	8.45
Lampang	6,941.66	6,941.66	0.00	-
South	25,520.82	17,966.66	7,554.16	29.60
Krabi	16,333.33	10,208.33	6,125.00	37.50
Narathiwat	9,187.50	7,758.33	1,429.17	15.56
Total	457,945.62	357,777.42	100,168.20	-
Average	-	-	-	15.56

Table 6 indicated that the tendency of the available agarwood for all regional and provincial agaroil factories were declined from the year 2002 to 2006, this mainly due to the agarwood importation in 2002 was easier to perform than the present (2006). Moreover, the existing *Aquilaria crassna* plantations were too young

to harvest. The most decreasing amount of the available was found in central region, it was 88,302.04 kg and with the decreasing rate of 23.58 percent.

1.1.4 Age of agaroil factory

The study indicated that the most agaroil factories were established in the last five years (58.33%). The maximum, minimum, mean and S.D. were 20, 1, 6.56 and 5.69 respectively. The oldest one was located in Trat province. There were over than 3 factories which their ages were only 1 year, 2 of them located in Nakhon Nayok province and the rest was transferred from Khon Kaen province. Based on the information mentioned above, there were only 6 agaroil factories in 1966, this could be interpreted that the age of the pioneer agaroil factory up right now (2007) should be older than 41 years. Hence, the most existing active agaroil factories were the new factories. The increasing in the number of agaroil factories is mainly due to the high price of agaroil, and the agarwood from plantation was started to be used as a raw material for agaroil production (Table 7).

Table 7 Distribution of the sample agaroil factories by age and region in 2006

Age of agar-oil factory (year)	Number and percentage of agar-oil factory by region:						
	Central	North	South	Northeast	Total		
1 -5	10	4	0	0	14		
	(41.67)	(16.67)	(0.00)	(0.00)	(58.33)		
6 – 10	3	0	2	0	5	Max.	20
	(12.50)	(0.00)	(8.33)	(0.00)	(20.83)	Min.	1
11 – 15	2	0	0	0	2	Mean	6.56
	(8.33)	(0.00)	(0.00)	(0.00)	(8.33)	S.D.	5.69
16 – 20	3	0	0	0	3		
	(12.50)	(0.00)	(0.00)	(0.00)	(12.50)		

Remark: The figures in the parenthesis are percentage.

1.2 Available agarwood, agarwood price and agaroil production and price

1.2.1 Distribution of the available agarwood by source

As presented above that the total quantity of available agarwood for agaroil factories in the whole country in 2006 was 357,777.42 kg, the most of this was distributed to the central with amount of 286,139.43 kg or 79.98 percent, and the rest was distributed to the north and south in amount of 53,671.31 and 17,966.66 kg or 15.00 and 5.02 percent respectively. In the central, the most using agarwood was come from it's own region with amount of 233,546.09 kg or 65.28 percent, the most of this was come from Chanthaburi province with amount of 105,921.67 kg or 29.61 percent, and for the rest was the imported agarwood in amount of 52,593.34 kg or 14.70 percent this including the importation from Malaysia, Cambodia, Lao and Myanmar in amount of 24,500.00, 12,954.38, 9,412.08 and 5,726.88 kg or 6.85, 3.62, 2.63 and 1.60 percent respectively. Furthermore, the most raw material using in the north agaroil factories was come from abroad in total amount of 50,608.83 kg or

94.29 percent of the total amount of using agarwood in the region, this including the importation from Lao and Myanmar in amount of 33,254.67 and 17,354.67 kg or 61.96 and 32.33 percent respectively, and the rest with a rather small proportion was come from Mae Hong Son Province, it was only 3,062.50 kg or 5.71 percent of the total amount of regional use. In addition, the raw material using in the south came from both of the regional areas and foreign countries, the amount of them were 10,780.00 kg (including 6,125.00 kg from Krabi Province and 4,655.00 kg from Narathiwat Province) and 4,083.33 kg and 3,103.33 kg which imported from Myanma and Malaysia respectively. Moreover, in the macro point of view, the most source of agarwood which supported the agaroil factories of the whole country was Chanthaburi province, it shared with amount of 105,921.67 kg or 29.61 percent of the total using amount of the country. In addition exclusively for the imported agarwood, it was mostly brought from Lao with amount of 42,666.75 kg or 11.93 percent to the total use amount of the country (Table 8 and Figure 6).

Table 8 Distribution of the available agarwood by source and destination

Source of agarwood	Quantity of the available agarwood by destination (kg)			
	Central	North	South	Total
Central	233,546.09	-	-	233,546.09
	(65.28)	-	-	(65.28)
Nakhon Nayok	21,539.42	-	-	21,539.42
	(6.02)	-	-	(6.02)
Prachin Buri	15,680.00	-	-	15,680.00
	(4.38)	-	-	(4.38)
Trat	68,355.00	-	-	68,355.00
	(19.11)	-	-	(19.11)
Chanthaburi	105,921.67	-	-	105,921.67
	(29.61)	-	-	(29.61)
Rayong	22,050.00	-	-	22,050.00
	(6.16)	-	-	(6.16)
North	-	3,062.50	-	3,062.50
	-	(0.86)	-	(0.86)
Mae Hong Son	-	3,062.50	-	3,062.50
	-	(0.86)	-	(0.86)
South	-	-	10,780.00	10,780.00
	-	-	(3.01)	(3.01)
Krabi	-	-	6,125.00	6,125.00
	-	-	(1.71)	(1.71)
Narathiwat	-	-	4,655.00	4,655.00
	-	-	(1.30)	(1.30)

Table 8 (Continued)

Source of agarwood	Quantity of the available agarwood (kg)			
	Central	North	South	Total
Foreign country	52,593.34	50,608.83	7,186.66	110,388.83
	(14.70)	(14.14)	(20.1)	(30.85)
Laos	9,412.08	33,254.67	-	42,666.75
	(2.63)	(9.29)	-	(11.93)
Myanmar	5,726.88	17,354.17	4,083.33	27,164.38
	(1.60)	(4.85)	(1.14)	(7.59)
Cambodia	12,954.38	-	-	12,954.38
	(3.62)	-	-	(3.62)
Malaysia	24,500.00	-	3,103.33	27,603.33
	(6.85)	-	(0.87)	(7.72)
Grand total	286,139.43	53,671.33	17,966.66	357,777.42
(%)	(79.98)	(15.00)	(5.02)	(100.00)

Remark: The figures in the parenthesis are the percentage.

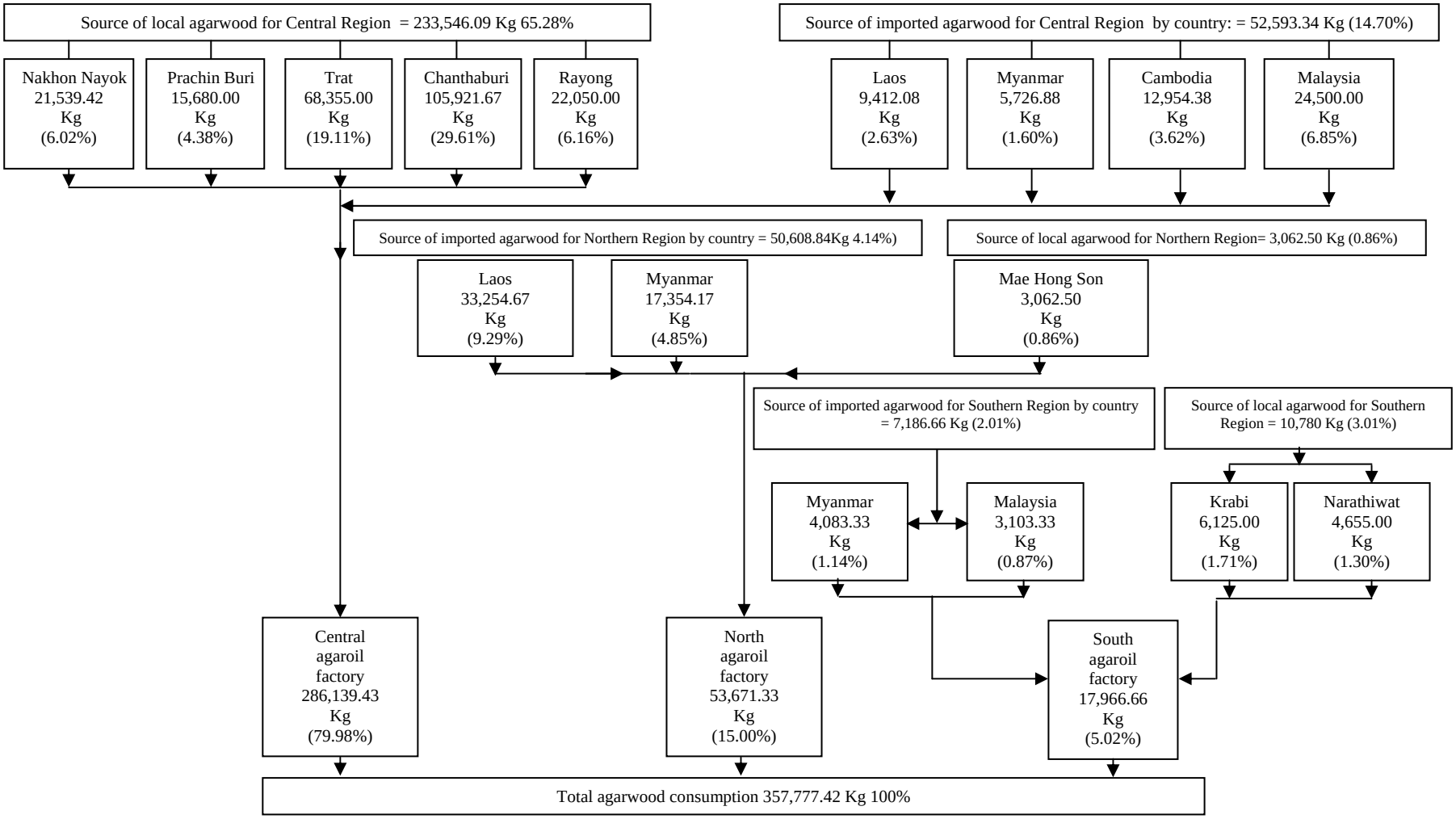

Figure 6 Source of agarwood for regional agaroil factories by region, province and exported country.

1.2.2 Agarwood price

Agarwood price is mainly due to its quality. The agarwood quality could be determined by its colour. The agarwood with darker colour having higher price than the pale one. The study indicated that agarwood was used as the raw material of agaroil factory were classified into 2 grades namely high and low agarwood price. The detailed information about the average price of agarwood with high and low price by region and province were represented in Tables 9 and 10 respectively.

Table 9 indicated that in 2006 the average price of agarwood with a high price in the north region was the highest one, it was 465.00 Baht/ kg while the average price of agarwood in the south region was the lowest one, it was 300 Baht/ kg, this because most of the using raw material in the north region was imported from Lao and Myanmar (Table 8), while the most using raw material of agaroil in the southern region was imported from Malaysia which very close to the factory site. Based on the comparison between average price of agarwood with a high price in 2002 and 2006 indicated that the tendency of the average price of agarwood with a high price was increased in almost all of the studied provinces except only one province in the central, it was Nakhon Nayok province which the average price of agarwood was decreased from 175.63 Baht/kg in 2002 to 166.25 Baht/ kg in 2006. Furthermore, in the whole country the average price of agarwood was increased from 311.46 Baht/ kg in 2002 to 341.25 Baht/ kg in 2006, this mainly due to agarwood in 2006 was scarcer than in 2002.

Table 9 Comparison between average price of agarwood with high price in 2002 and 2006 by region and province

Region/ province	Average price of agarwood with high price in		
	2002 (Baht/ Kg)	2006 (Baht/ Kg)	Change (%)
Central	309.44	284.17	8.17
Nakhon Nayok	245.00	220.00	-10.20
Prachin Buri	320.00	346.00	8.13
Trat	270.00	370.00	37.04
Chanthaburi	450.00	450.00	-
North	550.00	465.00	15.45
Chiang Mai	520.00	566.67	8.97
Lampang	300.00	320.00	6.67
South	250.00	300.00	20.00
Krabi	250.00	300.00	20.00
Narathiwat	250.00	300.00	20.00
Total	981.25	1,090.00	-
Average	311.46	341.25	9.56

Table 10 Comparison between average price of agarwood with a low price in 2002 and 2006 by region and province

Region/ province	Average price of agarwood with low price in		
	2002 (Baht/kg)	2006 (Baht/ kg)	Change (%)
Central	160.83	163.06	1.37
Nakhon Nayok	140.00	132.00	-5.71
Prachin Buri	180.00	172.00	-4.44
Trat	165.00	190.00	7.81
Chanthaburi	190.00	200.00	5.26
North	161.25	195.00	20.93
Chiang Mai	155.00	193.33	24.73
Lampang	180.00	200.00	11.11
South	225.00	250.00	11.11
Krabi	220.00	250.00	13.64
Narathiwat	230.00	250.00	8.70
Average	166.25	175.63	5.64

Table 10 indicated that in 2006 the average price of agarwood with a low price in north region was the highest one, it was 195.00 Baht/ kg, while the average price of agarwood in central region was the lowest one and it was 163.06 Baht / kg. The average price of agarwood with a low price of the over all country was showing a tendency to increase, it was increased from 166.25 Baht/ kg in 2002 to 175.63 Baht/ kg in 2006.

1.2.3 Agaroil production and price

A. Agaroil production

Generally, in each lot of agaroil production uses 15 kg of dried agarwood as raw material. The agaroil production per lot was ranging from 0.88 – 4.32 Tora. The average production of agaroil for the over all country was 1.90 Tora (Table 11). The agaroil production of the majority of agaroil factory (45.83%) were ranging from 0.8 – 1.59 Tora. (Table 11)

Table 11 Distribution of agaroil factories by agaroil production per 15 kg of agarwood and region in 2006

Agaroil production (Tora)	Number of agaroil factories by region				
	Central	North	South	Total	
0.8 – 1.59	8	1	2	11	
	(33.33)	(4.17)	(8.33)	(45.83)	
1.60 – 2.39	5	1	0	6	
	(20.83)	(4.17)	(0.00)	(25.00)	MAX 4.32
2.40 – 3.19	5	1	0	6	MIN 0.90
	(20.83)	(4.17)	(0.00)	(25.00)	Average 1.90
3.20 – 3.99	0	0	0	0	S.D. 0.88
	(0.00)	(0.00)	(0.00)	(0.00)	
4.00 – 4.79	0	1	0	1	
	(0.00)	(4.17)	(0.00)	(4.17)	
Total	18	4	2	24	
	(75.00)	(16.67)	(8.33)	(100.00)	

Remark: The figures in the parenthesis are percentage.

B. Agaroil price

The agaroil price of the whole country in 2006 was ranging from 2,001 to 7,000 Baht/Tora, while the average price was 3,845.83 Baht/Tora (Table 12). Moreover, the agaroil price of the majority of agaroil factory was ranging from 3,001 – 4,000 Baht/Tora. The agaroil price in each factory and region were varied from each other, this mainly due to the buying market, quality of the agaroil as well as the consumer's reliance on the producer. From Appendix Table C6 indicated that the agaroil price of the agaroil factory No. 17 was maximized, this because this firm usually using the high quality of agarwood as the raw material (the price of using agarwood with high and low price were 550 and 250 Baht/kg respectively which were rather high when compare with the other factories). So the agaroil was produced by this factory was widely accepted by the customers.

Table 12 Distribution of agaroil factories by factory price of agaroil and region in 2006

Agaroil price (Baht/ Tora)	Number of agaroil factories by region			
	Central	North	South	Total
< 3000	5	2	0	7
	(20.83)	(8.33)	(0.00)	(29.17)
3001 – 4000	7	2	2	11
	(29.17)	(8.33)	(8.33)	(45.83)
4001 – 5000	2	0	0	2
	(8.33)	(0.00)	(0.00)	(8.33)
5001 – 6000	3	0	0	3
	(12.50)	(0.00)	(0.00)	(12.50)
6001 – 7000	1	0	0	1
	(4.17)	(0.00)	(0.00)	(4.17)
Total	18	4	2	24
	(75.00)	(16.67)	(8.33)	(100.00)

MAX	7,000.00
MIN	2,200.00
Average	3,845.83
S.D.	1,195.36

Remark: The figures in the parenthesis are percentage.

Table 13 indicated that the retailed price of agaroil obtained from 14 sampled retailed shops at Nana Market was ranging from 3,950 to 4,200 Baht/Tora. The average agaroil retailed price was 4,092.50 Baht/ Tora.

Table 13 Agaroil retailed price at Nana market in 2006

Shop No.	Agaroil retailed price (Baht/ Tora)
1	4,000
2	4,200
3	4,100
4	3,890
5	4,170
6	4,180
7	3,980
8	4,185
9	4,200
10	3,970
11	4,160
12	4,160
13	4,150
14	3,950
Average	4,092.50

Furthermore, agaroil production in 2006 was produced most in the central region with amount of 36,244.33 Tora or 79.98 percent of the total production of the country. Moreover, Trat province was the main source of agaroil production, the quantity of production was 18,607.06 Tora or 41.06 percent. (Table 14)

Table 14 Agaroil production by region and province in 2006

Region/ province	Agaroil Production	
	(Tora)	(%)
Central	36,244.33	79.98
Nakhon Nayok	5,327.39	11.76
Prachin Buri	11,016.83	24.31
Trat	18,607.06	41.06
Chanthaburi	1,293.05	2.85
North	6,798.37	15.00
Chiang Mai	5,919.09	13.06
Lampang	879.28	1.94
South	2,275.78	5.02
Krabi	1,293.06	2.85
Narathiwat	982.72	2.17
Total	45,318.47	100.00

In addition, the comparison between agaroil price in 2002 and 2006 was also determined. The study indicated the average price of agaroil in 2006 of all of the studied provinces of the central and north are higher than the price in 2002. While the average price of agaroil in 2002 of the every studied provinces in the south were lower than the price in 2002. However, the average price of agaroil of the whole country showing a tendency to increase, it was increased from 3,451.96 Baht/ Tora in 2002 to 3,845.83 Baht/ Tora in 2006 or with the increasing rate of 11.41 percent (Table 15).

Table 15 Comparison between agaroil price in 2002 and 2006 by region and province

Region/ province	Agaroil price in 2002 and 2006		
	2002 (Baht/ Tora)	2006 (Baht/ Tora)	Change (%)
Central	3,711.97	4,471.07	20.45
Nakhon Nayok	2,700.00	3,214.29	19.05
Prachin Buri	2,470.00	3,090.00	25.10
Trat	4,680.00	5,580.00	19.23
Chanthaburi	5,000.00	6,000.00	20.00
North	3,175.00	3,312.50	4.33
Chiang Mai	3,233.33	3,233.33	-
Lampang	3,000.00	3,550.00	18.33
South	5,250.00	3,650.00	-31.48
Krabi	4,500.00	3,700.00	-17.78
Narathiwat	6,000.00	3,500.00	-41.67
Average	3,451.96	3,845.83	11.41

2. Agaroil Enterprise Problem and Recommendation for Problem Mitigation

The agarwood entrepreneurs faced various of problems which relevant to the operation of agaroil enterprise. The problems which were classified into 4 aspects namely raw material aspect, production aspect, marketing aspect, law and regulation aspect.

2.1 Raw material aspect: The study indicated that the problem related to the raw material and belong to the most respondents (91.66%) was agarwood shortage. The rest were the existing *Aquilaria crassna* was still too young to utilize as raw

material (87.50%), agarwood importation was difficult to undertaken (66.67%), agarwood price was so high (66.67%), source of agarwood quite remote from agaroil factory site (16.67%), and agarwood inspection was difficult to do (16.67%). In addition, the problems in production, marketing, and law and regulation aspect were high production cost, no having bargaining power when dealing with customers, and the relevant law and regulation cause slow import with the percentage of 16.16%, 16.67% and 45.83% respectively.

Furthermore, the respondents provided the valuable recommendation for mitigation such problems. The recommendations were government should provide the permission for increasing the agarwood importation (66.67%), the imported agarwood should be regularly inspected by customs (66.67%), and *Aquilaria crassna* should be promoted as the economical plant (12.50%) (Table 16).

Table 16 Problems and recommendations for problem mitigation of entrepreneurs of agaroil factories.

Item	No. of respondents	Percent
1. Problem		
1.1 Raw material aspect		
1.1.1 Agarwood shortage	22	91.66
1.1.2 The existing *Aquilaria crassna* was still too young to utilize as raw material	21	87.50
1.1.3 Agarwood importation was difficult to undertaken	16	66.67
1.1.4 Agarwood price was very high	16	66.67
1.1.5 Source of agarwood quite remote from agaroil factory site	16 4	66.67 16.67
1.1.6 Agarwood inspection was difficult to do	4	16.67

Table 16 (Continued)

Item	No of respondents	Percent
1.2 Production aspect		
High production cost	4	16.67
1.3 Agaroil marketing aspect		
Lack of bargaining power when dealing with customer	4	16.67
1.4 Law and regulation aspect		
The relevant law or regulation cause slow import	11	45.83
2. Recommendation for problem mitigation		
2.1 Government should provide the permission for increasing the agarwood importation	16	66.67
2.2 The imported agarwood should be regularly inspected by customs	16	66.67
2.3 *Aquilaria crassna* should be promoted as the economical plant	3	12.50

3. Production Process and Cost – Benefit Analysis of Agaroil Production

3.1 Production process of agaroil production. Agaroil production process could be divided into 2 steps namely the step for agarwood powder production and agaroil production. The agarwood powder production step starting from grinding the dried agarwood chips by using the grinder machine (Appendix Figure 1). Generally in each lot of agaroil production used 15 kg of dried agarwood, the time to be used for grinding 15 kg of dried agarwood was 20 minutes, and the obtained agarwood powder is equivalent to 15 kg The next step is to produce agaroil, thus the agarwood powder will be soaked in water which stored in 20 litres plastic container (Appendix Figure 2) for 45 days, after that proceed to the condensation process by employing the set of condenser (Appendix Figure 3), the condensation will be continuously operated for

96 hours. The liquid petroleum gas was used as the source of energy for the condensation. The demand for LPG for condensation in each lot of agaroil production is one and a half of the large tank (Appendix Figure 4). The obtained agaroil will be contained in the bottle (Appendix Figure 5). In addition, the chart representing agaroil production process was showed in Figure 7.

3.2 Cost – benefit analysis of agaroil production. The cost – benefit analysis of agaroil production was carried out by using agaroil factory A as a case study, this mainly due to the limitation of the most sampled entrepreneur's participation in providing the necessary information in detail especially about cost and revenue for agaroil production.

Based on the case study indicated the cost of agaroil production was composed of two parts namely cost of agarwood powder production and cost of agaroil production. The first item of the cost of agarwood powder production was material cost (the quantity of agarwood which be used as raw material for each lot of agaroil production, was 15 kg this will be also transformed to be 15 kg of agarwood powder. The agarwood were classified into 2 grades namely high and low agarwood price, the price of them in form of dried agarwood were 300 and 120 Bath/kg respectively. Thus, their values were 4,500 and 1,800 Bath respectively (Tables 15 and 16). The next items were the labour cost for control the grinder machine, the depreciation cost of grinder machine and cost of electricity for grinding agarwood chip, they were 10, 1.50 and 10 Baht respectively. The cost of agaroil production including the depreciation cost of 20 liters plastic container and a set of agaroil condenser, and the cost of liquid petroleum gas for agaroil condensation, they were 282.15, 264, 1,230 Baht. Hence, the total cost of agaroil production for a high and a low agarwood price were 6,297.65 and 3,597.65 Baht respectively. In addition the agaroil production process was showed in Figure 7.

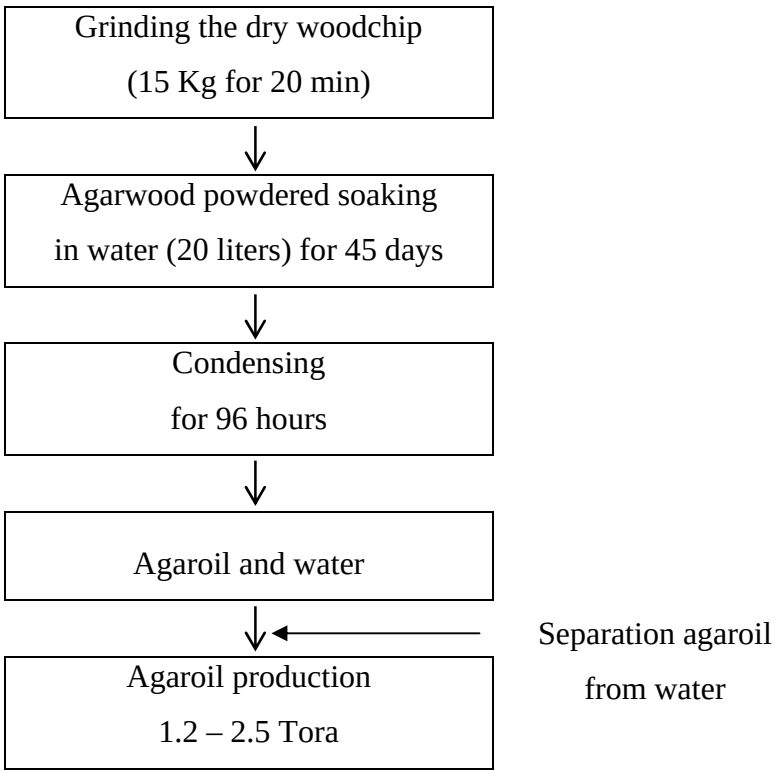

Figure 7 Agaroil production process in Thailand.

The revenue from agaroil production was come from 2 sources namely selling the obtained agaroil and the used agarwood powder. The quantities of agaroil production for high and low agarwood price were 2.5 and 1.20 Tora respectively. The agaroil price was 3,500 Baht. Thus, the revenue from agaroil which was produced from high and low agarwood price were 8,750 and 4,200 Baht respectively. In addition, the used agarwood powder could be sold at the price of 4 Baht/kg, thus the revenue from selling the 15 kg of used agarwood powder was 60 Baht.

The waste of agarwood powder could be used as the raw material for incense production. Hence, the profit from agaroil production by such grade of the using agarwood will be 2,512.35 and 662.35 Baht/ lot respectively. In addition, the average cost of agaroil production of each grade of agarwood was computed and compared with the agaroil price. The results indicated that the average cost of agaroil production of high agarwood price was lower than the average cost of low agarwood price, they were 2,519.06 and 2,998.04 Baht/ Tora respectively. Furthermore the obtained profit from producing 1 Tora excluding the return from selling the used agarwood powder of high and low agarwood price were 980.94 and 501.16 Baht/ Tora. The cost revenue analysis of agaroil production in detail for high and low agarwood prices were represented in table 17 and 18 respectively.

In addition, the annual profit from using each condenser for agaroil production could be estimated. According to the average working days per annum of the sampled agaroil factories was 283.33 days (Appendix Table C7) and duration of the continual agaroil distillation per lot was 96 hours or 4 days. Hence, the total lot number of agaroil production per annum of each condenser will be 70 lots. As mentioned above, the obtained profit from agaroil production per each lot by using agarwood with a high and a low price were 2,512.35 and 662.35 Bath respectively. Hence, the annual profit from agaroil production of each condenser by using a high price agarwood and a low price agarwood will be 175,864.50 Baht and 46,364.50 Baht respectively. This indicated that the agaroil production is an interesting enterprise which provides a rather high profit to the entrepreneurs.

Table 17 Average cost, revenue, and profit of agaroil production per 15 kg of high agarwood price

Item	Quantity	Price (Baht/ unit)	Value (Baht)
1. Cost			
1.1 Equipment			
1.1.1 Wood grinder machine	1	36,000.00	36,000.00
1.1.2 Plastic container	1	380.00	380.00
1.1.3 Set of oil condensation	1	22,000.00	22,000.00
1.2 Cost of agaroil production			
1.2.1 Cost of agarwood powder production			
1.2.1.1 Material cost agarwood (kg)	15	300.00	4,500.00
1.2.1.2 Labour cost (manday)	0.05	200.00	10.00
1.2.1.3 Machinery cost			
1.2.1.3.1 Depreciation cost of grinder machine			1.50[1)]
1.2.1.4 Cost of electricity for agarwood chip production			10.00
1.2.2 Cost of agaroil production			
1.2.2.1 Depreciation of plastic container of agarwood powder soaking			282.15[1)]
1.2.2.2 Depreciation of a set of agaroil condenser			264.00[1)]
1.2.2.3 Cost of liquid petroleum gas for agaroil condenser			1,230.00
Total			6,297.65
2. Revenue			
2.1 Revenue from agaroil production (Tora)	2.5	3,500.00	8,750.00
2.2 Revenue from selling the used agarwood powder	15	4.00	60.00
Total			8,810.00
3. Profit = 2 – 1			2,512.35

Remark: 1) The depreciation cost was calculated by using the formula representing in Appendix D.

2) 1 Tora is equivalent to 12 gm or 12.5 cc.

Table 18 Average cost, revenue, and profit of agaroil production per 15 kg of low agarwood price

Item	Quantity	Price (Baht/ unit)	Value (Baht)
1. Cost			
1.1 Equipment			
1.1.1 Wood grinder machine	1	36,000.00	36,000.00
1.1.2 Plastic container	1	380.00	380.00
1.1.3 Set of oil condensation	1	22,000.00	22,000.00
1.2 Cost of agaroil production			
1.2.1 Cost of agarwood powder production			
1.2.1.1 Material cost agarwood (kg)	15	120.00	1,800.00
1.2.1.2 Labour cost (manday)	0.05	200.00	10.00
1.2.1.3 Machinery cost			
1.2.1.3.1 Depreciation cost of grinder machine			1.50[1)]
1.2.1.4 Cost of electricity for agarwood chip production			10.00
1.2.2 Cost of agaroil production			
1.2.2.1 Depreciation of plastic container of agarwood powder soaking			282.15[1)]
1.2.2.2 Depreciation of a set of agaroil condenser			264.00[1)]
1.2.2.3 Cost of liquid petroleum gas for agaroil condenser			1,230.00
Total			3,597.65
2. Revenue			
2.1 Revenue from agaroil production (Tora)	1.2	3,500.00	4,200.00
2.2 Revenue from selling the used agarwood powder	15	4.00	60.00
Total			4,260.00
3. Profit = 2 – 1			662.35

Remark: 1) The depreciation cost was calculated by using the formula representing in Appendix D.

2) 1 Tora is equivalent to 12 gm or 12.5 cc.

4. Market Structure, Market Conduct, Market Performance, and Marketing Channel of Agaroil

4.1 Market Structure.

The agaroil market structure could be determined from the concentration ratio (the proportion of the total production of the top 4 agaroil factories to the total production of the industry in term of percentage). In case of the concentration ratio of the leading firms is 100 percent indicated that the market structure is monopoly. On the other hand the concentration ratio of the firms ranging from 5 to 10 percent indicated that the market structure is competitive market. Other view, if the concentration ratio ranging between the 2 mentioned interval values. The market structure is classified as oligopoly. (Caves, 1982)

From the study indicated that the total production of the top 4 agaroil factories was 13,261.05 Tora. While the total production of the industry was 45,318.47 Tora, so the concentration ratio was 29.26 percent (Table 19). This could be interpreted that the agaroil market structure was oligopoly. Moreover, the agaroil factory which having the highest production with amount of 3,721.41 Tora was located in Trat Province.

Table 19 Agaroil production of the top 4 factories

No.	Agaroil production (Tora)	Factory site
1	3,721.41	Trat
2	3,332.98	Chiang Mai
3	3,103.33	Prachin Buri
4	3,103.33	Prachin Buri
Total	13,261.05	
Total production of industry	45,318.47	
Percent	29.26	

4.2 Agaroil Market Conduct

Normally, the producers under oligopoly market always attempt to fix or increase their market share by various means: selling their products at a discount, fixed their productions for stability the market supply as well as the market price and to perform collusion among the producers. In case of the price discount, if any producers, reduce their product prices the others also reduce their product prices too, thus everyone couldn't gain benefit from the price reduction. Furthermore, the oligopolies usually fixed their production in order to stabilize the market supply and the market price. If there are someone attempt to increase their selling value by raising their production, this will cause the increasing in market supply and decline of the product price this will impact on all of the oligopolists.

According to the results from the study on agaroil market behavior indicated that the market behavior of agaroil was quite differentiate from the market behavior of the general product because there was no problem about the market for absorbing all of the produced agaroil, while the production of agaroil was mainly due to the limitation of the raw material. Moreover, each agaroil producer independently produce and sell his product without the collusion. In addition, the agaroil price was mainly due to it's quality, the reliability of the producer as well as the personal relationship between the customer and the producer, hence the producers couldn't set the price by themselves. So the selling price was also depended on the bargaining power of the sellers. Based on the results of the study which were presented above indicated that the range of agaroil was broad enough, it was ranging from 2,200 to 7,000 Baht per Tora. Nowadays, there is no standardization in the agaroil industry, this cause the quality of agaroil being much differentiate from firm to firm. Thus, the standardization in the agaroil industry should be implemented as soon as possible.

4.3 Market Performance of Agaroil

There are four methods used for testing the marketing performance namely 1) analysis of the marketing margin 2) analysis of pricing efficiency 3) analysis of producer's share and 4) analysis of profit cost ratio.

Table 20 indicated that the marketing margin of agaroil was 246.67 Baht/Tora or 6.03%, this was a rather low, so the performance of agaroil marketing was accepted. In a addition, the producer's share was 93.97 percent which was quite high, this means that the producer could gain a very large proportion of return from the retailed price. Furthermore, the pricing efficiency was 1,659.10 percent, this indicated that the pricing efficiency of agaroil is quite high.

Table 20 Average retailed price, factory price, marketing margin, producer's share and pricing efficiency of agaroil in 2006

Item	Value
1. Average retailed price (Baht/Tora)	4,042.50
2. Average factory price (Baht/ Tora)	3,845.83
3. Marketing margin (Baht/ Tora)	246.67
4. Marketing margin (%)	6.03
5. Producer's share (%)	93.97
6. Pricing efficiency (%)	1,659.10

Based on the results of the study was represented in Table 12. The minimum price, maximum price and average price of agaroil were 2,200, 7,000 and 3,845.83 Baht/ Tora respectively, while the average cost per Tora by using the high and low agarwood price were 2,519.06 and 2,998.04 Baht/ Tora respectively. If the producers sell their products at the minimum price, the profit cost ratio in case of using the high and low agarwood price were -12.67 and -26.62 percent respectively, this indicated that the entrepreneurs will get loss.

Table 21 indicated that the profit cost ratio is directly related to the product price and inversely related to the cost. In case of using a high agarwood price (low cost) and a low agarwood price (high cost), and with the maximum agaroil price, their profit cost ratio were 177.88 and 133.49 percent respectively. In addition, in case of using a high agarwood price and a low agarwood price and with the average agaroil

price, their profit cost ratio were reduced to 52.67 and 28.28 percent respectively. These indicated that the profit cost ratio of agaroil was at a rather high level.

Table 21 Profit cost ratio of agaroil production by agaroil and agarwood price level in 2006.

Agaroil price level	Profit cost ratio by agarwood price level:	
	High	Low
Maximum	-12.67	-26.62
Minimum	177.88	133.49
Average	52.67	28.28

Remark: The average cost per Tora by using the high price and low price agarwood were 2,519.06 and 2,998.04 Baht/Tora

4.4 Marketing Channel of Agaroil.

The total production of agaroil of the whole country in 2006 was 45,318.47 Tora and with the total value of 174.29 million Baht, (the average price of agaroil was 3,845.83 Baht/Tora), this came from central, north and south of 36,244.33, 6,798.37 and 2,275.77 Tora or 79.98, 15.00 and 5.02 percent of the total production respectively. The most of agaroil production in the Central was distributed to Nana market at Sukhumvit Soi3 Klongtoey Nua sub district, Wattana district, Bangkok of 23,230.20 Tora or 51.25 percent of the regional total production, and the rest was sold to the local and foreign middlemen in amount of 8,223.83 and 4,790.30 Tora or 18.15 and 10.57 percent of the regional total production respectively. While the most agaroil which was produced from the north was sold to the foreign middlemen in amount of 5,272.56 Tora (11.63%) and the rest of 1,525.81 Tora (3.37%) was distributed to Nana market. In addition, all of agaroil produced in the South was distributed to Nana market. Finally the total agaroil which was sold to the local middlemen in amount of 8,223.83 Tora or (18.15%) was sold to the consumers from overseas. Hence, the total agaroil which distributed to Nana market will be 27,031.78 Tora or 59.65 percent, all of this was sold to the consumer (visitor) from

overseas. In addition the total agaroil in hand of foreign middlemen in amount of 10,062.86 Tora (22.20%) was solden mostly to Dubai in amount of 5,166.30 Tora (11.40%) and the rest was distributed to Saudi Arabia and other countries in amount of 3,697.98, 1,198.58 Tora or 8.16 and 2.64 percent respectively (Figure 8).

According to the study on marketing system of agaroil had manifold significance issues to discuss about their advantage and disadvantage as follows.

1) The market structure of agaroil was classified as oligopoly. By nature of oligopolies usually create the barrier to prevent the new comers by collusion or cutting the price. However, the number of agaroil factories could be easily increased because the new comers could apply for the permission from the Industrial Factory Department. Furthermore, the investment in agaroil factory needs a rather small budget, so anyone who interested in this business could enter easily by starting from a small scale of production in form of cottage industry. Thus, the competition level in agaroil market could be continuously raised, this will be the benefit for the consumers. Moreover, the agaroil production as well as exportation will be increased, this will be a way to support the Thai economy development.

2) The analysis of profit cost ratio of agaroil was mainly due to the selling price of agaroil and price of agarwood which using for agaroil production. The agaroil price is depended on its quality and the reliability of the consumer toward the producer, so the improvement in agaroil quality is the very important issue to be determined. Furthermore, the quality of agaroil is also depended on the quality of agarwood, thus the searching for the appropriate technology for the stem treatment is needed in order to increase the production of the high quality agarwood.

3) Results from the study on the marketing channels of agaroil indicated that in 2006 the amount of agaroil was sold through the middlemen was high enough, it was 18,280.69 Tora or 40.34 percent of the total production of 45,318.47 Tora (Table 22 and Figure 8), thus the agaroil producers could sell their product at a higher price (in case the price at Nana market was higher than the local price), this because

agaroil is not a clumsy product, it need only a little space for transportation, thus it could be easily transported even by the 4 wheel personal car.

Table 22 Marketing channel of agaroil from the source of production to the ultimate destination

Region/ Province	Agaroil production (Tora)	Selling to: Nana market (Tora)	Local middlemen (Tora)	Foreign middlemen (Tora)
Central	36,244.33 (79.97)	23,230.20 (51.26)	8,223.83 (18.15)	4,790.30 (10.57)
Nakhon Nayok	5,327.39 (11.76)	387.93 (0.86)	4,939.46 (10.90)	- (0.00)
Prachin Buri	11,016.83 (24.32)	4,887.75 (10.79)	3,025.75 (6.68)	3103.33 (6.85)
Trat	18,607.06 (41.05)	16,661.47 (36.76)	258.65 (0.57)	1,686.94 (3.72)
Chanthaburi	1,293.05 (2.85)	1,293.05 (2.85)	- (0.00)	- (0.00)
North	6,798.37 (15.00)	1,525.81 (3.37)	- (0.00)	5,272.56 (11.63)
Chiang Mai	5,919.09 (13.06)	646.53 (1.43)	- (0.00)	5,272.56 (11.63)
Lampang	879.28 (1.94)	879.28 (1.94)	- (0.00)	- (0.00)
South	2,275.77 (5.02)	2,275.77 (5.02)	- (0.00)	- (0.00)
Krabi	1,293.06 (2.85)	1,293.06 (2.85)	- (0.00)	- (0.00)
Narathiwat	982.72 (2.17)	982.72 (2.17)		- (0.00)
Total	45,318.47 (100.00)	27,031.78 (59.65)	8,223.83 (18.15)	10,062.86 (22.19)

Remark: The figures in the parenthesis are percentage.

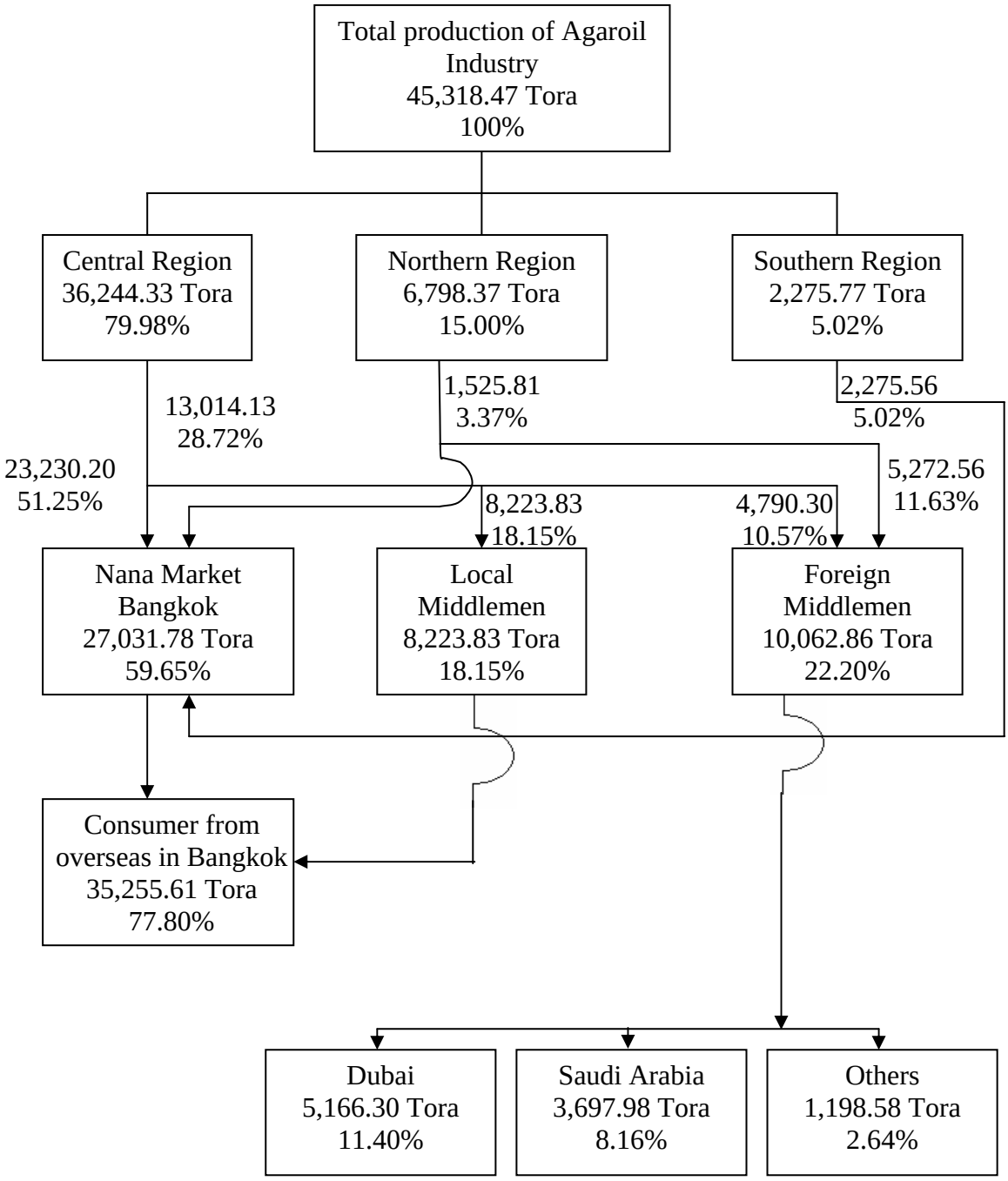

Figure 8 Marketing channel of agaroil from the source of production to the ultimate consumer.

4.5 National Trade in Agarwood and Agaroil

Agarwood plays an important role in the economy of south and southeast asian countries which were the source (exporter) and various countries located in the other regions which were the exporters. Based on the annual report of Cites from 1995 to 1997, *Aquilaria malaccensis* import and exports (kg) from range States namely Indonesia, Peninsular, Malaysia, and Thailand were fluctuated from year to year as represented in Table 23.

Table 23 *Aquilaria malaccensis* imports and exports (kg) from range States as reported in CITES annual report data from 1995 to 1997

Range State	Year	Imports reported from range States	Exports reported by range States
Indonesia	1995	500	323,577
	1996	214,095	293,593
	1997	0	305,483
Peninsular	1995	116,581	90,478
Malaysia	1996	157,713	163,107
	1997	90,830	87,230
Thailand	1997	216	244

Source: Angela *et al*. (2001)

Table 23 indicated that from 1995 to 1997 the yearly exports of Indonesia were much higher than exports while the exports of Peninsular in 1995 was lower than imports, this mainly due to the domestic demand for *Aquilaria malaccensis* in each year of such countries. In addition, the imports and exports of Malaysia and Thailand were rather equivalence to each other. While the exports and imports of Thailand were rather small amount.

Agarwood Importation of Taiwan

Furthermore, Taiwan was a country which having a large amount of agarwood importation. The agarwood were come from both exporter countries and re-exporter countries. The yearly total amount of agarwood importation from 1993 to 1998 was fluctuated from year to year this mainly due to the quantity of agarwood production and domestic consumption of the exporter and re-exporter countries in each year. Table 24.

Table 24 Imports of *Aquilaria* spp. into Taiwan (kg)

Country of origin/export/re-export	1993	1994	1995	1996	1997	1998	Total	%
Australia	0	0	100	0	0	0	100	0.0022
Other Australasian countries	0	190	0	0	0	0	190	0.0043
Cambodia	3,822	54,737	133,819	73,512	35,953	13,244	315,087	7.0718
Canada	0	0	0	0	0	10,504	10,504	0.2357
Hong Kong	200	60	0	0	37	0	297	0.0067
India	375	21,074	27,500	1,908	6,279	545	57,681	0.0129
Indonesia	661,265	491,190	482,874	336,946	302,032	555,229	2,829,536	63.5065
Lao PDR	0	1,850	0	0	0	0	1,850	0.0415
Madagascar	29	0	0	0	0	0	29	0.0006
China	11,135	15,454	4,009	7,507	5,272	3,371	46,748	1.0492
Malaysia	43,630	35,451	28,287	44,041	21,275	18,543	191,227	4.2919
Pakistan	0	0	0	203	0	0	203	0.0045
Singapore	32,821	34,276	46,179	8,063	9,442	3,067	133,848	3.0041
South Africa	0	0	7,540	0	0	0	7,540	0.1092
Switzerland	100	0	0	0	0	0	100	0.0022
Thailand	539	83,124	68,342	67,028	42,680	65,570	327,283	7.3455
USA	688	100	6	9	461	250	1,514	0.0339
Vietnam	19,681	84,779	103,068	91,129	96,427	136,685	531,769	11.9351
Total	774,285	822,285	901,724	630,346	519,858	807,008	4,455,506	

Source: Angela *et al*. (2001)

Table 24 indicated that the quantity of agarwood exportation from Indonesia shared the largest proportion in every year from 1993 to 1998. The quantity of agarwood was exported from Indonesia during the five years period shared the first rank of 63.50 percent of the totality, while Vietnam and Thailand shared the second and third rank of 11.93 and 7.34 percent respectively.

Trade in *Aquilaria malaccensis by* country of import

The available data about *Aquilaria malaccensis* imports and exports inform of chips, powder and timber were not clarify, and furthermore the available information about imports and exports of agaroil was quite rather scarce (Table 24).

Table 25 Trade in *Aquilaria malaccensis* (kg) by country of import

Country	Year	Chips, powder and timber		Oil	
		Imports reported by country of import	Exports/re-exports to country of import reported by country of export/re-export	Import reported by country of import	Exports/re-exports to country of import reported by country of export/re-export
Bangladesh	1995	0	1,170		0
	1996		1,646		
	1997		3,420		
Bhutan (NP)	1995	0	20		0
	1996		72		
	1997		574		
Canada	1996*	125	125		0
China	1995*	0	9,800		0
Egypt	1995		9,000		0
Hong Kong	1995*	25,855	40,275		0
	1996*	47,256	57,357		
	1997		52,770		

Table 25 (continued)

Country	Year	Chips, powder and timber		Oil	
		Imports reported by country of import	Exports/re-exports to country of import reported by country of export/re-export	Import reported by country of import	Exports/re-exports to country of import reported by country of export/re-export
India	1995*	38	14,454	0	0
	1996*	0	15,184		
	1997*	0	19,364		
Indonesia	1996*	0	1,440	0	0
Japan	1995*	6,629	11,159	0	0
	1996*	0	22,302		
	1997		4,758		
Republic of Korea	1995*	0	375	0	0
	1996*	0	80		
	1997*	0	135		
Kuwait (NP)	1995		1,532	1,532	0
	1996		1,515	1,515	
	1997		2,994	2,994	
Morocco	1995*	0	197		0
	1997*	0	301		
Oman (NP)	1995	0	12,788		2
	1997		10,613		
Qatar (NP)	1995	0	3,018	0	0
	1996		1,285		
	1997		5,249		
Saudi Arabia	1995	N/A	39,885	N/A	377
	1996		13,307		
	1997		75,392		
Singapore	1995*	116,581	345,677		2
	1996*	375,882	417,130		
	1997*	91,046	350,158		

Table 25 (continued)

Country	Year	Chips, powder and timber		Oil	
		Imports reported by country of import	Exports/re-exports to country of import reported by country of export/re-export	Import reported by country of import	Exports/re-exports to country of import reported by country of export/re-export
Spain	1997*	0	70	0	
Taiwan (NP)	1995		211,308	0	1
	1996		69,756		
	1997		121,302		
Thailand	1997*	0	3,566	0	
United Arab	1995		51,256	0	2
Emirates	1996		25,388		
	1997*	0	52,429		

* annual reports received; NP = non-party

Source: Angela *et al.* (2001)

Table 25 indicated that the top 10 export/ re-export destination for *Aquilaria malaccensis* chips, powder and timber between 1995 and 1997, were: Singapore (1,113 tons); Taiwan (402 tons); Hong Kong (150 tons); Saudi Arabia (129 tons); United Arab Emirates (129 tons); India (49 tons); Japan (38 tons); Oman (23 tons); China (13 tons) and Qatar (10 tons). A further 10 countries were recorded as export or re-export destination for smaller amounts of *A. malaccensis* chips, powder and timber, totaling less than 10 tons for the period. Singapore plays a central role as an re-export in the agarwood industry, with the majority of *A. malaccensis* imported subsequently re-exported in it's original or a more processed form. Saudi Arabia is reported as the destination for most of the oil (379 kg) recorded in CITES annual report data.

Wholesale prices for *Aquilaria malaccensis*

Wholesale agarwood prices are fixed by certain forest divisions in the north-east. The Forest Department collects and reviews existing market prices for the various grades of agarwood from different Divisional Forest Officers to decide the price. The Principal Chief Conservator of Forests then approves these. Table 26 shows the price ranges allocated by the Assam Forest Department to various grades between 1993 and 1998.

Table 26 Wholesale prices for *Aquilaria malaccensis* fixed by Assam Forest Department

Year	Grade	Price (INR/kg)	Price (USD/kg)	Price adjusted for inflation to 1998 dollars (USD/kg)
1993	1st class Black Agar	30,000	956	1,054
	2nd class Bantang	20,000	638	703
	3rd class Phutas, Kalaguchi	7,500	239	264
	4th class Dhum	100-250	3-8	3-9
1994	1st class Black Agar	65,000	2,072	2,231
	2nd class Bantang	15,000	478	515
	3rd class Phutas, Kalaguchi	7,000	223	240
	4th class Dhum	350	11	12
1998	1st class Black Agar	50,000	1,213	1,213
	2nd class Bantang	30,000	728	728
	3rd class Phutas, Kalaguchi	10,000	243	243
	4th class Dhum	450	11	11

Source: Gupta (1999)

Based directly on the agarwood prices in Indian rupees shown above (therefore not accounting for inflation), between 1993 and 1994 the prices of 2nd class and 3rd class agarwood decreased by 25% and 7%, respectively. However, both the lowest class (Dhum Agarwood) and the highest class (Black Agar) increased in price

by between 40-250% and by 117%, respectively, in a single year. The timing of these changes in price corresponded to the submission of the CITES listing proposal for *Aquilaria malaccensis* by India.

Market and prices

Agarwood grade classifications vary slightly with locality and also from one middleman or collector to another. The government has never issued a standard grading classification that was acceptable to trading companies and collectors alike (Oetomo, 1995; Soehartono and Mardiastuti, 1997).

In 1997, in the Apau Kayan area of East Kalimantan, 'super grade A' agarwood was quoted as selling for IDRI 250,000/kg (USD 450/kg) (Hartadi, 1997). In NTB, the best grade of agarwood was quoted at approximately IDRI 500,000/kg (USD 540/kg) in 1997 (Anon., 1997b). In 1999, in Jayapura, 'super grade' agarwood was for sale for approximately IDR3 500,000/kg (USD 385/kg), but at the time of the first monetary crisis in November 1997, the same grade sold for approximately IDR7 500,000/kg (Priyadi, 1999).

In West Kalimantan, the one trading company in operation quoted prices paid to middlemen (who typically link collectors with traders) and those which they themselves charged (Table 27) (Soehartono and Mardiastuti, 1997). The prices shown in Table 6 were originally obtained in Indonesian rupiahs, but were converted in 1995/6 at USD1: IDR2361. Table 28 shows a range of Indonesian agarwood prices obtained from the former chief of the former agarwood trade association *Asosiasi Pengusaha Damar, Gubal Gaharu dan Kemedangan Indonesia* (APDGKI – the Indonesian Traders Association of Resin-Gaharu and Garrowood).

Table 27 Agarwood prices paid to middlemen and the selling price set by one trading company in West Kalimantan, November 1996

Grade price	Prices paid to middlemen (USD/kg)	Selling price (USD/kg)	Quantity indicators
Super A	200-300	300-400	Very black, heavy with much resin
Super B	150-200	250-300	Black, heavy with moderate amounts of resin
Super C	100-150	200-250	Fairly black, heavy with moderate amounts of resin
Sabak	75-100	150-200	Less black, moderately heavy with less resin
Kemedangan bungkus	15-17	20-25	Very brown, less resin
Teri padat	10-12	15-17	Debris of Super A and B
Teri timbul	7-10	10-15	Debris of Super C and Sabak
Teri laying	5-7	10-15	Debris of Kemedangan bungkus
Kemedangan kropos	4-5	7-10	Yellowish brown, light and very little resin

Source: Soehartono and Mardiastuti (1997)

Table 28 Agarwood grades and prices ranges

Specification	Grade	Price (IDR/kg)	Price (USD/kg)
	Super	1000000-1500000	450-675
	A B	500000-900000	225-405
	B C	250000-500000	113-225
Gubal gaharu	TG	250000-500000	113-225
	CI	100000-250000	45-113
	Sabah	60000-150000	27-68
	Tri A	100000-250000	45-113
	C 2	40000-100000	18-45
	TA 1	25000-40000	12-18
	TA 2	15000-25000	7-12
Kemedangan	TA 3	5000-15000	3-7
	Abu	500-3000	0.2-1.4
	TRI B	50000-10000	23-45
	TRI C	15000-50000	7-23
	TRI MD	5000-15000	2-7
	Super	100000-150000	45-68
Abu	Biasa	40000-100000	18-45
	Kerokan	10000-40000	5-18

Source: Oetomo (1995)

CONCLUSION AND RECOMMENDATION

Conclusion

Findings from the study could be concluded as follows.

1. The agaroil industry in Thailand was mostly found in the central region. In 2006 the total demand for agarwood at full capacity of all agaroil factories in the whole country was 683,611.25 kg, while the available quantity of agarwood was only 357,777.42 kg, so the amount of agarwood shortage was become 325,833.38 kg The price of agarwood with high price and low price showing a upward tendency they were increased from 311.46 and 166.25 Baht/ kg in 2002 to 341.25 and 175.63 Baht/ Kg. in 2006 Baht/ kg respectively.

2. The most severe problem of agaroil industry was raw material shortage which occurred to the most respondents of 91.66 percent.

3. The high agarwood price provided an average profit per lot of agaroil production (using 15 kg of dried agarwood) higher than the low price, they were 2,512.35 and 662.35 Baht/ lot respectively. In addition, the marketing margin, producer's share and pricing efficiency of agaroil were 246.67 Bath/ Tora, 93.97 and 1,659.10 percent, respectively. Furthermore, the average annual profit per each set of condenser from agaroil production by using agarwood with a high and a low price were 175,864.50 and 46,364.50 Baht respectively, this indicated the performance of agaroil market was good enough.

4. Market structure of agaroil was oligopoly. The market conduct of agaroil represented that the producers could not set their product price and have no bargaining power, thus the selling price is mainly due to the satisfaction of the customers. In addition, the results of the study on the profit cost ratio indicated that the profit cost ratio is directly related to the product price and inversely related to the cost of production. In case of using a high agarwood price (low cost) and a low

agarwood price (high cost) and with the maximum agaroil price, their profit cost ratio were 177.88 and 133.49 percent respectively. While in case of using a high price agarwood and a low price agarwood and with the average agaroil price, their profit cost ratio were reduced to52.67 and 28.28 percent respectively. These indicated that the profit cost ratio of agaroil were at a high to a very high level.

The total production of the top 4 agaroil factories was 13,261.05 Tora or 29.26 percent of the total production of the industry (45,318.47 Tora) and the average price of agaroil was 3,845.83 Baht/Tora. Such the total agaroil production of 45,318.47 Tora, this came from the central, north and south region of 36,244.30 Tora (79.98%), 6,798.37 Tora (18.15%) and 2,275.78 Tora (5.02%) respectively. The agaroil distributed to the ultimate consumer by 3 routes; the first route starting from the 3 sources of production (central, north and south region), the entrepreneurs brought their products to sell directly to the retailers at Nana market in total amount of 35,261.61 Tora and then selling to the local middle mean going to buy the product from the factory and then selling to the retailers at Nana market with amount of 8,223.83 Tora (18.15%). The third route, starting from the middlemen going to buy the product from the factory, and then exported to the consumers in Dubai, Saudi Arabia and others with amount of 5,167.21 Tora (11.40), 3,698.92 Tora (8.16%) and 1,190.73 (2.63%) respectively.

Recommendation

Based on the finding from the study, the relevant recommendations were given as follows.

1. Based on the results of the study visualized that the raw material shortage was the severe problem of agaroil industry. Thus, in order to mitigate the problem as well as to develop the potential of agaroil industry to bring prosperity to the Thai economy, the extension program of *Aquilaria crassna* plantation under the related government and private regencies should be implemented immediately in the proper sites. Moreover, the searching for an the effective agarwood treatment method is

needed, in order to originate the high concentration of fragrant substance in agarwood texture.

2. According to the information obtained from interviewing Mr. Bab Pongchin (the agarwood tree grower and the owner of agaroil factory who living at 87 Nong Sano Village, Nong Sano Sub district, Muang District, Trat Province) on 15 October, 2007). Nowadays, agarwood plantation was widely practiced in Trat Province, the used spacing was 2.5 x 3 metre or the average tree number per rai will be about 214 trees. The stem treatment could be conducted when the agarwood plantation was 7 years old and need one year more for developing the fragrant substance so the rotation of the agarwood plantation (R) was become 8 years. The productivity of the fragrant agarwood per tree was 2 kg, so the productivity of fragrant agarwood per rai (P) will be 428 kg Based on the mentioned information, the agreeable demand for agarwood at full capacity of all agaroil factories in the country (QDf) was 683,611.25 kg/annum. Thus, in order to stabilize the agaroil industry, the using raw material should be only come from plantation and with quantity that adequate to meet the requirement of all agaroil industries in the country at their full capacity. Hence, the needed plantation area for sustainable supporting the demand for agarwood at the full capacity of all agarwood factories in the country (A) will be 12,777.78 rais[1/]. On the other hand, the average area of agarwood plantation per an agaroil factory will be 260.77 rais, and then the plantation in each region could be estimated. The purposive agarwood plantation area in the central, north and south will be 9,583.34, 2,130.66 and 1,063.78 rais respectively. In case of the number of agaroil factories increase in the near future, the average regional agarwood plantation area per an agaroil factory (the purposive agarwood plantation area in each region

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Remark: [1/]

$$A = \frac{R(QDf)}{P}$$

$$\text{So, } A = \frac{8(683,611.25)}{428}$$

$$= 12,777.78 \text{ rais}$$

divided by its number of agaroil factories) could be used as a guideline for formulating the extension program for agarwood reforestation.

3. Based on the average annual profit per a set of condenser from agaroil production by using agarwood with a high and a low price were rather high, they were 175,864.50 and 46,364.50 Baht respectively or 14,655.37 and 3,863.70 Baht/month. Thus, the agaroil production should be an appropriate enterprise for the ones who have a limited budget (not over than 64,130 and 61,430 Baht in case of using a high and a low price agarwood[2/] to invest on a small scale at the beginning as their main or subsidiary occupation, and in the form of cottage industry. Thus, the increasing in number of agaroil factories will be a strong probability in the near future if and only if the existing *Aquilaria crassna* plantation could produce the fragrant agarwood in amount of over than the demand for agarwood at full capacity of the active agaroil factories in the present. However, in order to develop the agaroil enterprise effectively, the action plan for expanding the raw material should be formulated. Moreover the research on the determination of an appropriate technology for stimulating the origination of the fragrant substances in agarwood texture is needed.

4. Actually, there was no standardization of agaroil quality (the agaroil with different quality levels were mixed together before selling or the agaroil had only one price level). Thus, in order to improve the reliability of agaroil, the standardization of it's quality should be performed, this will enable the domestic agaroil producers to compete with their overseas rivals.

[2/] The needed budget including the overhead cost for purchasing a grinder machine, a set of condenser and a plastic container which their prices were 36,000, 22,000 and 380 Baht respectively (the span of life of the first two instruments are over than 8 years, while the third is only one year), and the rest was the variable cost excluding implicit cost using for producing the first lot of agaroil which including agarwood to be used as raw material, it's values were 4,500 and 1,800 Baht in case of using a high and a low price agarwood, and the cost of labour, electricity and liquid petroleum gas with values of 10, 10 and 1,230 Baht respectively. The obtained profit from the first lot could be allocate for producing the second lot of agaroil as well as the obtained profit from the second lot will be used for producing the third lot and so on.

5. The nature of agaroil is not a clumsy product, it could be contained in a rather small container even the small bottle, so even any 4 wheels car is suitable for the transportation. Due to the agaroil don't get into difficulties with the transportation. Thus, the agaroil factory could be established in any sites even in the remote areas. Thus the proper site to be selected for locating the agaroil factory should be closed to the areas which covered with the abundant plantation of *Aquilaria crassna*.

6. Based on the information about the productivity of the fragrant agarwood from the plantation is unknown, thus the research to be carried out in the near future should be emphasized on the entitled "The productivity of fragrant agarwood from the plantation".

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APPENDICES

Appendix A

Questionnaire for agaroil factory survey

Appendix A

Questionnaire for agaroil factory survey

Name of agaroil factory .....

Address ..... Village .....

Sub district ..... District ..... Province .....

Date of interview Date ..... Month 2006

Interviewer .....

1. Agaroil factory was established in the year .....

2. Daily demand for agarwood at full capacity ..... Kg.

3. Available quantity of agarwood per day ..... Kg.

4. Source of agarwood.
   - 4.1 Sellers come to approach at agaroil factory ..... %
   - 4.2 Importation ..... %
   - 4.3 Other (specific) .....

5. No. of working days per annum ..... days

6. Tendency of the agarwood comparison between the available quantity in present and in the last 5 years.
   - 6.1 Tendency to decline ..... %
   - 6.2 Tendency of increase ..... %
   - 6.3 Constant

7. Comparison between agarwood price in present and in the last 5 years.

		Decrease %	Increase %
High price type	Baht/ Kg.	.....	.....
Low price type	Baht/ Kg.	.....	.....

8. Average agaroil production per 1 kg. of the using agarwood.

Ranging from ..... to ..... Tora

9. The total agaroil production in the year 2006 ..... Tora

10. Where did you sell your agaroil.

Market 1 (specify) ..... Quantity ..... %

Market 2 (specify) ..... Quantity ..... %

Market 3 (specify) ..... Quantity ..... %

Market 4 (specify) ..... Quantity ..... %

Market 5 (specify) ..... Quantity ..... %

11. Comparison between the actual price and price in the last 5 year of agaroil.

Actual price	Decrease	Increase
	.....	.....
	.....	.....

12. Problems and obstacles took place in agaroil business including production and marketing aspect.

12.1 Production aspect

1) .....

2) .....

3) .....

4) .....

5) .....

12.2 Marketing aspect

1) .....

2) .....

3) .....

4) .....

5) .....

Appendix B

Appendix Table B1: List of agaroil factory in Thailand by region

Appendix Table B1 List of agaroil factory in Thailand by region

Region	No.	Name	Address
Central			
Nakhon Nayok	1	Mr. Boonchai ANODAT	182 Moo. 2 Sarika sub distric Nakhon Nayok Province 20600 Tel. 037-328261
	2	Mr. Somkiat JITKHAM	Sub distric Sarika Muang district Nakhon Nayok Province 26000
	3	Mr. Somsak TOOHUAYTHAY	Sub distric: Sarika, Muang district Nakhon Nayok Province 26000
	4		Sub distric Sarika, Muang district Nakhon Nayok Province 26000
	5	Mrs. Buathong KHOKCHAI	134/1 Moo. 1, Sarika sub distric Muang district, 26000 Nakhon Nayok Province
	6	Mr. Sompao HOMJAN	135 Moo. 2, Sub distric: Sarika Muang district, 26000 Nakhon Nayok Province
	7	Mr. Barnjong JITSA - NJANG	226 Moo. 2, Sub distric: Sarika Muang district, Nakhon Nayok Province 26000
	8	Mrs. Siriwan SAEUNG	397 Moo. 1, Sub distric: Sarika Muang district, Nakhon Nayok Province 26000
	9	Mr. Somkit SAETUAY	28/1 Moo. 2, Sub distric: Sarika Muang district, Nakhon Nayok Province 26000
	10		83 Moo. 1, Sub distric: Sarika Muang district, Nakhon Nayok Province 26000
	11		458/322 Moo. 1, Sub distric: Sarika Muang district, Nakhon Nayok Province 26000
	12	Mr. Pikul NAREE	51/3 Moo. 1, Sarika-Nakhon NayokRoad, Sub distric: Sarika Nakhon Nayok Province 26000
	13	Mr. Boonrung ONG-ARJ	Moo. 1, Sub distric: Hin-Tang Muang district, 26000 Nakhon Nayok Province
	14	Mr. Suwann SORNDEE	NS.3 No. 313/153 Moo. 1, Sub distric: Sarika, Muang district, Nakhon Nayok Province 26000

Appendix Table B1 (Continued)

Region	No.	Name	Address
Central			
Nakhon Nayok	15	Mrs. Thomyar KINGPHAR	133 Moo. 1 Sarika Sub distric Muang: district Nakhon Nayok Province 26000
Prachin Buri	16	Mrs. Sommitre WATTAVANICHKUL	14 Moo. 2, Nernhom, Muang district, Prachin Buri Province, 25230
	17	Mr. Amnarj NOONAM	12/4 M00. 19, Sub distric Nernhom, Muang district, Prachin Buri Province, 25230
	18	Mr. Samuay POONITTHAYA	76 Moo. 12, Sub distric Nongkaew Prajantakam district, Prachin Buri Province, 25130
	19	Mr. Yanisa KHAMPIRA	Moo. 15, Nernhom Sub distric Prachin Buri Province, 25230
	20	Mr. Sonthaya NADEE	137 Moo. 13, Poonjarm Sub distric Prajantakarm, Prachin Buri Province, 25130
	21		87/2 Moo. 13, Nernhom Sub distric Muang district, Prachin Buri Province, 25230
	22	Kamonvan KRISNA	75/2 Moo. 12, Sub distric Nongkaew Prajantakarm district, Prachin Buri Province, 25130
	23	Jae Muay ESLENTIALOIL	8 Moo. 2, Sub distric Nernhom Muang district, Prachin Buri Province, 25230
	24	Thai-Hok	135 Moo. 17, Poo-njarm Sub distric Prajantakarm district, Prachin Buri Province, 25130
Trat	25	Miss. Yupa CHIANGRAN	Moo. 3, Taproe Sub distric Muang district, Trat Province, 23000
	26	Mr. Somboon SUNET	72/1 Moo. 3, Klonhyai Sub district Klonhyai district Trat Province, 23110

Appendix Table B1 (Continued)

Region	No.	Name	Address
Trat	27	Mr. Somkuan TABPANBUPPHA	136/1 Moo. 1 Borploy Sub district Borrai District Trat Province, 23140
	28	Mrs. Boontham CHORNSOOU	89/2 Moo. 1 Nongsano Sub district Muang District Trat Province
	29		155 Moo. 6 Borploy Sub district Borrai district Trat Province
	30	Mr. Komsak SAKPHETPLOY	Moo. 3 Borploy Sub district Borrai district Trat Province
	31		Moo. 8 Klongyai Sub district Laemngob district Trat Province, 23120
	32		Moo. 3 Chamrak Sub district Muang district Trat Province, 23000
	33		Moo. 3 Mairood Sub district Klongyai district Trat Province, 23110
	34	Mr. Sura CHAISIRI	482/3 Moo. 8 Wangkrajae Sub district Muang District Trat Province, 23000
	35		Moo. 3 Borploy Sub district Borrai district Trat Province, 23140
	36	Mr. Paisan CHAROENSRI	Moo. 4 Mairood Sub district Klongyai district Trat Province, 23110
	37		148 Moo. 4 Nongsano Sub district Muang District Trat Province, 23000
	38		Moo. 6 Nongsano Sub district Muang district Trat Province, 23000
	39	Mr. Sarawut SINGHAPHAN	196/20 Moo. 3 Borploy Sub district Borrai District Trat Province, 23140
	40	Mr. Pradit SA-MART	14 Moo. 3 Takarng Sub district Muang district Trat Province, 23000
	41		8 Moo. 3 Takarng Sub district Muang district Trat Province, 23000
	42	Kor. WANCHAI (1)	86 Moo. 3 Borploy Sub district Borrai district Trat Province, 23140

Appendix Table B1 (Continued)

Region	No.	Name	Address
Chanthaburi	43	Surasit NAMHORM	30/1 Moo. 8 Phongnamron sub district Phongnamron district Chanthaburi Province, 22140
North			
Chiang Mai	44	Greenoil	Moo. 3 Sanpayang sub district Maetaeng district Chiang Mai Province, 50150
	45	Thawanratsceneoil	111/4 Moo. 5 Kee-lek sub district Maetaeng district Chiang Mai Province, 50210
	46	Top CHAROEN	9 Moo. 15 Banphai sub district Sansai district Chiang Mai Province, 50210
Lampang	47	Mr. Somchoke KAMLUNGMARK	296 Moo. 3 Maipattana Sub district Kohka District Lampang Province
South	48		
Krabi		Somyos KRISSANAWOOD	413/1 Moo. 2 Klongkanan sub district Nuaklong district Krabi Province
Narathiwat	49	Mr. Paju YUELAPAE	Bannangatar sub district Muang district Narathiwat Province

Appendix C

Basic data collected from field survey

Appendix Table C1 Basic data about age of factory, quantity of demand for agarwood full capacity, quantity of the available agarwood and source of agarwood in Thailand

Region/Province	Factory No.	Age of factory (year)	Quantity of demand for Agarwood full capacity (kg/annum)	Quantity of the Available Agarwood (kg/annum)	Source of Agarwood in Thailand	
					Nakhon Nayok	Prachin Buri
Central						
Nakhon Nayok	1	6	3,400.00	1,000.00	1,000.00	-
	2	3	10,400.00	6,500.00	-	-
	3	18	4,000.00	2,500.00	750.00	-
	4	10	9,930.00	5,000.00	4,500.00	-
	5	2.5	1,500.00	600.00	600.00	-
	6	3	5,200.00	3,000.00	2,700.00	300.00
	7	1	4,000.00	2,000.00	1,000.00	-
Prachin Buri	8	1	12,800.00	4,200.00	-	2,100.00
	9	3	30,000.00	12,000.00	-	2,400.00
	10	3	9,600.00	4,800.00	-	2,880.00
	11	3	19,200.00	9,600.00	-	-
	12	15	19,200.00	12,000.00	-	-
Trat	13	12	90,000.00	54,000.00	-	-
	14	15	15,000.00	8,500.00	-	-
	15	4	2,000.00	1,000.00	-	-
	16	20	10,000.00	6,200.00	-	-
	17	10	16,000.00	2,250.00	-	-
Chanthaburi	18	3	10,000.00	5,000.00		-
North						
Chiang Mai	19	1	24,000.00	12,888.00	-	-
	20	2	10,000.00	5,000.00	-	-
	21	5	10,000.00	5,000.00	-	-
Lampang	22	3	4,600.00	3,400.00	-	-
South						
Krabi	23	9	9,000.00	5,000.00	-	-
Narathiwat	24	5	5,000.00	3,800.00	-	-

Appendix Table C2 Basic data about source of agarwood in Thailand

Region/Province	Factory No.	Source of Agarwood in Thailand				
		Trat (kg)	Chanthaburi (kg)	Rayong (kg)	Mae Hong Son (kg)	Krabi (kg)
Central						
Nakhon Nayok	1	-	-	-	-	-
	2	650.00	5,850.00	-	-	-
	3	500.00	500.00	-	-	-
	4	-	-	-	-	-
	5	-	-	-	-	-
	6	-	-	-	-	-
	7	500.00	500.00	-	-	-
Prachin Buri	8	-	-	-	-	-
	9	-	9,600.00	-	-	-
	10	-	-	-	-	-
	11	-	2,880.00	-	-	-
	12	-	-	-	-	-
Trat	13	21,600.00	21,600.00	10,800.00	-	-
	14	2,550.00	5,950.00	-	-	-
	15	1,000.00	-	-	-	-
	16	6,200.00	-	-	-	-
	17	-	-	-	-	-
Chanthaburi	18	-	5,000.00	-	-	-
North						
Chiang Mai	19	-	-	-	-	-
	20	-	-	-	-	-
	21	-	-	-	1,500.00	-
Lampang	22	-	-	-	-	-
South						
Krabi	23	-	-	-	-	3,000.00
Narathiwat	24	-	-	-	-	-

Appendix Table C3 Basic data about source of agarwood in Thailand and foreign country

Region/Province	Factory No.	Source of Agarwood				
		in Thailand	Foreign country			
		Narathiwat (kg)	Laos (kg)	Myanmar (kg)	Cambodia (kg)	Malaysia (kg)
Central						
Nakhon Nayok	1	-	-	-	-	-
	2	-	-	-	-	-
	3	-	750.00	-	-	-
	4	-	500.00	-	-	-
	5	-	-	-	-	-
	6	-	-	-	-	-
	7	-	-	-	-	-
Prachin Buri	8	-	-	2,100.00	-	-
	9	-	-	-	-	-
	10	-	1,920.00	-	-	-
	11	-	2,880.00	-	3,840.00	-
	12	-	-	-	-	12,000.00
Trat	13	-	-	-	-	-
	14	-	-	-	-	-
	15	-	-	-	-	-
	16	-	-	-	-	-
	17	-	-	225.00	2,025.00	-
Chanthaburi	18	-	-	-	-	-
North						
Chiang Mai	19	-	12,888.00	-	-	-
	20	-	-	5,000.00	-	-
	21	-	-	3,500.00	-	-
Lampang	22	-	3,400.00	-	-	-
South						
Krabi	23	-	-	2,000.00	-	-
Narathiwat	24	2,280.00	-	-	-	1,520.00

Appendix Table C4 Basic data about available agarwood, agaroil product and price

Region/Province	Factory No.	Available Agarwood (kg/annum) 2006	Available Agarwood (kg/annum) 2002	Agaroil Product (Tora/ lot)	Agaroil Price (Baht/ Tora)
Central					
Nakhon Nayok	1	1,000.00	1,500.00	0.90	2,500.00
	2	6,500.00	9,300.00	2.80	3,500.00
	3	2,500.00	3,500.00	2.50	3,000.00
	4	5,000.00	7,000.00	1.11	3,000.00
	5	600.00	900.00	2.50	3,500.00
	6	3,000.00	4,500.00	2.00	3,500.00
	7	2,000.00	3,000.00	2.00	3,500.00
Prachin Buri	8	4,200.00	7,000.00	0.94	3,450.00
	9	12,000.00	20,000.00	1.52	3,600.00
	10	4,800.00	8,000.00	1.56	3,200.00
	11	9,600.00	16,000.00	1.21	2,200.00
	12	12,000.00	20,000.00	2.67	3,000.00
Trat	13	54,000.00	56,500.00	1.25	5,000.00
	14	8,500.00	9,000.00	0.94	6,000.00
	15	1,000.00	1,000.00	3.00	5,400.00
	16	6,200.00	6,500.00	2.25	4,500.00
	17	2,250.00	2,250.00	2.34	7,000.00
Chanthaburi	18	5,000.00	7,500.00	2.00	6,000.00
North					
Chiang Mai	19	12,888.00	14,000.00	1.61	3,700.00
	20	5,000.00	5,500.00	1.12	3,000.00
	21	5,000.00	5,500.00	4.32	3,000.00
Lampang	22	3,400.00	3,400.00	3.00	3,550.00
South					
Krabi	23	5,000.00	8,000.00	1.00	3,700.00
Narathiwat	24	3,800.00	4,500.00	1.00	3,500.00

Appendix Table C5 Basic data about high and low agarwood price

Region/Province	Factory No.	High Agarwood Price (Baht/ kg)		Low Agarwood Price (Baht/ kg)	
		2006	2002	2006	2002
Central					
Nakhon Nayok	1	100.00	110.00	75.00	80.00
	2	300.00	335.00	150.00	160.00
	3	180.00	200.00	150.00	160.00
	4	100.00	110.00	50.00	50.00
	5	500.00	560.00	200.00	210.00
	6	180.00	200.00	150.00	160.00
	7	180.00	200.00	150.00	160.00
Prachin Buri	8	150.00	140.00	100.00	105.00
	9	500.00	460.00	250.00	260.00
	10	500.00	460.00	200.00	210.00
	11	80.00	75.00	60.00	65.00
	12	500.00	465.00	250.00	260.00
Trat	13	300.00	220.00	150.00	130.00
	14	250.00	180.00	120.00	105.00
	15	500.00	365.00	250.00	215.00
	16	250.00	185.00	180.00	155.00
	17	550.00	400.00	250.00	220.00
Chanthaburi	18	450.00	450.00	200.00	190.00
North					
Chiang Mai	19	300.00	275.00	200.00	160.00
	20	1,000.00	920.00	200.00	160.00
	21	400.00	365.00	180.00	145.00
Lampang	22	320.00	300.00	200.00	180.00
South					
Krabi	23	300.00	250.00	250.00	220.00
Narathiwat	24	300.00	250.00	250.00	230.00

Appendix Table C6 Basic data about agaroil product and selling

Region/Province	Factory No.	Agaroil Product (Tora)	Selling at factory to:		
			Nana Sub district (Tora)	Local Middlemen (Tora)	Foreign middlemen (Tora)
Central					
Nakhon Nayok	1	126.67	9.22	117.45	-
	2	823.33	59.94	763.39	-
	3	316.67	23.05	293.61	-
	4	633.33	46.11	587.23	-
	5	76.00	5.53	70.47	-
	6	380.00	27.66	352.34	-
	7	253.33	18.44	234.89	-
Prachin Buri	8	532.00	236.05	146.09	149.86
	9	1,520.00	674.42	417.39	428.18
	10	608.00	269.77	166.96	171.27
	11	1,216.00	539.54	333.91	342.55
	12	1,520.00	674.42	417.39	428.18
Trat	13	6,840.00	5,987.74	28.73	823.54
	14	1,076.67	942.51	4.52	129.63
	15	126.67	110.88	0.53	15.25
	16	785.33	687.48	3.30	94.55
	17	285.00	249.49	1.20	34.31
Chanthaburi	18	633.33	633.33	-	-
North					
Chiang Mai	19	1,632.48	178.27	-	1,454.21
	20	633.33	69.16	-	564.17
	21	633.33	69.16	-	564.17
Lampang	22	430.67	430.67	-	-
South					
Krabi	23	633.33	633.33	-	
Narathiwat	24	481.33	481.33	-	

Source: From the field survey

Appendix Table C7 Annual working days of agaroil factories by region and province in 2006

Region/Province	Factory No	Number of working days per annum (days)
Central		
Nakhon Nayok	1	300
	2	280
	3	300
	4	270
	5	250
	6	290
	7	260
Prachin Buri	8	290
	9	300
	10	300
	11	280
	12	300
Trat	13	260
	14	250
	15	300
	16	300
	17	270
Chanthaburi	18	300
North		
Chiang Mai	19	250
	20	270
	21	300
Lam pang	22	280
South		
Krabi	23	300
Narathiwat	24	300
Average		283.33

Source: From the field survey

Appendix D

Calculation method for depreciation cost

Appendix D
Calculation method for depreciation cost

Calculating the approximate cost per day of machine could be done by using the formula as fallows.

$$M_C = \frac{P}{100} \times M_f$$

Where:

M_C = machinery cost per day (Baht/ day)

P = Current purchase price of machine (Baht)

M_f = multiplying factor

The multiplying factor is inversely related to the span of life of machine as presented in Appendix Table D.

Appendix Table D1 Multiplying factor of machine

Year	Multiplying factor
1	5.5
2	3.0
3	2.2
4	1.8
5	1.5
6	1.3
7	1.2
8	1.1
9	1.0
10	1.0

Source: Hoamuangkaew (2006)

The total machinery cost could be done by multiplying the machinery cost per day with the number of the working days.

Appendix E

Figures

Appendix Figure D1 Grinder machine.

Appendix Figure D2 Plastic container.

Appendix Figure D3 Condenser.

Appendix Figure D4 Liquid petroleum gas (LPG) tank.

Appendix Figure D5 The bottle of agaroil.