Marketing Potential of Mai Taku (*Anthocephalus chinensis*) and Investment Feasibility of Forest Plantations

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ABSTRACT

The objective of the study was to investigate the marketing potential of Mai Taku (Bur-flower tree) (*Anthocephalus chinensis*) and the feasibility of investment in forest plantations. The study considered every stage of the integrated enterprise, starting with seed collection and then nursery seedling production, wholesaling and retailing of seedlings, plantation management, timber markets, wood processing and finally, the consumer. A stratified sampling method was used for data collection by enterprise type. The results indicated that since the beginning of 2007, Mai Taku has been called various names for promotional purposes in various media. The development of an advertising label as part of the process has proven to be an effective method of promotion. To date, 12,318 farmers have planted 5,196 hectares (32,473 rai) of Mai Taku on their own land, amounting to a total investment cost of about USD 15.89 million (533 million baht). Most investors were educated to diploma level and were members of wealthy families. The results of marketing potential analysis indicated that seed sources, nurseries and forest plantations were distributed throughout the entire country, with the northern region being the main seed source and the northeastern region having the largest plantation area. Financial analysis indicated a breakeven point of USD 51.64/ton or 1,734 baht/ton. Based on a comparative study of Mai Taku investment opportunity with five economic plant species, Mai Taku provided the lowest annual net present value. Furthermore, sensitivity analysis indicated that the investment would be profitable with a seedling price of USD 0.03/seedling (1 baht/seedling) and a resultant breakeven point for the timber price of about USD 23.82/ton (800 baht/ton). Thus, based on the current economic situation, Mai Taku plantation should be judged as an unviable project.

Keywords: Mai Taku or Bur-flower tree, marketing potential, production system, forest plantation, financial analysis

บทคัดย่อ

วัตถุประสงค์ของการศึกษาศักยภาพด้านการตลาดของไม้ตะกูและโอกาสความเป็นไปได้ของการลงทุนปลูกสร้างสวนป่า ได้ศึกษาวิจัยตั้งแต่แหล่งผลิตเมล็ดพันธุ์และกล้าไม้ การค้าส่งและค้าปลีกกล้าไม้ สวนป่าไม้ตะกู แหล่งรับซื้อไม้ตะกู โรงงานประดิษฐกรรมไม้และผู้ใช้ผลิตภัณฑ์ที่กระจายอยู่ในทุก

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ภูมิภาคของประเทศ ซึ่งการศึกษาได้มีการสุ่มตัวอย่างแบบจำแนกชั้นในแต่ละประเภทธุรกิจ ผลการศึกษาพบว่า ไม้ตะกูถูกตั้งชื่อเรียกทางการค้ามากมายเพื่อการโฆษณาในหลากหลายรูปแบบอย่างเป็นรูปธรรมตั้งแต่ต้นปี พ.ศ. 2550 และที่มีประสิทธิภาพมากที่สุดได้แก่ การติดป้ายโฆษณาขายกล้าไม้ริมสองข้างถนนสายหลักในแต่ละภูมิภาค ปัจจุบันพบว่ามีเกษตรกร 12,318 คน ได้ดำเนินการปลูกสร้างสวนป่าไม้ตะกูไปแล้วในพื้นที่ 32,473 ไร่ และคิดเป็นมูลค่าเงินหมุนเวียนที่เกิดขึ้นจากการลงทุนประมาณ 533 ล้านบาท โดยพบว่าผู้ที่ดำเนินธุรกิจเกี่ยวกับไม้ตะกูเป็นผู้ที่มีการศึกษาระดับอนุปริญญาและฐานะทางการเงินดี ในส่วนของระบบการผลิตและครรลองการตลาดพบว่าแหล่งผลิตเมล็ดพันธุ์ไม้และกล้าไม้รวมทั้งสวนป่า มีการกระจายครอบคลุมทุกภูมิภาคของประเทศโดยเมล็ดไม้ตะกูส่วนใหญ่มีแหล่งผลิตมาจากภาคเหนือของประเทศ ส่วนการปลูกสร้างสวนป่ามีการดำเนินการอยู่ในภาคตะวันออกเฉียงเหนือมากที่สุดการคำนวณมูลค่าปัจจุบันสุทธิ (net present value, NPV) และอัตราผลได้ต่อต้นทุน (B/C ratio) ที่ระดับอัตราดอกเบี้ยร้อยละ 6 และกำหนดรอบตัดฟันเท่ากับ 5 ปี พบว่าประสบกับปัญหาการขาดทุนในทุกระดับราคาไม้ท่อนตะกูที่ต่ำกว่า 1,734 บาทต่อตัน ซึ่งเป็นราคาที่ทำให้เกิดจุดคุ้มทุน (breakeven point) ส่วนโอกาสด้านการลงทุนพบว่าไม้ตะกูให้ผลตอบแทนต่ำที่สุดเมื่อเปรียบเทียบกับพืชเศรษฐกิจ 5 ชนิด มากไปกว่านั้นการวิเคราะห์ความอ่อนไหวของการปลูกสร้างสวนป่าไม้ตะกู พบว่า เมื่อราคากล้าไม้เท่ากับ 1 บาทต่อต้น ซึ่งถือว่าเป็นราคาต่ำสุดที่เป็นไปได้ ราคารับซื้อไม้ท่อนอย่างน้อยต้องเท่ากับหรือมากกว่า 800 บาทต่อตัน จึงจะเหมาะสมสำหรับการลงทุน ดังนั้นในสภาวะเศรษฐกิจปัจจุบันการลงทุนปลูกสร้างสวนป่าไม้ตะกู จำเป็นต้องพิจารณาเกี่ยวกับความเป็นไปได้ของการลงทุนให้รอบคอบ

คำสำคัญ: ไม้ตะกู, ศักยภาพด้านการตลาด, ระบบการผลิต, การลงทุนปลูกสร้างสวนป่า, ผลตอบแทนด้านการเงิน

INTRODUCTION

Anthocephalus chinensis (Lam) Rich ex Walp is the botanical name of Mai Taku. It is a fast-growing tree species that thrives in high moisture areas and is classified as having medium to hard wood. Records for an almost two-year period (2007-2009) indicated there were 12,318 Mai Taku growers throughout the country. Investment in forest plantation required a rather high budget, as well as a rather long production period. Thus, information about costs, benefits, the rate of return to be obtained from selling the timber, the market for absorbing the product, as well as the market price are needed to assist the entrepreneur to make a decision on investment. Hence, studying the marketing potential of Mai Taku and its plantation investment opportunities are of considerable interest. Thus, the principal objectives of this research were to: determine the potential of Mai Taku from a macro viewpoint considering the socioeconomic conditions of the entrepreneur and those engaged in all relevant enterprises, in order to analyze the feasibility of the investment; and to formulate the research conceptual framework of the marketing potential nationwide. The process involved considering seed sources, seedling production, wholesalers, retailers, Mai Taku growers, the timber market, and wood factories, as well as the finished products users (Figure 1).

METHODOLOGY

1. Secondary data that were collected nationally included information about the number of seed sources and seedling production (nurseries), wholesalers, retailers, plantations, timber markets, and wood factories. Data were collected from various government and private agencies, as well as from other media, such as the internet and roadside advertising boards, and were classified by type of enterprise. Furthermore, related research results on the financial analysis of investment in some other tree species, forest plantations, and agricultural crop

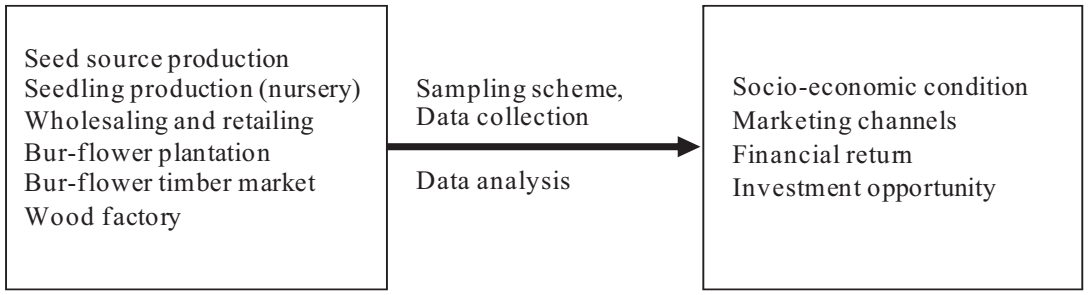

Figure 1 Research conceptual framework

cultivation were also collected for comparison of the financial return data.

2. Primary data collection included information on the socio-economic conditions of the entrepreneurs, production potential, costs, and product price, which occurred in each type of enterprise, as well as the entrepreneurs' attitudes toward Mai Taku. Then, a field survey was conducted using questionnaires specifically designed for the respondents in each focus group.

3. Data were analyzed based on the distribution of the relevant enterprises. In addition, the primary data obtained from interviewing the respondents were analyzed and coupled with the data obtained from the focus groups in order to determine the socio-economic conditions of the entrepreneurs, as well as the marketing potential of Mai Taku.

4. Financial analysis of the investment in Mai Taku utilized three methods:

1) Net Present Value (NPV), which was calculated on a per rai basis (1 rai = 1,600 m^2). Investment is feasible if NPV>0.

2) Benefit-Cost ratio (B/C), which was used to calculate the profitability, with investment profitable if B/C >1.

3) Annual Net Present Value (ANPV), which was calculated in terms of annual net profit. Hence, a sound project should provide ANPV>0. The ANPV can be computed by Equation 1: (Hoamuangkaew, 1985):

$$\text{ANPV} = \frac{NPV(0.0i)(1.0i)^t}{(1.0i^t - 1)} \qquad (1)$$

Where:

ANPV = annual net present value
NPV = net present value
i = interest rate
t = year 1,2,3,...n

5. The feasibility study on the investment in Mai Taku plantation was used to compare the return with the investment return of other economic plants, such as eucalypts, para rubber, cassava, sugarcane and maize, using available data from previous research by various sources.

6. Sensitivity analysis of the investment in Mai Taku was conducted to determine the feasibility of investment by changing various variables, such as seedling and timber price for given fixed interest rates.

RESULTS AND DISCUSSION

1. Current situation for the production and marketing system

Mai Taku was marketed under various names, such as "Mai Taku Yak" "Mai Taku Yai" "Mi Sak Kheiw" and "Mi Ma Ha Sed Tee". Based on a review of the literature and a comparison of physical characteristics, Mi Kra Thume was considered to be the correct common name. There are several regional native names for Mai Taku: Krong prayan (Yala), Kra thum bok (Bangkok), Kwang (Laos), Kowa (Trang), Khae saeng (Chon Buri), Taku (Chanthaburi, Nakhon Si Thammarat, Sukhothai),

Tako som (Chaiyaphum, Chon Buri), Tako yai (Trat), Thum phrai (Khon Kaen), Tum kan suang, Tum kan yao, Tum niang, Tum luang (Northern), Tum khi mu (Penisular), Pa-dae, Poe-dae, Sa-phrang (Karen-Mae Hong Son); and Pa-yae (Malay-Pattani) (Smitinand, 2001). Mai Taku is classified as a pioneer tree species that can be found in natural forest. It is easily regenerated and is a fast-growing tree species. A dominant characteristic of Mai Taku is the large branches extending to provide shade for the seedlings and saplings of other species in the natural forest. Thus, due to its early dominance, pioneer investors increased seedling production and widely promoted planting Mai Taku. Mai Taku planting promotion was first conducted in early 2007, using advertising boards along the roadsides, establishment of nurseries and planting demonstrations, advertisements on the internet and radio, preparation of contract planting by farmers, and demonstrations of wood utilization for construction. The research indicated that the most common pattern of advertising involved roadside boards containing the telephone number of the entrepreneur in the area of the targeted group. While the advertising boards were found in almost all provinces countrywide, they were most common in the northern, northeastern, eastern, and central regions; they were least common in the southern and western regions. The next most effective advertising pattern was through the internet. Data was collected from websites and analyzed in conjunction with the data obtained from the field surveys, in order to estimate the number of entrepreneurs involved in each type of Mai Taku business. The study indicated that in the period from 2006 to 2009, there were 12,406 entrepreneurs engaged in relevant types of Mai Taku business; most were involved in Mai Taku plantation (12,318), followed by seedling producers and sellers (68), timber buyers (12), seed sellers (6), and entrepreneurs with wood factories (2), respectively. A total of 34 entrepreneurs were randomly sampled by business type from all parts of the country. The distribution of sampled entrepreneurs by business type is summarized in Table 1.

1.1 Socio-economic conditions of entrepreneurs involved in Mai Taku businesses

The study indicated that most respondents were male, with an average age of 47 y, married and living with their spouse. Most of them were educated to diploma level. Agriculture was the main occupation of most respondents (22% of the total entrepreneurs), and the next largest groups were in private business, merchants and government officials, respectively, representing in total over half of all the entrepreneurs. Seedling production for sale was a subsidiary occupation for most respondents (63.64%). Moreover, most Mai Taku businesses were operated through an existing local seedling shop supplemented with Mai Taku seedlings. Normally, the seedling shop owners had Mai Taku plantation on their own land as a demonstration plot for their customers. Moreover, the annual household income of most entrepreneurs (47.06%) ranged from USD 7,146 to 10,719 (240,000 to 360,000 baht). Most respondents had a

Table 1 Sample number of entrepreneurs by type of Mai Taku business in 2009

Business type	Total number of entrepreneurs	Number of sample
Seed sellers	6	2
Seedling producers and sellers	68	11
Mai Taku plantations	12,318	17
Timber buyers	12	4
Wood factories	2	-
Total	**12,406**	**34**

Note: The number of Mai Taku growers was calculated by dividing the number of saleable seedlings by the average number of seedlings per sale (5,715,330/464 = 12,318 growers)

sufficient excess of annual household income over expenditure, with 53 percent of total entrepreneurs having average debt per household of USD 15,799 (530,625 baht). This information suggested that current Mai Taku entrepreneurs belong to medium-rich families.

1.2 Production system and marketing channel

The complete production system and marketing channels are represented in Figures 2 and 3, respectively. Figure 2 shows that the production system started from searching for a seed source and then proceeded to seedling production and distribution. The selling of seedlings could be broken into two patterns, namely seedling producers selling seedlings by themselves, or through a middle man. The middle men could be classified into two groups, namely the ones selling Mai Taku seedlings coupled with other seedling species and those selling only Mai Taku seedlings. Some small and big farming enterprises used seedlings produced by middle men. The next step was the timber market, which occurred in every part of the country; after the timber had been sold in the forest, it was transported to the wood factory. In the final step, the finished products were distributed to the customers. Figure 3 indicates that the marketing channel system of Taku timber has not been perfectly developed.

During 2006-2009, the production and marketing systems of Taku timber were only in the early stages of development, from seed production up to forest plantation, with most other activities not yet developed, including timber distribution to the wood industry for processing and the distribution of finished products to the ultimate consumers. This was mainly due to limited Mai Taku timber utilization. However, the marketing channel could be employed for explaining the detail of some characteristics of product distribution. There were six sources of seed production, with the important ones accounting for almost 80% of total production located in Sukhothai, Tak and Nan provinces. Seedlings were sold to existing seedling suppliers (middle men) in each area or directly to the farmer. There were 68 seedling suppliers distributed in three regions (in the north, northeast, and east). The largest source of seedling production was in Sukhothai province. In addition, the average cost of seedling production was USD 0.02/seedling (0.69 baht/seedling). A good quality seedling should be aged 4-6 months, have a height of 30 cm and have 6-8

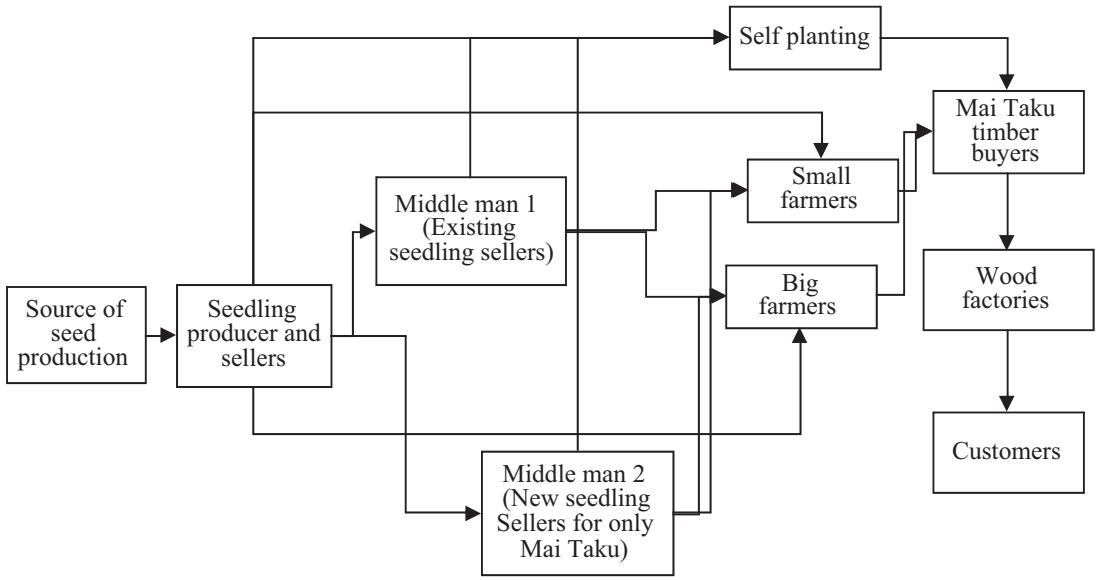

Figure 2 Production system of Mai Taku

leaves. A preferred seedling should have a yellow-green leaf color with a red stalk, rather than a yellow one, with a leaf:stalk ratio of 95:5. However, the importance of the difference between a red and a yellow stalk was not clear under the identification scheme. Two hypotheses can be suggested, namely: (1) Mai Taku with red stalks are different species from seedlings having yellow stalks; or (2) Mai Taku is a single species with young seedlings having yellow stalks which change to red as they age. Thus, a study on the anatomical characteristics of seedlings by an expert is necessary. The seedling wholesalers and retailers or middle men may only sell Mai Taku seedlings, but they played an important role in seedling distribution to Mai Taku growers. Normally, seedlings purchased from a middle man should have a higher price than seedlings purchased directly from a nursery because transportation cost and the desired profit margin would already have been added to the seedling price (USD 0.03-0.09/seedling, or 1-3 baht/seedling). In contrast, the price of delivery for seedlings was USD 0.09-0.15/seedling (3-5 baht/seedling), mainly due to the distance carted and the requirement for seedling orders to be at least 5,000 seedlings. Thus, it was common for some farmers to buy Mai Taku seedlings at the rather high price of USD 0.29-0.59/seedling (10-20 baht/seedling). In 2009, there were 12,318 farmers who had established Mai Taku plantation, covering an area of 5,195.68 ha (32,473 rai), distributed in every region of the country. The largest amount of Mai Taku plantation was found in the northeast followed by the north, east, central, and south. Moreover, some seedling customers came from the Lao Peoples' Democratic

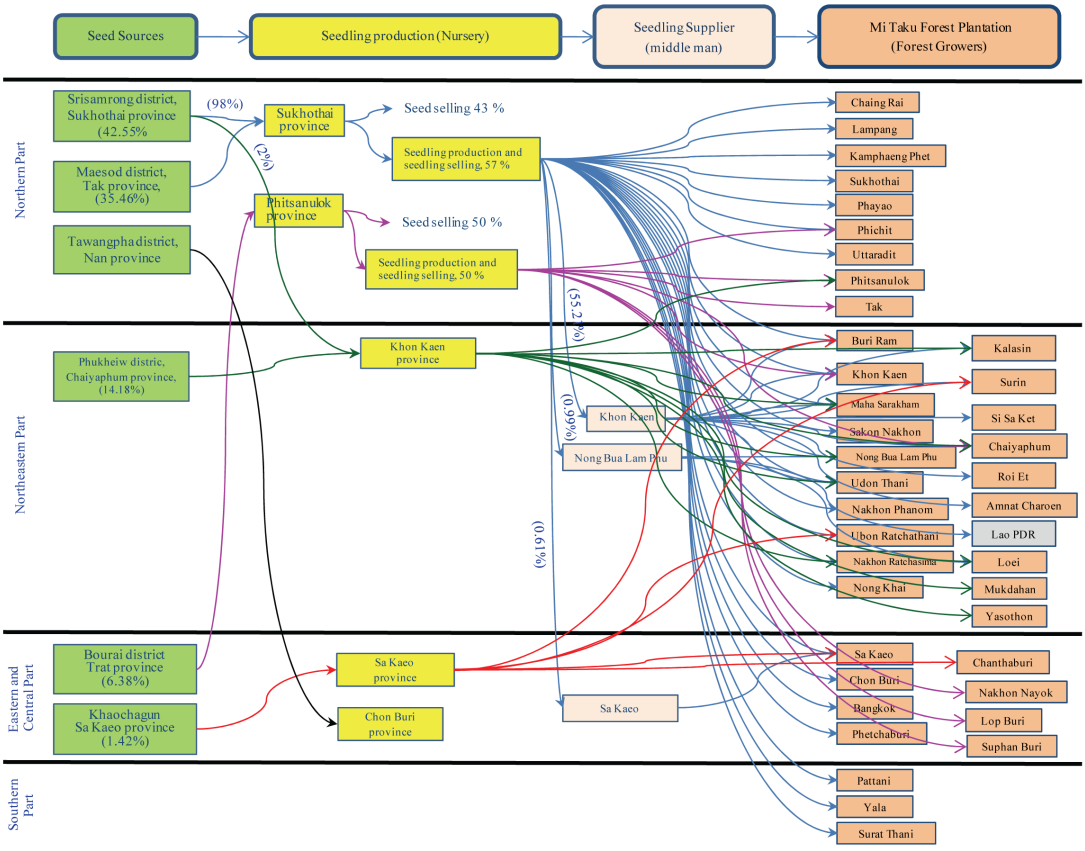

Figure 3 Marketing channels of Mai Taku from sample in 2009

Republic (Laos). There were several forest plantation patterns depending on grower preference, such as planting Mai Taku mixed with agricultural crops or other tree species in a large plot, or planting along fence lines. The objectives of the planted forests were: planting for shade and as a windbreak, leisure utilization, for expected high returns, and as an inheritance. Furthermore, over 90% of the total Mai Taku growers had no information about the timber market, and no one had a firm contract to sell their timber products.

The total value of the production system and marketing channels during 2006-2009 is presented in Table 2, indicating that the total monetary value in relevant enterprises was USD 15,691,183 (533,500,224 baht). This included seed, seedlings, and the forest plantation costs of about USD 11,275 (383,344 baht), USD 6,198,611 (210,752,790 baht) and USD 9,481,297 (322,364,091 baht), respectively.

2. Financial analysis of Mai Taku plantation

Based on the extension program for Mai Taku undertaken by private agencies through various media, the merchantable age for this species was 5 y and so this was used as the rotation age for the financial analysis. The results, especially the rate of return in terms of annual net present value (ANPV), were used in a comparison with the rate of return from the cultivation of other economic plants. According to the study, the average Mai Taku forest plantation cost in years one to five was: 1,511.09, 336.27, 189.82, 87.46, and 87.46 USD/ha or 8,120, 1,807, 1,020, 470, and 470 baht/rai, respectively. The forest plantation cost could be classified into three categories, namely opportunity cost, labor cost, and material cost. The timber production per rai for a rotation of 5 y was 16.75 m^3 or 8.375 tons, while the volume per rai at 2 y was 4.35 m^3 (Wanthongchai, 2009). The financial analysis results are shown in Table 3. In addition, the study on the growth rates of five tropical leguminous fuelwood species, namely *Calliandra calothyrsus* Meissn, *Acacia auriculiformis* A. Cunn. Ex Benth. *Sesbania grandiflora* (L.) Pers. *Leucaena diversifolia* (Schelecht.) Benth., *Leucaena leucocephala* (Lam.) de Wit., found the mean wood volume equivalent to be 1.97 2.05 6.00 7.50, and 7.58 m^3/rai at 2 y, respectively, (MacDicKen and Brewbaker, 1988). Thus Mai Taku could be classified as an intermediate fast-growing tree species.

Table 2 Summary of operational costs in complete system of Mai Taku production and marketing, 2009

Items related to seed production	Amount	Item related to seedling supply and forest plantation	Amount
Average quantity	10.07 kg/person	Average seedling production	160,154 seedling/nursery
Average price	6,344 baht/kg	Average seedling price	36.88 baht/seedling
Average value of sellable seed	63,891 baht/dealer	Average value	3,099,306 baht/nursery
Number of seed source	6 persons	Number of nurseries	68
Total seed production	60.43 kg	Total seedlings produced	10,890,491 seedlings
		Number of saleable seedlings	5,715,330 seedlings
Total value of seed (baht)	**383,344**	**Value of saleable seedlings (baht)**	**210,752,790**
Notes:			
• Spacing of 3×3 m was most common for forest plantations, therefore it was used as a representative spacing;		Average planting cost in the first grow:	9,927 baht/rai
		Total planted area:	32,473 rai
• Average number of saleable seedlings was about 52.48% of the total number of seedling produced;		**Total value of forest plantation (baht)**	**322,364,091**
• Currency exchange rate, 1 USD = 33.585 baht;		**Total capital value circulating in**	
• Area conversion rate 1, ha = 6.25 rai.		**the whole system (baht) =**	**533,500,224**

Table 3 Forest plantation cost and timber production per rai of Mai Taku plantation using a five-year rotation

Items	Forest plantation cost (baht/rai) in year:				
	1	2	3	4	5
Opportunity cost (land rent)	470	470	470	470	470
Labor cost:					
- Land preparation	200				
- Planting line and weeding	450	150	150		
- Replanting	83				
Material cost:					
- Seedling	6,490	325			
- Chemical fertilization 15-15-15	200	400			
- Manure	160	280	400		
- Chemical weed control	150	100			
Total	**8,120**	**1,807**	**1,020**	**470**	**470**
Timber production volume (m^3/rai)					16.75
Timber production in weight (ton/rai)					8.375

Note: the ratio between volume and weight of Mai Taku was 2:1 at age 5 y, weight = 8.375 ton/rai (Wanthongchai, 2009); Currency exchange rate, 1 USD = 33.585; Area conversion rate, 1 ha = 6.25 rai.

The net present value (NPV) and benefit-cost ratio (B/C) were used to evaluate the feasibility of investment in Mai Taku plantation. Four interest rates (4, 6, 8 and 10%) that covered the current interest rates of several commercial banks, two rates of forest plantation cost (5 and 10%) and three timber prices (11.91, 14.89 and 53.60 USD/ton or 400, 500, and 1,800 baht/ton) were used in the financial analysis. The study returned an NPV<0 and B/C<1 for every level of timber price, except when the timber price was USD 53.60 /ton (1,800 baht/ton). At this timber price, the NPV was greater than zero, indicating a profit; when the interest rate was 4% with fixed (not increasing) forest plantation costs, the NPV was USD 226.48 /ha (1,217 baht/rai). With the forest plantation cost increasing at 5 and 10% and under the former conditions, the NPV was USD 122.64 and 18.61/ha or 659 and 100 baht/rai, respectively. In addition, for an interest rate of 6 percent and forest plantation costs remaining fixed, the NPV reduced to USD 77.42/ha (416 baht/rai), as shown in Table 4.

At an interest rate of 6 percent, representing the actual rate of interest in the present monetary market, the breakeven point of the investment in a Mai Taku plantation with a rotation age of 5 y occurred only when the timber price was raised to USD 51.63/ton (1,734 baht/ton). Hence, the finding from this study was in conflict with the statement that "Mai Taku is an economical tree species that could provide the beauty of return" (Ratsameetamawong, 2008), because achieving a profit required the timber price to be higher.

3. The feasibility of the investment

A comparison was conducted among the returns in terms of the annual net present value (ANPV) obtained from investing in Mai Taku plantation and other economic plant species, namely eucalypt, para rubber, cassava, sugarcane, and maize because these other species are currently popular and can have several rotations on the same land area used for the Mai Taku plantation. The findings indicated that maize provided the maximum ANPV of 516.79 USD/ha (2,777 baht/rai) followed by para rubber,

Table 4 Net present value (NPV) and benefit cost ratio (B/C) of Mai Taku resulting from changes in interest rate, timber price and forest plantation cost

Age (year)	Increasing rate of forest plantation cost (%)	NPV (baht/rai) and B/C ratio at interest rate (%)							
		4		6		8		10	
		NPV	B/C	NPV	B/C	NPV	B/C	NPV	B/C
Mai Taku timber price = 400 baht/ton									
5	0	-8,420	0.25	-8,345	0.23	-8,263	0.22	-8,174	0.20
5	5	-8,978	0.23	-8,888	0.22	-8,790	0.21	-8,687	0.19
5	10	-9,537	0.22	-9,430	0.21	-9,317	0.20	-9,200	0.18
Mai Taku timber price = 500 baht/ton									
5	0	-7,731	0.31	-7,719	0.29	-7,693	0.27	-7,654	0.25
5	5	-8,290	0.29	-8,262	0.27	-8,220	0.26	-8,167	0.24
5	10	-8,849	0.28	-8,804	0.26	-8,747	0.25	-8,680	0.23
Mai Taku timber price = 1,800 baht/ton									
5	0	1,217	1.11	416	1.04	-283	0.97	-894	0.91
5	5	659	1.06	-126	0.99	-810	0.93	-1,407	0.87
5	10	100	1.01	-668	0.94	-1,337	0.88	-1,919	0.83

Note: Currency exchange rate, 1 USD = 33.585; Area conversion rate, 1 ha = 6.25 rai.

sugarcane, cassava, and eucalypt, with values for ANPV of 502.83, 303.52, 178.65 and 169.16 USD/ha or 2,702, 1,631, 960 and 909 baht/rai, respectively. The ANPV of Mai Taku was 340.93 USD/ha (1,832 baht/rai), indicating that growing Mai Taku would result in a loss of USD 340.93/ha/y (1,832 baht/rai/y). The detailed findings are presented in Table 5 and Figure 4, which show that it was not economically feasible to invest in Mai Taku plantation under the current economic situation. However, Mai Taku plantation could become plausible if either the Mai Taku seedling price were less than the current average price of USD 1.10/seedling (36.88 baht/seedling), or the sale price of timber were higher than USD 14.89/ton (500 baht/ton). A comparison between the ANPV from an investment in Mai Taku plantation and an investment in *Melaleuca cajuputi* plantation, using a ten-year rotation, medium site quality, and an interest rate of 6 percent, indicated that the *Melaleuca cajuputi* plantation would still provide an ANPV of USD 2.05/ha (11 baht/rai) (Hoamuangkaew, 2004). The income received from Mai Taku plantations clearly depended on only timber price. This is similar to the situation for several tree species in Thailand and other countries. For example Sengon in Indonesia is not widely planted outside Java, because Sengon timber does not have much value compared to other native timber there, such as Dipterocarp species (Siregar *et al.*, 2007).

4. Sensitivity analysis of Mai Taku plantation

Analysis was carried out changing both the seedling and timber price; the seedling price started at USD 2.98/seedling (100 baht/seedling) and was reduced to USD 0.03/seedling (1 baht/seedling), while the timber price changed from 11.91 to 59.55 USD/ton (400 to 2,000 baht/ton) and other variables remained fixed. At an interest rate of 6 percent, the timber price was USD 14.89/ton (500 baht/ton), and for a five-year rotation, the NPV at every seedling price level (even at 1 baht/seedling) was less than zero (Table 6). On the other hand, when the timber price was raised to USD 23.82/ton (800 baht/ton), the

Table 5 Annual net present value (ANPV) comparison among three economic tree species and three cash crop species in 2009

Species	Harvesting year	NPV(baht/rai)	ANPV(baht/rai)
Mai Taku	5	-7,719	-1,832
Eucalypt	5	3,828*	909
Para rubber	25	34,539*	2,702
Cassava	1	906**	960
Sugarcane	1	1,539**	1,631
Maize	1	2,620**	2,777

Note: interest rate = 6%; Mai Taku timber price = 500 baht/ton; eucalypt timber price = 800 baht/ton.
Currency exchange rate, 1 USD = 33.585; Area conversion rate, 1 ha = 6.25 rai;
Source: * data from the Forest Industry Organization (FIO) 2008; ** Sunthornhao (2008).

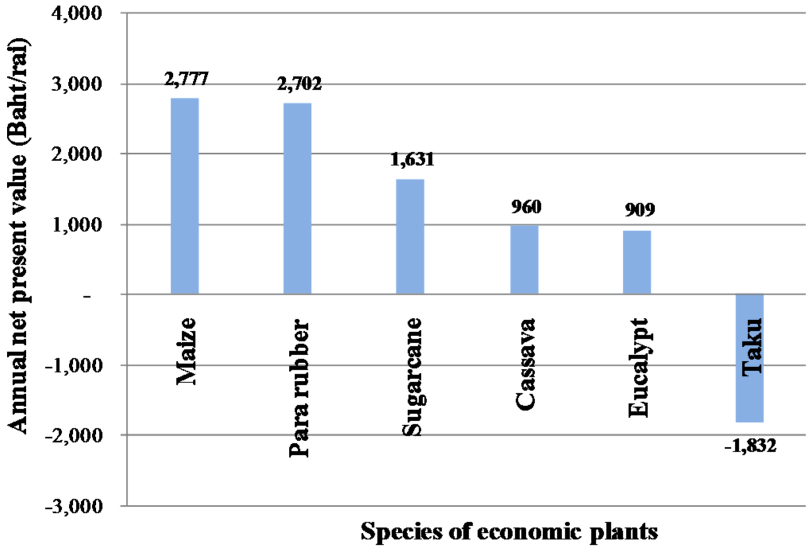

Figure 4 Comparison among annual net present values (ANPV) of six economic plant species

Table 6 Net present value (NPV) of Mai Taku with five-year rotation and a 6% interest rate for different timber prices (baht/ton), and timber values(baht/rai), seedling prices (baht/seedling) and forest plantation costs (baht/rai). Green cells represent a positive NPV

Seedling price (baht/ seedling)	Present value of forest plantation cost per rai for 5 year rotation (baht/rai)	NPV (baht/rai) by timber price (baht/ton) and timber value (baht/rai)											
		400	500	600	700	800	900	1,000	1,200	1,400	1,600	1,800	2,000
		3,350	4,188	5,025	5,863	6,700	7,538	8,375	10,050	11,725	13,400	15,075	16,750
100	21,824	-19,321	-18,695	-18,069	-17,443	-16,817	-16,192	-15,566	-14,314	-13,062	-11,811	-10,559	-9,307
75	17,477	-14,974	-14,348	-13,722	-13,096	-12,471	-11,845	-11,219	-9,967	-8,716	-7,464	-6,212	-4,961
50	13,131	-10,627	-10,001	-9,376	-8,750	-8,124	-7,498	-6,872	-5,621	-4,369	-3,117	-1,866	-614
25	8,784	-6,280	-5,655	-5,029	-4,403	-3,777	-3,151	-2,526	-1,274	-22	1,229	2,481	3,733
20	7,914	-5,411	-4,785	-4,159	-3,534	-2,908	-2,282	-1,656	-405	847	2,099	3,350	4,602
15	7,045	-4,542	-3,916	-3,290	-2,664	-2,038	-1,413	-787	465	1,716	2,968	4,220	5,471
10	6,176	-3,672	-3,047	-2,421	-1,795	-1,169	-543	83	1,334	2,586	3,837	5,089	6,341
5	5,306	-2,803	-2,177	-1,551	-926	-300	326	952	2,204	3,455	4,707	5,959	7,210
2	4,785	-2,281	-1,656	-1,030	-404	222	848	1,473	2,725	3,977	5,228	6,480	7,732
1	4,611	-2,108	-1,482	-856	-230	396	1,022	1,647	2,899	4,151	5,402	6,654	7,906

Note: Currency exchange rate, 1 USD = 33.585 baht; Area conversion rate, 1 ha = 6.25 rai.

NPV became positive at USD 73.69/ha (396 baht/rai), and this decreased to USD 41.31/ha (222 baht/rai) when the seedling price increased to USD 0.06/seedling (2 baht/seedling). When the timber price increased to USD 59.55/ton (2,000 baht/ton), for seedling prices of 0.03, 0.06, 0.15, 0.30, 0.45, 0.60, and 0.75 USD/seedling or 1, 2, 5, 10, 15, 20, and 25 baht/seedling, the NPV was 1,471.27, 1,438.89, 1,341.74, 1,180.03, 1,018.13, 856.41, and 694.69 USD/ha or 7,906, 7,732, 7,210, 6,341, 5,471, 4,602, and 3,733 baht/rai, respectively. The results of the sensitivity analysis will be useful for entrepreneurs to apply in decision making with uncertainty in future scenarios.

CONCLUSION

Mai Taku is known by several common names, such as "Mai Taku Yak", "Mai Taku Yai", "Mi Tum Luang", "Mi Sak Khiew" and "Mi Ma Ha Set Tee". The accepted dominant characteristics of this species are that it is fast growing and is a pioneer tree species in natural forest that rapidly regenerates. Hence, advertisements to grow the tree as a forest plantation were a relatively easy way to encourage widespread forest plantations in a very short period. The current processes of production and marketing of Mai Taku have not yet been completely developed because of the lack of a timber market. However, the production stage from seed production to forest plantation has been developed. The total monetary value involved in related activities was about USD 15,691,183 (533,500,224 baht), including the value of seed, seedlings, and forest plantations amounting to USD 11,275 (383,344 baht), USD 6,198,611 (210,752,790 baht), and USD 9,481,297 (322,364,091 baht), respectively. The conceptual framework of Francisco and Pabuayon (1993) was applied to develop an integrated marketing system for the forest project and the findings indicated that a forestry extension project could achieve its goals, if the production and marketing system were efficiently implemented at every step, as shown in Figure 5. In fact, the activities relating to any Mai

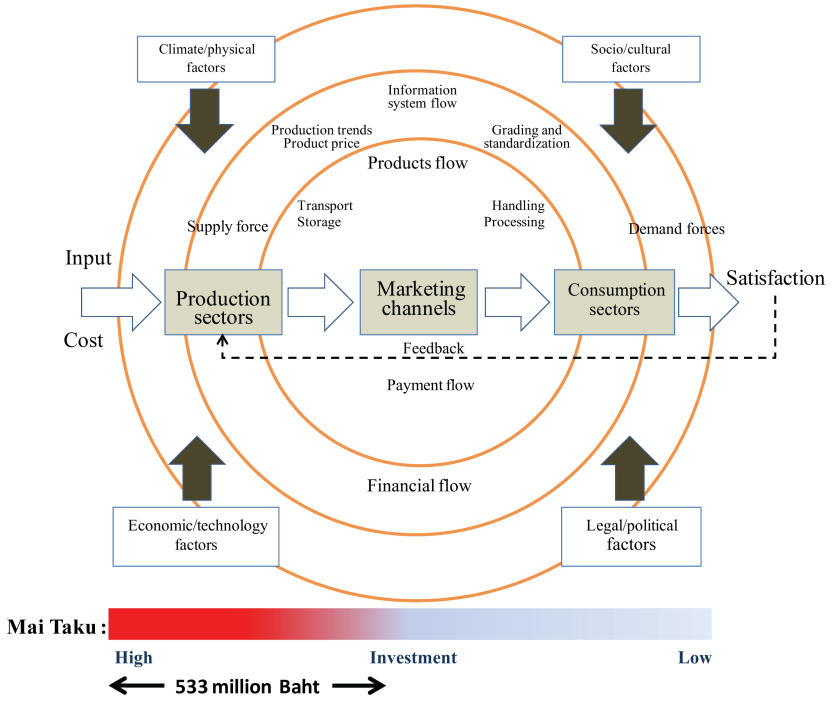

Figure 5 Comparison of the production and marketing system of Mai Taku with a general forest enterprise

Taku enterprise that were clearly in operation were only seed and seedling production up to forest plantation establishment. Thus, it is becoming urgent to evaluate in detail the market for absorbing timber production as soon as possible. The financial analysis of Mai Taku forest plantation indicated that when the interest rate was 6% and the forest plantation cost was fixed, the breakeven point required a timber price of USD 51.63/ton (1,734 baht/ton). Furthermore, under the same conditions, the return from growing a Mai Taku plantation could not compete on an economic basis with the cultivation of other economic plants, such as maize, para rubber, sugarcane, cassava, and eucalypt. Sensitivity analysis of parameters associated with growing Mai Taku in a forest plantation indicated that, at a current actual timber price of USD 14.89/ton (500 baht/ton), even with the seedling price decreased to USD 0.03/seedling (1 baht/seedling), it was still impossible to make a profit. This would make it very difficult to develop these activities further as a sustainable business. It can be concluded that the marketing potential of Mai Taku is rather low, but its potential in environmental rehabilitation is accepted because of it is a fast-growing tree species with a large leaf area. Thus, it is suitable for providing shade for tolerant species during their early growing stages, to assist soil and water conservation, as well as to mitigate ecosystem degradation. A weak point in the prospective marketing of Mai Taku is the lack of a market to absorb timber production at an industrial scale. However, if the quality of finished products of Mai Taku could be improved and be widely accepted by users and its production potential was great enough, then Mai Taku could become a new, alternative, economic tree species. Furthermore, if the system for the promotion of Mai Taku were to be efficiently implemented, it could rapidly reach targeted groups. Therefore, the agencies responsible for establishing forest plantations should concentrate on a proper system of promotion to implement a forestry extension program, once the potential of every aspect of such a tree species has been determined in detail. In addition, the development of Mai Taku finished products is needed in order to create a market to absorb Mai Taku timber in the near future, because at present, there are more than 10,000 growers and their established plantations cover an area of more than 5,000 hectares. Under the current situation, Mai Taku forest plantation is not considered to be a viable investment enterprise. However, it is a suitable species to grow for shading light intolerant tree species and accelerating their growth rates. Thus, Mai Taku is a suitable tree species for environmental quality improvement.

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