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# Tapioca Sub-sector Strategy

**Thai-German Programme for**
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# Table of Content


1. Background 4

2. Importance of the Tapioca Industry 6

3. Market and Competition 11

4. Global Market for Starch and Starch Products 18

5. TG-PEC Tapioca Sub-sector Strategy 20

6. Tapioca Sub-sector Interventions 23

7. List of Agencies, Organizations, Associations and Institutes 39


## Tables


Table 1: Summary of Thailand's Tapioca Production 6

Table 2: Plantation Area of Tapioca in Each Thai Province (2002 – 2005) 8

Table 3: World Tapioca Production 13

Table 4: Distributions of Native Starch Factories in Thailand 16

Table 5: Contributions of TG –PEC's interventions to addressed issues from each stakeholder 26


## Figures


Figure 1: Thai German Programme for Enterprise Competitiveness's structure 5

Figure 2: Tapioca Value Chain Map 8

Figure 3: Country Map Showing the Provinces Where Tapioca is Grown in Different Scales 10

Figure 4: Distribution of Land Holding of Tapioca Growers 11

Figure 5: Flow of Tapioca Roots for Industrial Processing, 2005 12

Figure 6: Price and Fresh Root Production Output in Comparison 14

Figure 7: Inflation adjusted average income per kg/root 15

Figure 8: Native Starch Factory Distributions 16

Figure 9: Locations of Native Starch Factories in Thailand 17

Figure 10: World Starch and Starch Products Demand 19

Figure 11: Prices of Starch in Taiwan 19

Figure 12: The Synergy and Links between TG-PEC, Thai Partner Organizations, Projects and TG-PEC Goal 24

## Appendixes

Brief Intervention Appendix 28

Brief Proposal Appendix 35

# Tapioca Sub-sector Strategy

## 1. Background

German Technical Cooperation (GTZ) has a track record of 30 years of successful cooperation with Thailand. In response to Thailand's economic progress, GTZ together with the Royal Thai Government is now focusing its portfolio on strengthening the competitiveness of Thai Small and Medium-sized Enterprises (SMEs) particularly those in the agro-industry sector. This is a multi-partner programme that works with a wide range of private and public agencies interested in developing competitiveness in the selected agro-enterprise sectors. In order to cope with international environmental standards, GTZ places a special emphasis on introducing enterprises to eco-efficient technologies as a way to sustain the country's industrial resource basis and to enhance its competitiveness in international markets.

In Thailand, high important is attached to promoting SMEs. There are many public and private sector promotion programme which provide services aimed at making SMEs more competitive. The impact on the target group however is often sub-optimal not only because they are frequently implemented in an uncoordinated fashion but also because they are often driven by what the promoters can supply rather than what is demanded by SMEs. Based on an emerging set of best practices derived from international experience in enterprise promotion, the Thai-German Programme for Enterprise and Competitiveness (TG-PEC) is concentrating its activities on selected SME sectors or clusters that are potentially competitive and that have impact on income and employment growth. With this focus the programme will be able to assist in the coordination of sector based development efforts supplied by private service providers, business membership organizations and other public support agencies. Through harmonizing and sequencing intervention with a wide range of partners, the programme expects to achieve greater impact on sector competitiveness.

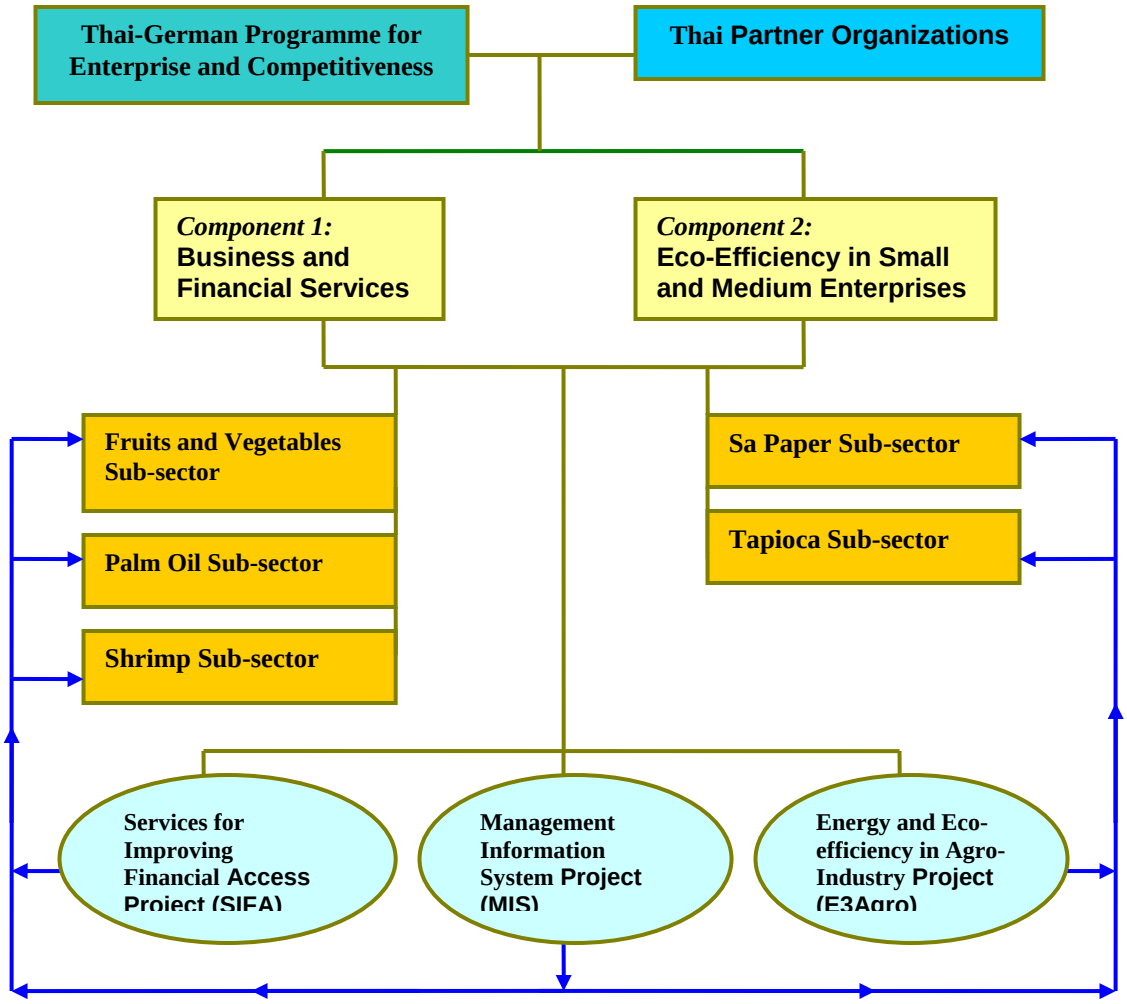
The TG-PEC consists of two components which one component is focusing on improving the access of SMEs to better business services (Business and Financial Services component) and the other on stimulating the eco-efficiency of industry (Eco-efficiency in Small and Medium Enterprises component). In addition, the both components are also complemented

by specialized projects on energy efficiency (E3agro project), management information system (MIS project) and financing services (SIFA project).

In terms of programme achievements and indicators, the programme's impact will be measured by the changes in SMEs competitiveness. Specifically, the programme will focus on four aspects of the followed competitiveness of:

- ***Productivity*:** improves productivity of labor, capital and energy
- ***Capacity:*** better business performance in terms of increased market shares and profitability
- ***Innovation:*** the introduction of successful innovations
- ***Resource efficiency:*** Increased use of environmentally sustainable production processes

**Figure 1: Thai German Programme for Enterprise Competitiveness's structure**




## 2. Importance of the Tapioca Industry

For Thailand, tapioca sub-sector is very important. In 2005, with the planted area of 6.5 million rai, it generated 25,000 million baht in farm income and 33,000 million baht in export value with the world market share of 85 %. (The summary of recent figures can be seen in table 1.)

It is also large and diverse. Tapioca is an important raw material that used in many industries such as Animal Feed, Alcohol, Food and Beverage, Sweetener, Textile, Paper, Glue, Plywood, MSG and Lysine, Medical and Biodegradable Materials. Historically, the flow of the

tapioca roots goes mainly through two channels: brokers/chippers and starch factories. **In 2005, 41 % of the root was used for chip production and 59 % for starch production. The local requirement in terms of root supply is only 28 % while the rest is for export in either form of chip/pallet or starch.** However, with the expansion of ethanol plants recently, it will add an additional important channel to the flow. The current value chain map can be seen in Figure 2.

**Table 1: Summary of Thailand's Tapioca Production**

| | 2003 | 2004 | 2005 |
|---|---|---|---|
| Number of Households | 486,123 | 487,088 | 464,956 |
| Planted Area (Mill. Rai) | 6.44 | 6.76 | 6.52 |
| Harvested Area (Mill. Rai) | 6.39 | 6.61 | 6.16 |
| Production (Mill. Ton) | 19.72 | 21.44 | 16.94 |
| Yield/Planted Area (Kgs./Rai) | 3,064 | 3,173 | 2,596 |
| Production Cost (Baht/Ton) | | | |
| - Total production cost | 747 | 740 | 995 |
| - Variable Cost | 638 | 635 | 867 |
| Farm Price (Baht/Ton) | 930 | 940 | 1,490 |
| Net Earning (Baht/Rai) | 562 | 633 | 1,285 |
| (Baht/Ton) | 183 | 200 | 495 |
| **Total Farm Income (Mill. Baht)** | **18,337** | **20,154** | **25,238** |
| **Total Net Earning to Farmers (Whole Kingdom, Mill. Baht)** | **3,613** | **4,279** | **8,381** |
| **EXPORTS:** | | | |
| - Tapioca Chip Export (Mill.Baht) | 5,353 | 8,641 | 11,939 |
| - Tapioca Pellet Export (Mill.Baht) | 5,096 | 6,391 | 838 |
| - Tapioca Starch Export (Mil.Baht) | 16,215 | 15,697 | 20,150 |
| **Total Export Value of Tapioca Products (Mill. Baht)** [1] | **26,664** | **30,729** | **32,927** |

Source: Office of Agricultural Economics,
1/Thai Customs Department & The Thai Tapioca Trade Association

Due to the structure of the sub-sector, it also provides a great opportunity for improving income of poor people and competitiveness of the SMEs. In the primary production which involved almost 500,000 households, it is mainly composed of small-holders with the holding of less than 40 rai per household. The distribution of the holding area can be seen in figure 4. In addition, more than 50 % of the plantation is in the northeast which is the poorest area. Tapioca has relatively high drought tolerance which make it the only choice for many areas in that region.

For the downstream industry, they are also composed mainly of small and medium sized enterprises. Even in the starch industry, out of 85 native starch factories, 52 factories are small scale with machine capacity below 5,000 HP, 26 factories are medium size with the capacity between 5,001-10,000HP and only 7 factories that have the capacity of over 10,000 HP. (Tapioca starch industry in Thailand covers three types of production, which are: native starch production; modified starch production; and starch derivatives production. Modified starch and starch derivatives productions are usually invested by big scale and influential investors. The TG-PEC will focus its activities only on native starch industry which is comprised of many small and medium SMEs.)

***Noted:*** *Tapioca is known by various names in different regions of the world. It is called "tapioca" in Asia, "manioc" in Africa and "manioca", "yucca" and "mandioca" in South America. In Europe and the USA, "cassava" is the term usually applied to the roots, and "tapioca" is the name given to the starch and other processed products.*

*In this report, "tapioca" refers to the roots harvested for further processing, starch and other processed products.*

**Figure 2: Tapioca Value Chain Map**

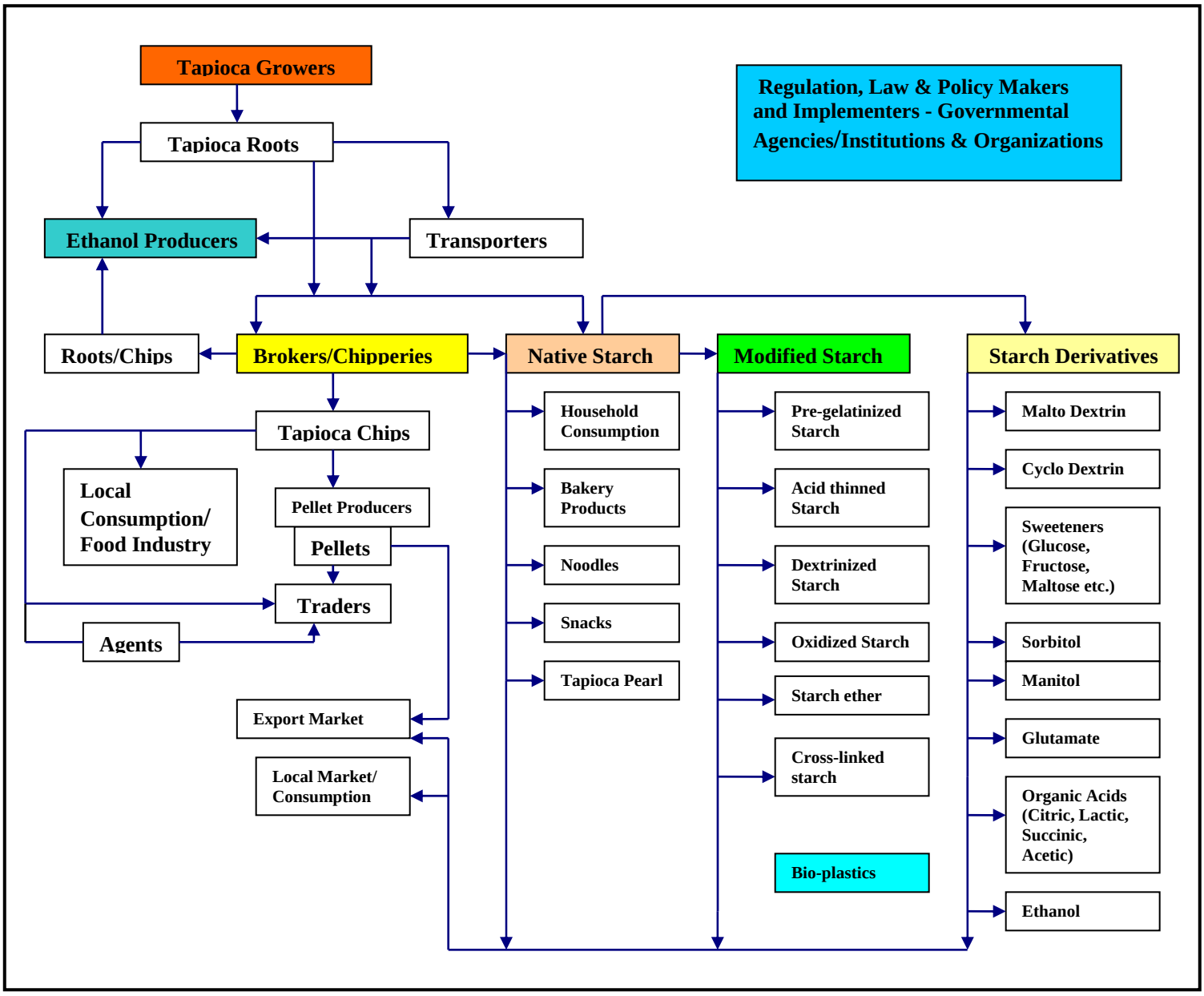



**Table 2: Plantation Area of Tapioca in Each Thai Province (2002 – 2005)**

| Region | Tapioca Plantation Location | Plantation Area (Rai) | | | |
|---|---|---|---|---|---|
| | | 2002 | 2003 | 2004 | 2005 |
| Northeast | Nakhon Ratchasima | 1,320,722 | 1,353,734 | 1,396789 | 1,470,924 |
| | Chaiyaphum | 358,051 | 388,228 | 417,591 | 348,674 |
| | Kalasin | 289,332 | 297,284 | 304,080 | 295,524 |
| | Khon Kaen | 237,698 | 245,904 | 271,652 | 190,700 |
| | Buriram | 173,076 | 179,305 | 183,123 | 194,149 |
| | Loey | 129,807 | 142,203 | 171,667 | 132,955 |
| | Roi Ed | 122,221 | 130,281 | 134,849 | 104,102 |
| | Udonthani | 120,099 | 130,858 | 140,129 | 145,740 |
| | Mahasarakham | 104,311 | 118,875 | 125,930 | 111,055 |

| Region | Tapioca Plantation Location | Plantation Area (Rai) | | | |
|---|---|---|---|---|---|
| | | 2002 | 2003 | 2004 | 2005 |
| | Mukdahan | 85,233 | 90,352 | 92,671 | 102,953 |
| | Ubon Ratchathani | 70,954 | 75,067 | 79,803 | 68,765 |
| | Sakon Nakhon | 63,529 | 65,093 | 70,498 | 66,689 |
| | Nongkhai | 55,180 | 58,958 | 65,787 | 44,417 |
| | Sri Saket | 43,566 | 47,711 | 51,379 | 53,344 |
| | Surin | 42,381 | 43,137 | 45,981 | 36,757 |
| | Yasothorn | 39,711 | 41,699 | 42,383 | 43,634 |
| | Nhongbualamphoo | 36,121 | 38,629 | 51,481 | 38,566 |
| | Amnaj Chareon | 31,289 | 30,558 | 34,619 | 31,411 |
| | Nakhon Phanom | 16,465 | 16,570 | 18,649 | 12,270 |
| East | Chacheonsao | 362,537 | 365,636 | 366,332 | 314,540 |
| | Chonburi | 297,705 | 303,117 | 312,969 | 275,620 |
| | Chanthaburi | 229,813 | 229,779 | 238,937 | 223,213 |
| | Rayong | 209,628 | 215,918 | 213,540 | 227,046 |
| | Trad | 7,212 | 4,128 | 3,676 | - |
| Central | Srakaew | 339,090 | 345,873 | 362,728 | 356,914 |
| | Kanchanaburi | 202,548 | 209,472 | 230,613 | 248,796 |
| | Uthaithani | 150,217 | 161,622 | 171,827 | 179,084 |
| | Prachinburi | 107,569 | 112,499 | 117,917 | 147,909 |
| | Ratchaburi | 92,717 | 99,213 | 102,829 | 90,805 |
| | Chainath | 63,571 | 66,498 | 74,394 | 68,993 |
| | Lopburi | 55,956 | 63,328 | 78,108 | 89,828 |
| | Suphanburi | 17,963 | 23,578 | 27,141 | 26,181 |
| | Saraburi | 8,277 | 9,439 | 10,682 | 20,304 |
| | Petchburi | 3,811 | 4,373 | 4,685 | 3,204 |
| North | Kampangpetch | 348,648 | 323,531 | 330,985 | 371,145 |
| | Pisanuloke | 185,341 | 186,705 | 183,599 | 147,337 |
| | Nakhon Sawan | 146,614 | 154,807 | 164,506 | 188,277 |
| | Petchabul | 22,695 | 25,253 | 26,884 | 21,482 |
| | Chiangrai | 16,190 | 18,108 | 19,013 | 4,596 |
| | Uttaradith | 4,798 | 5,181 | 5,553 | 11,102 |
| | Pichit | 4,108 | 4,544 | 3,312 | 3,507 |
| | Nan | 4,082 | 4,336 | 4,410 | 5,985 |
| | Prae | 998 | 1,062 | 1,230 | 1,515 |
| | Tak | 853 | 1,113 | 1,119 | 1,894 |
| | Sukhothai | 560 | 622 | 624 | 823 |
| | Payao | 383 | 434 | 460 | 538 |
| | Lampang | 234 | 283 | 280 | 630 |

Source: Agricultural Economics Office, Ministry of Agriculture and Cooperatives, 2005 (cited in E3Agro Tapioca Starch Desk Study, 2006)

**Figure 3: Country Map Showing the Provinces Where Tapioca is Grown in Different Scales.**

***Source: MIS, Thomas Spehs***

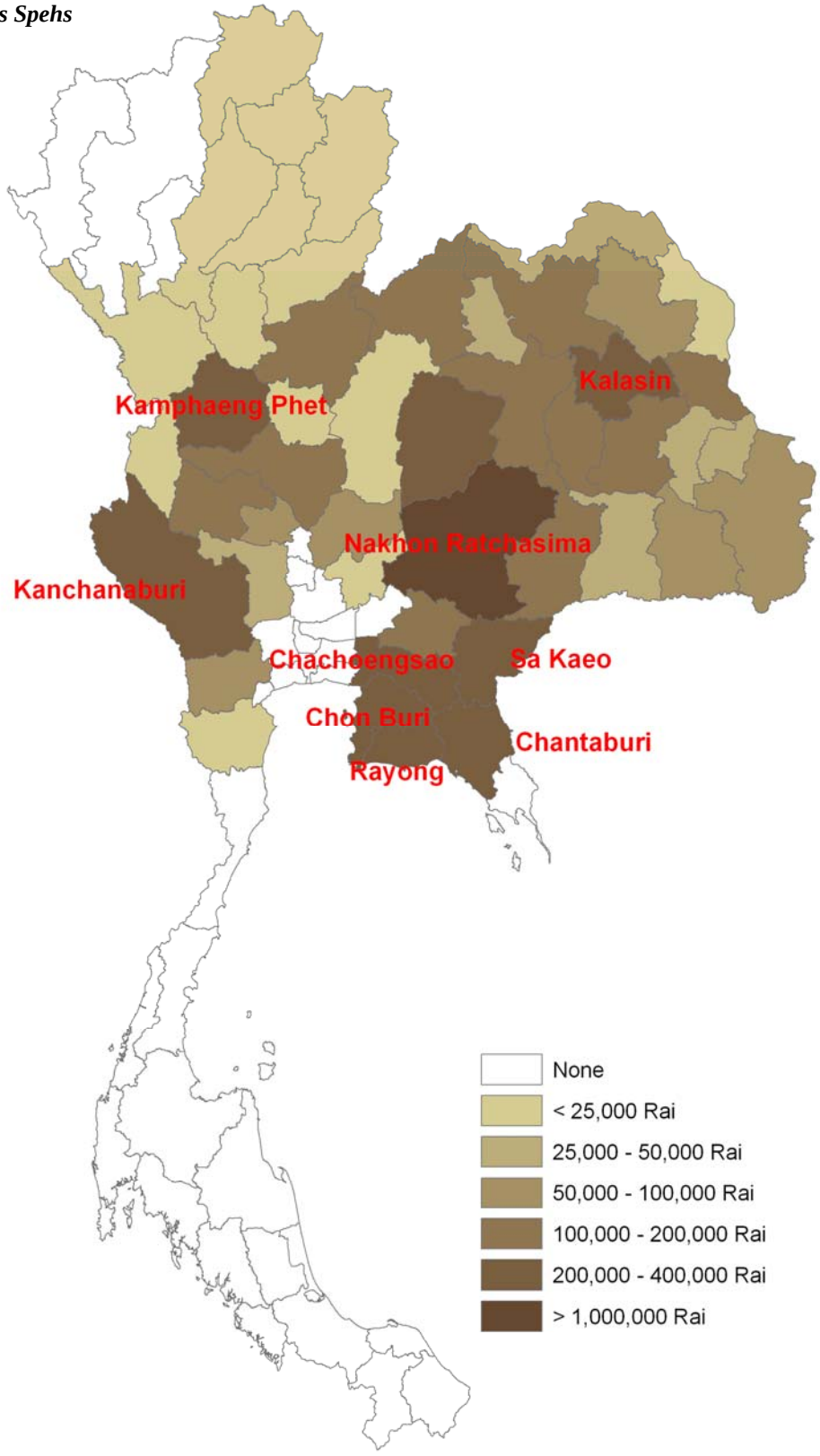
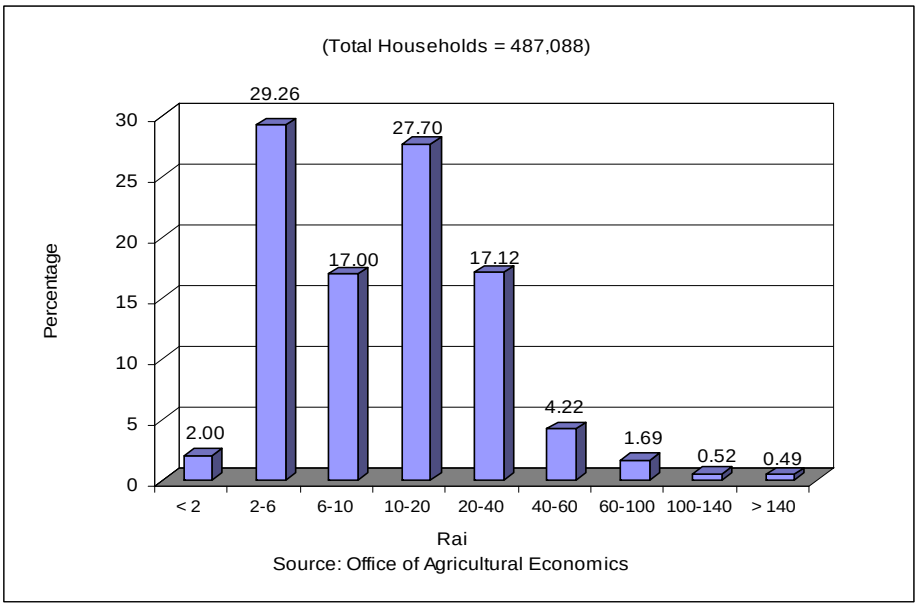


**Figure 4: Distribution of Land Holding of Tapioca Growers**




## 3. Market and Competition

As mentioned in the above section, currently, there are three major channels for tapioca roots: Chips/Pallets, Starch and Ethanol. Prior to the establishment of the ethanol plants, **in 2005, 41% (around 7 mill. metric Ton) of roots was used for producing chips and 59 % (around 10 mill. metric ton) for starch. Supply of the roots was sufficient to serve both industries.**

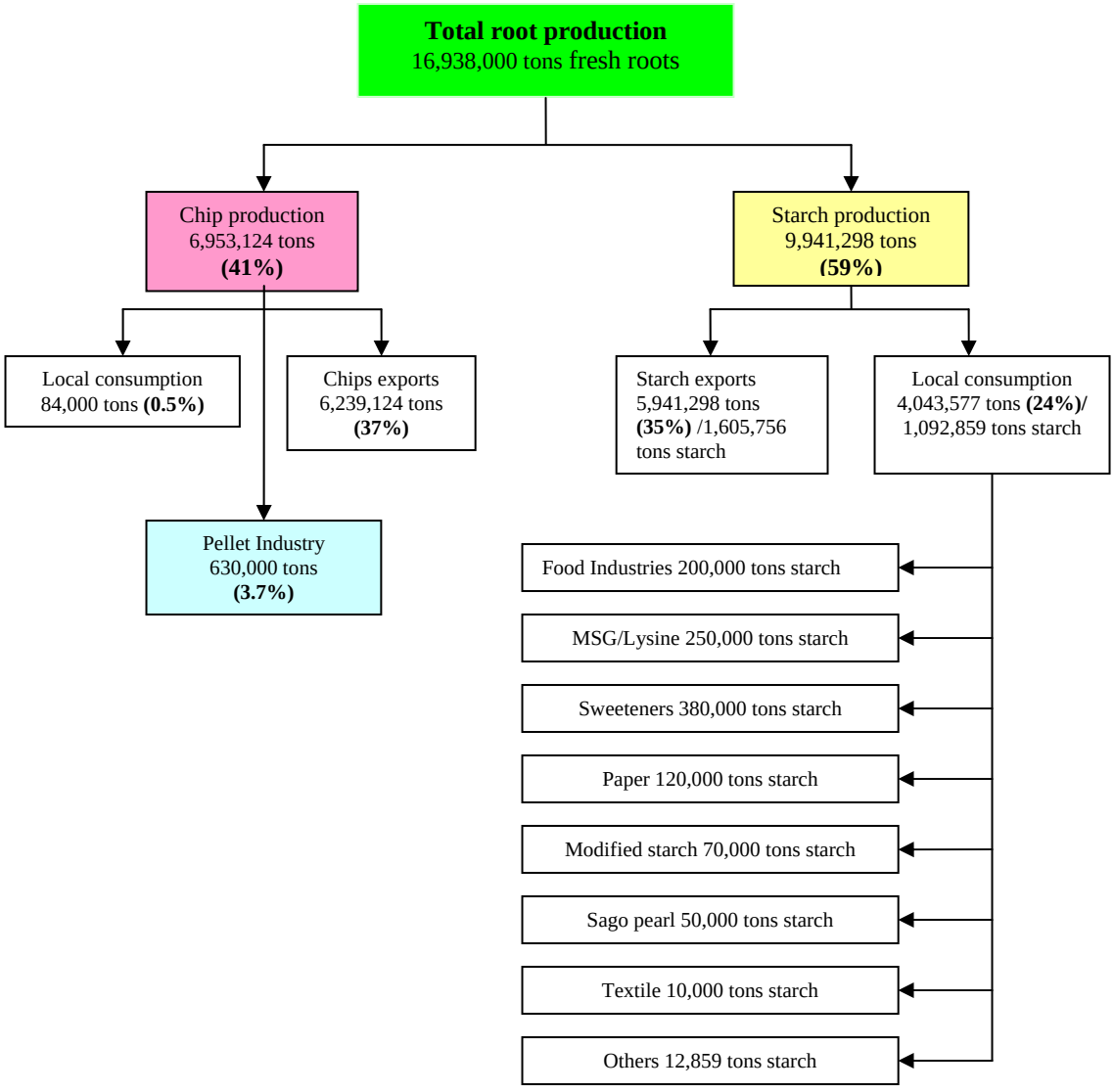
However, new ethanol plants will compete for the root supply and will alter the demand and supply situation. Incumbents in both chips and starch industries are expected the shortage of roots and claims that it will hurt the industries and the economy as well.

However, this might not be the case.

Although Thailand export of tapioca chips was grown considerably from only 1 mil. Ton (2,700 mil. Baht) in 2001 to 2.8 mil. Ton (12,000 mil. Baht) in 2005, nearly all of that goes to China's edible alcohol production. The figure might look fantastic. However, it does not in terms of added value. The added value per ton of root for chip production is only 324 baht per ton while higher added value can be generated from native starch (830 baht per ton), modified starch (1,202 baht per ton) or ethanol (2,510 baht per ton). Generally, it will be benefit the country more if the roots are used for producing higher value added products while using the chip market for balancing the excess supply.

In terms of starch, tapioca starch is the mostly traded starch in the world and it is also the most competitive in terms of price. This is due to the fact that tapioca starch is considered as the best raw material for starch production. Tapioca root contains high starch content and very low quantities of impurities. In addition, tapioca starch can be used in wide range of applications due to its tasteless, odourless and colourless properties. World import volume of native tapioca starch has grown considerably for more than 10 times from 1996 to 2004.

**Figure 5: Flow of Tapioca Roots for Industrial Processing, 2005**




Source: AgriSource's estimate modified from The Thai Tapioca Trade Association Year Book 2004
(Based on Data from Ministry of Agriculture and Cooperatives & The Customs Department)

Note: a) Tapioca Roots Conversion Ratio

| | |
|---|---|
| 1 kg of chips | : 2.2-2.35 kg of tapioca roots |
| 1 kg of pellets | : 2.5-3 kg of tapioca roots |
| 1 kg of starch | : 3.5-4 kg of tapioca roots |

b) Imports of modified starch in 2005: 10,071 tons

**Table 3 World Tapioca Production**

| Country | Harvested Area (1,000 rai) | | | Production (1,000Tons) | | | Yield per Rai (Kgs.) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2003 | 2004 | 2005 | 2003 | 2004 | 2005 | 2003 | 2004 | 2005 |
| **World Total** | **109,933** | **111,690** | **116,440** | **191,310** | **196,541** | **203,863** | **1,740** | **1,760** | **1,751** |
| Nigeria | 21,875 | 21,875 | 25,738 | 33,379 | 33,379 | 38,179 | 1,526 | 1,526 | 1,483 |
| Brazil | 10,286 | 11,130 | 12,082 | 22,147 | 24,230 | 26,645 | 2,153 | 2,177 | 2,205 |
| Indonesia | 7,748 | 8,036 | 7,648 | 18,474 | 19,197 | 19,459 | 2,384 | 2,389 | 2,544 |
| Thailand [1] | 6,386 | 6,608 | 6,162 | 19,718 | 21,440 | 16,938 | 3,087 | 3,244 | 2,749 |
| Congo | 11,875 | 11,875 | 11,534 | 14,945 | 14,951 | 14,974 | 1,259 | 1,259 | 1,298 |
| Ghana | 5,045 | 5,119 | 4,899 | 10,239 | 9,828 | 9,739 | 2,030 | 1,920 | 1,988 |
| India | 1,688 | 1,688 | 1,500 | 7,100 | 7,100 | 6,700 | 4,206 | 4,206 | 4,467 |
| Tanzania | 4,125 | 4,125 | 4,188 | 6,890 | 6,890 | 7,000 | 1,670 | 1,670 | 1,672 |
| Mozambique | 6,535 | 6,535 | 6,563 | 6,150 | 6,150 | 6,150 | 941 | 941 | 937 |
| Angola | 4,024 | 4,000 | 4,679 | 5,699 | 5,600 | 8,606 | 1,416 | 1,400 | 1,839 |
| Vietnam | 2,324 | 2,398 | 2,438 | 5,310 | 5,573 | 5,700 | 2,284 | 2,325 | 2,338 |
| Others | 30,346 | 30,699 | 31,448 | 46,569 | 47,776 | 49,473 | 1,535 | 1,556 | 1,546 |

Source: Food and Agriculture Organization of the United Nations

Remark: 1 Office of Agricultural Economics

1hectare=6.25rai

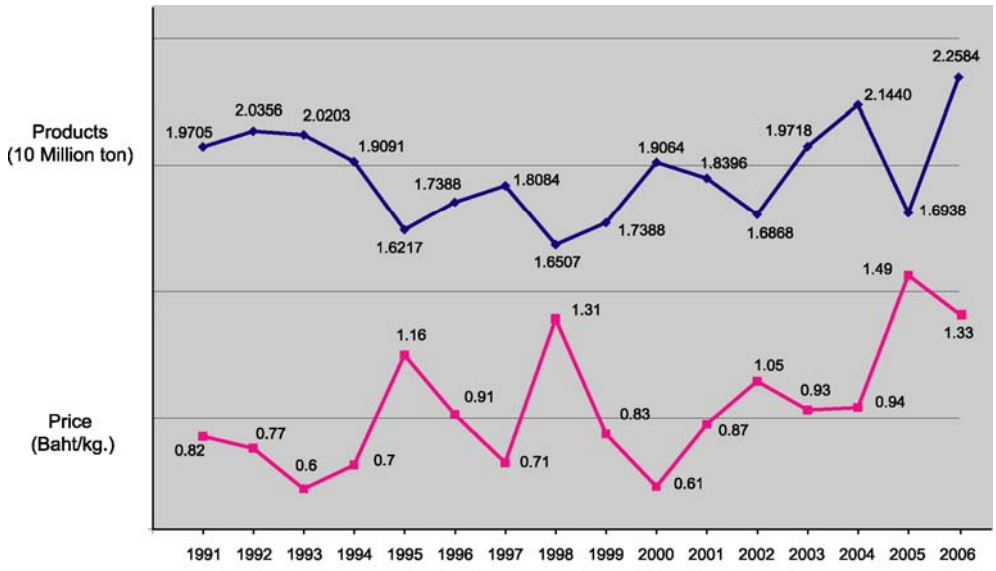
In 2005, Thailand exported about 1.6 mil. Ton of tapioca starch (around 60 % of total production). Native starch is the main product for Thai export which is accounted for approximately 60 % of the total volume (around 1mil. ton). The main markets are China, Indonesia and Malaysia. For modified starch, Thailand exported around 0.6 mil. Ton of a simple modified starch mainly to Japan and China.

For the tapioca starch sector, Thailand competitive strategy is based on ability to supply high quality standard product to the mass market regularly in high volume with the market price. This strategy is supported by regular supply of low costs root from large plantation areas with reasonably quality and yields together with updated production technologies in the starch factory. In addition, there are several research institutes that support various parts of the value chain. However, rising fuel price and reducing root supply have affected the position of the industry significantly.

**Ethanol is a new and high potential channel for tapioca roots. With the current situation, tapioca is the most competitive raw material for producing ethanol considering the current molasses price**. In addition, it can generate higher added value compared to other tapioca products. Currently, Thai government has promoted to usage of Gasohol 95. This requires around 1mil. litre of ethanol per day. Half of this is expected to come from tapioca. Furthermore, the bigger market for ethanol is Gasohol 91 which requires around 2 million litre of ethanol per day. This will be promoted in the near future. In addition, the increasing demands for roots from ethanol plants will help to stabilise tapioca root price. Obviously, ethanol production provides attractive alternative supply opportunities for tapioca roots. Facing with limited planted areas, the options are only increasing yields and/or shifting the supply from lower added value products mainly exported chips and pellets. We have no reason to support China's liquor industry.

**In terms of competitiveness, at the first glance, the sub-sector looks very promising. Thailand is the largest exporter of tapioca products with the world market share of 85%. In terms of root production**, Thailand ranks fourth with the production of around 17 mill. Metric ton. In terms of yields, Thailand is only second to India. The recent figure can be seen in table 3. :

**Figure 6: Price and Fresh Root Production Output in Comparison**




Source: E3agro: A Co-operation Model for Thai Farmers and Companies Based on an Integrative Approach, 2007

**However, farmer income is relatively low. In 2005, average net earning per rai is only 1,285 baht per year. For the households with 20 rai holding, the annual income is only 25,720 baht per household.** This figure is based on average yields of 2.596 ton per rai. The inflation adjusted average income from tapioca roots overall has been consistently dropping when compared to 1991 prices. An option for the farmers may simply switch to other crops which give higher returns.

However, in many areas, this might not be the case. Tapioca might be their only option. Fortunately, with high quality stems and good farm management practices, the yields can be significantly improved. With the right stems and practices, the starch content in the root will be higher than average therefore can get the better price. **In addition, increasing demands from ethanol plants should stabilise the price and kept it at high level. With these two factors, farmer income should significantly be improved**.

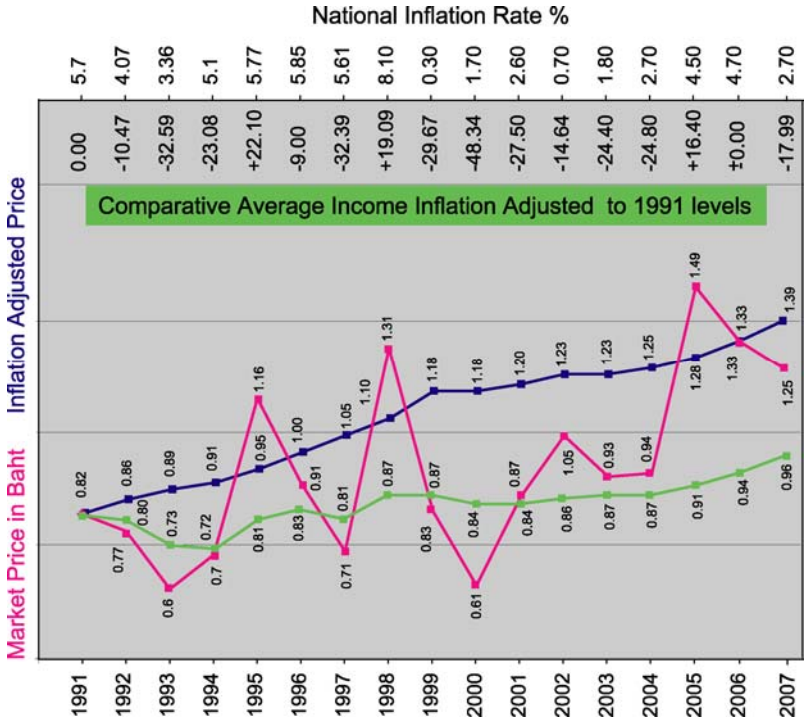
However, high root price will put pressure on the chippers and the starch mills. Normally, the downstream processors are the margin takers. With abundant roots supply, they just

calculated the root price from the finished product price plus their margin. The inefficiencies can easily be buried the required margin and ability to set the purchased root price.

However, with the tight supply situation, this might not be the case. Rising root price will put pressure on the margin. Furthermore, high fuel price will also put additional pressure on their margin. Hence, in order to remain competitive, starch mills has to improve their overall productivity to offset the rising costs. The potential areas that can yields high impact are quality of purchased root (starch content), production and energy efficiency and utilisation of biomass. This might not be a problem for large scale starch mills which their technology and management can be considered as a world class. However, SMEs may need help in these matters. **For Thai starch industry, another factor that might limit the growth potential of the industry is lack of product innovation**. However, it depends on the future prospect of current market segments whether they can still provide sufficient return and growth prospect.

For ethanol plants, the current issue is to start up networks of root supply. They have to compete with the existing buyers. However, considering current ethanol price, they can afford to pay more for the root and can also provide various embedded services to the farmers.

**Figure 7: Inflation adjusted average income per kg/root**




Source: E3agro: A Co-operation Model for Thai Farmers and Companies Based on an Integrative Approach, 2007

**Table 4: Distributions of Native Starch Factories in Thailand**

| Region | Factory Location | Number of Factories |
|---|---|---|
| Northeast | Nakhon Ratchasima | 20 |
| | Kalasin | 8 |
| | Chaiyaphum | 3 |
| | Khon Kaen | 2 |
| | Mahasarakham | 2 |
| | Udonthani | 2 |
| | Roy Ed | 1 |
| | Loey | 1 |
| East | Rayong | 11 |
| | Chonburi | 10 |
| | Chachoensao | 4 |
| | Chanthaburi | 3 |
| Central | Uthaithani | 2 |
| | Srakaew | 2 |
| | Nakhon Pathom | 1 |
| | Samutprakarn | 1 |
| | Samutsakhorn | 1 |
| | Kanchanaburi | 1 |
| | Prachinburi | 1 |
| | Ratchaburi | 1 |
| | Lopburi | 1 |
| | Saraburi | 1 |
| North | Kampangpetch | 5 |
| | Uttharadith | 1 |
| Total | | 85 |

Source: Information and Communication Technology Bureau, DIW (2005)

**Figure 8: Native Starch Factory Distributions**

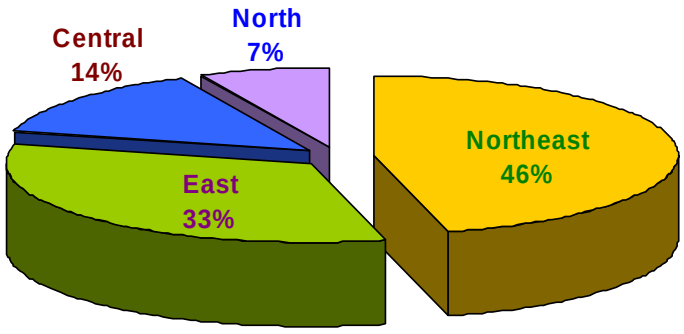
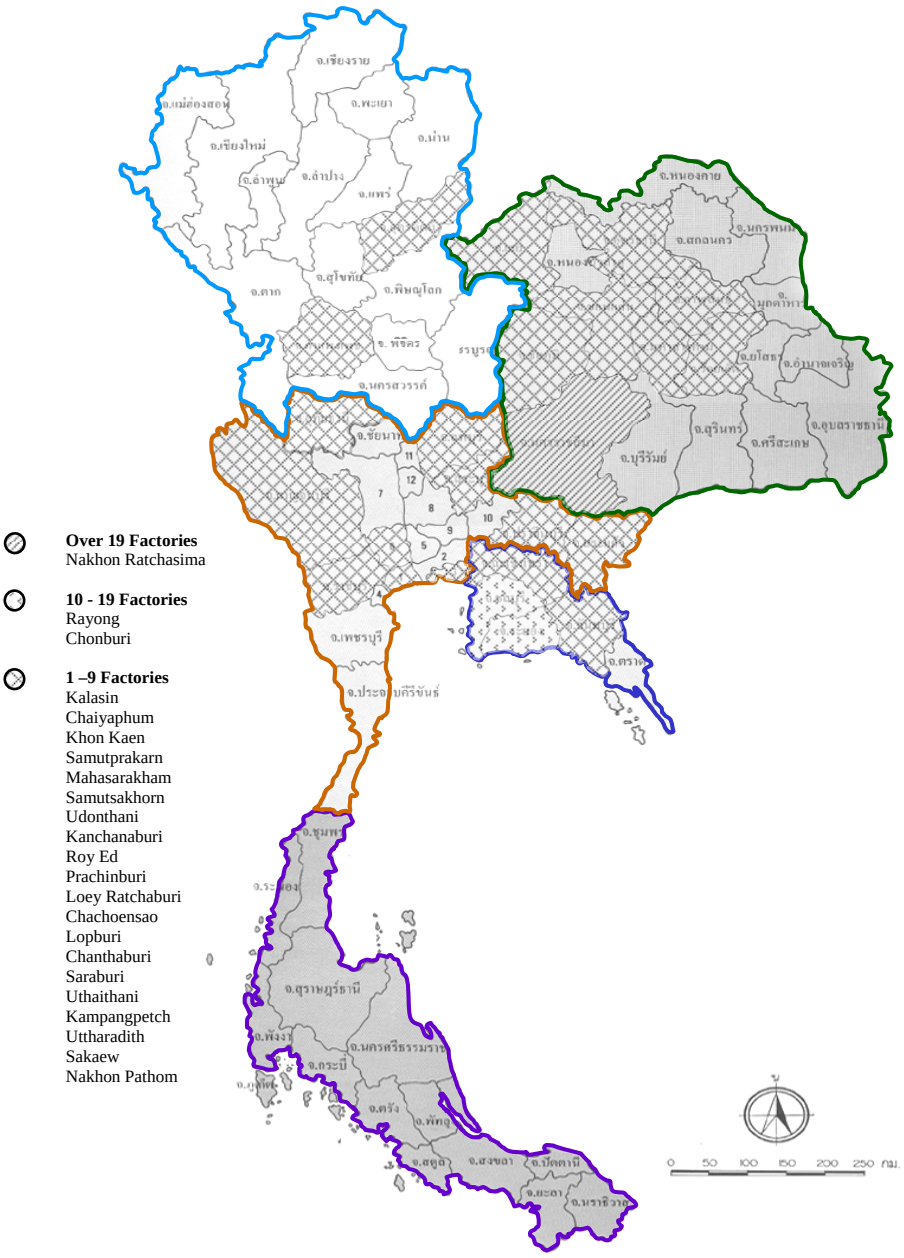


**Figure 9: Locations of Native Starch Factories in Thailand**



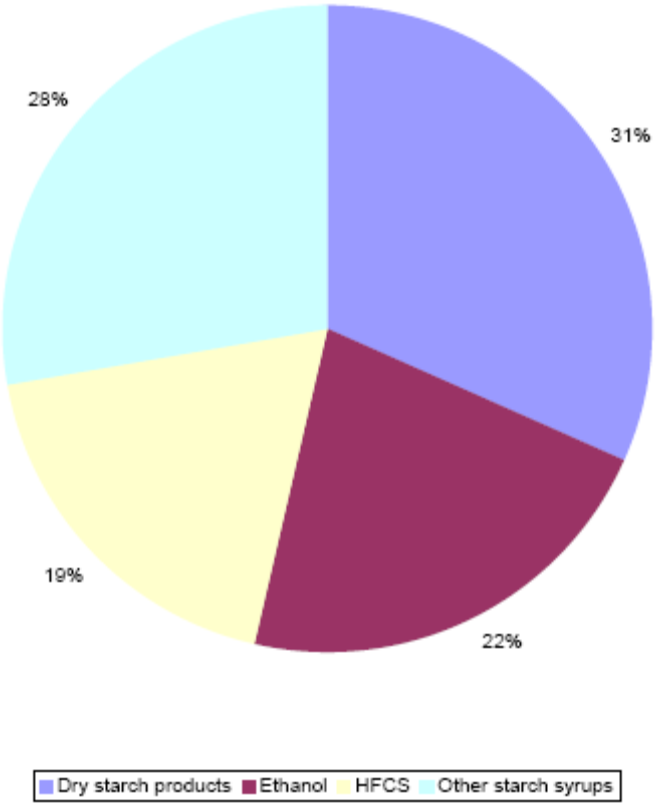

Source: Information and Communication Technology Bureau, DIW (2005)

## 4. Global Market for Starch and Starch Products

The world starch market is about 50 million tonnes per annum in size. The major uses of starch are starch syrups, dry starch products and ethanol. The US accounts for about half of the world's starch syrup production. Large production base for starch syrups in the US is due to the US government's sugar price supports in the 70s. The production of starch syrups also benefits from the EU's Common Market Organizations (CMOs). CMOs are in essence production quotas. The quotas inflate the prices of cereals produced in the EU. Corn gluten feed, a by-product from the high fructose corn syrup (HFCS), is imported from the US to be used as a cereal substitute. The inflated price it receives in the EU helps improve the production economics of HFCS.

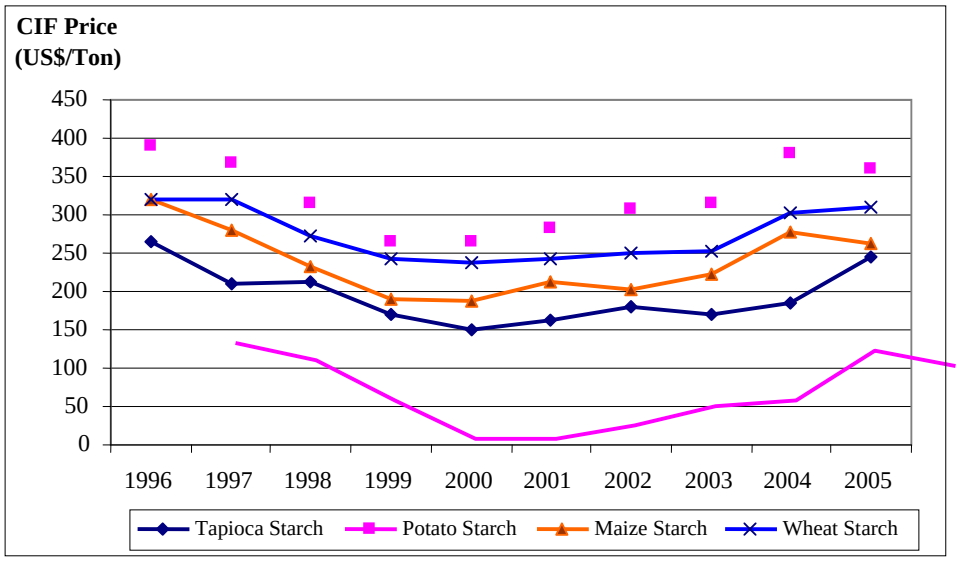
The US is also the dominant producer of starch-based ethanol, producing about 90% of the world output. Brazil, who produces roughly the same amount of ethanol as the US, is using cane sugar as feedstock. The US's production of ethanol is buoyed by tax rebates from both the federal government and state governments and bans on MTBE that are in place in 25 states. The Energy Policy Act 2005 requires gasoline sold in the US to be blended with at least 7.5 million US gallons (23 million tonnes) ethanol by 2012.In all, HFCS and ethanol represent about three quarters of the US's starch product output about 60% of dry starch products are in form of native starch, the remainders are modified. Slightly over half of dry starch products are used in papermaking and corrugating. Around 20% of dry starch products are used in food industry. The remainder are used in a variety of industries. Over 80% of global starch production is based on maize. This reflects the US's dominant position in the starch industry. The US produces about half of the world's starch and starch products. Less than 2% of the US starch production is based on feedstock other than maize. Elsewhere maize supplies 60% of starch production, cereals 15% and potato 10%. On the global scale, the industrial processing of tapioca is still limited despite tapioca's cost competitiveness (see Figure 4). This reflects the fact that cassava is grown mainly in developing countries whose agro-industries are still in infantile stage. Thailand produces around 5% of the world's total starch output mainly from tapioca. The combined output of tapioca starch from other countries is less than 1% of the global starch market.

**Figure 10: World Starch and Starch Products Demand**




Source: Global Trade Atlas, (cited in Evaluation for Raw Intervention Ideas fro Thailand Tapioca's Sub-sector, 2006)

**Figure 11: Prices of Starch in Taiwan**




Source: Global Trade Atlas, (cited in Evaluation for Raw Intervention Ideas fro Thailand Tapioca's Sub-sector, 2006)

## 5. TG –PEC Tapioca Sub-sector Strategy

The structure of the Tapioca agro-industry is comprised of many levels and a wide range of upstream and downstream producers or stakeholders. According to the tapioca value chain map (see figure 1), there are many groups of stakeholders who play significant roles in the industry which are tapioca growers, native starch producers, modified starch producers, starch derivatives producers, ethanol producers, brokers/chipperies, pellet producers, and bio-plastics. However, some stakeholders, like for examples pellet producers, have become less important in the sub-sector due to the drastic decreasing demand of pellets from European markets which constitute the main customer of such products. On the other hand, the bio-plastics industry, it is currently still at the toddler stage but in the future, it is expected that the bio-plastics industry will significantly increase the demand of tapioca starch supply.

To increase eco-efficiency and competitiveness of the tapioca industry, it is necessary that each stakeholder need to be structurally identified their constraints and competitiveness; and implemented by tailored interventions or activities that suit the specific needs and fulfill the gaps. The later step is to draw and harmonize the overall objectives from each stakeholder into the same direction and come up with the consistent strategy and goal at the macro level. TG-PEC is giving attention only to some stakeholders that TG-PEC Tapioca sub-sector's interventions will create potential achievement impacts to SMEs or small to medium scale businesses. There are a least 7-8 groups of stakeholders that the sub-sector have decided to intervene and here below are details of the opportunities and constraints on each of them.

- **Tapioca growers**

Tapioca growers are the largest stakeholder in terms of population number. In 2005, at least 464,000 families are accounted for in the sub-sector scattering throughout the country. The stakeholder needs investment and knowledge to increase their productivity, as well as an established market who buy their tapioca roots at a reasonable and relatively stable price. The tapioca growers usually still achieve low yields/acre, low starch content per kg/root, and have to work in an investment intensive farming environment for e.g. fertilizer, chemicals, stems and wages among others, and still achieve a very low income.

There is a need for eco-sufficient farming approach and harvesting as to improve the productivity and control sustainability of supply. Hence, there is need to have the incentive of reliable market prices for tapioca growers to improve their farm management and crop productivity options.

- **Native Starch Producers**

Native starch production industries provide the very first value added products processed from tapioca roots and/or chips and play the most important role in sourcing material supply to most of the downstream tapioca related industries. However it is still considered relatively low in terms of added price value. Most of the plants in these industries are still operated in a long old and traditional management style and show a decisive lack of innovation, effective production processes, pollution control mechanisms and waste recycling/re-use and energy efficiency options. They also frequently experience raw-material under- or over- supply of feedstock with an unstable price-structure. Water shortage problem in native starch manufacturing is also another critical problem for this industry.

- **Modified Starch Producers**

Modified starch industry is an exclusive business that normally invested by big scale and international enterprises. Most of the modified starch production technologies are also expensively imported and strictly confidential.

Modified starch substances are directly derived from native starch used as thickening agents, stabilizer and emulsifier. Modified starch is an important raw material that used for a wide range of products such as processed food, candies, tablet medicine, animal feeds, paper, paper board, corrugating glue, wall board, laundry starch, textile, and plywood. Under the sub-sector framework, there is an opportunity to explore other innovative products from modified starch at SME levels supporting by affordable technology developed by local tapioca related development institutes like for example, Cassava and Starch Technology Unit, Kasetsart University.

- **Starch Derivatives Producers**

Starch derivatives (and sweeteners) are hydrolyzed substances by some special acids and enzymes used as sweeteners, Dextrins, Mono Sodium Glutamate (MSG), amino acids, syrups and organic acids and mixed in processed food as thickeners. Starch derivatives also play an influential role in beer and liquor industry in the production process of ethyl-alcohol. Starch derivatives industry in Thailand is far greater exclusive than the modified starch industry, and are strengthened and promoted by their own intensive investments. The industry also has a very small potential in allowing SMEs to involve, therefore the TG-PEC will have very less focus for this stakeholder.

- **Bio-Plastics**

Even though, the bio-plastics industry is only at a very early stage of development, a study of bio-plastics product trends, environmental and risk assessments can be a very useful activity for this intervention area. Bio-plastic based products have an environmentally friendly image

and produce less GHG, drawbacks and risks need to be clarified before developing future outlooks for the industry in Thailand.

Chances for SMEs in this market are improving through participation in the automotive sector production chains, as especially car-manufacturers increasingly ask for bio-plastics. Other interested industries are the food and packaging industries.

The manufacture of bio-plastics is based on a native starch based on a number of carefully guarded production processes. The production itself is, therefore, high-tech intensive and the vast majority of players involved are as yet mostly larger companies. Only part of the bio-plastics industry is directly linked to the tapioca sub-sector. The future potential of the market, however, warrants a more detailed description of Thailand's potential for bio-plastics manufacture and use, as well as its impact on the tapioca sub-sector.

- **Ethanol Producers**

Ethanol has been encouraged by the government for renewable energy since the last decade. However, the uncertainty of the ethanol market is still as high as its supply of feedstock from tapioca roots.

Furthermore, Thailand has a considerable potential to produce ethanol based products such as ethyl-alcohol for domestic and international markets. There is a need of research and study in this product chain that will help to explore new opportunity in increasing the capacity, product range, know-how and markets. The ethanol based products can greatly contribute to the overall demand of tapioca and increase links and opportunities of the local tapioca industry to gain access to value added production processes.

- **Brokers/Chipperies**

Chips; chip processors can be either a stand alone business or part of the process for the starch and ethanol industries. A stand alone chip processor or chippery dries the tapioca roots as chips to locally substitute raw material in the off-harvesting season or exports chips abroad for alcohol processing and/or animal feed. There is a need for eco-efficient chippery plant design and pollution control standards in the sub-sector.

- **Policy, Law and Regulation Makers and Implementers - Governmental Agencies/Organizations and Associations**

In terms of policies, law and regulations, the tapioca industry in Thailand concerns many governmental agencies, public & private organizations and associations. Policies, law and regulations have influenced and intervened in the entire tapioca value chain for a number of issues as for examples, limitation policy on tapioca growing areas (currently limited to 6.6 million *rai* in the entire country but to improve the yield in order to increase productivity),

subsidy of tapioca roots and ethanol plant license to name but a few. Since the tapioca industry is such a big sector that covers a number of populations and a wide range of hi and low-tech businesses, conflicts of interests and loss of confidence can emerge and thus downgrade the industry in various aspects. The policies, law and regulations should be coordinated and promoted with solid background research and consultations from relevant disciplines.

Many existing national policies and regulations on the tapioca industry are still vague and have created some confusion among stakeholders and the civil society. Opportunities for TG-PEC interventions are to facilitate discussion forums on tapioca policies and related contemporary issues, as well as to conduct relevant research, develop lessons learned and guidelines for this sector.

## 6. Tapioca Sub-sector Interventions

The concept of the TG-PEC tapioca sub-sector is based on synergies created by a two-fold approach focusing on services and eco-efficiency objectives indicated in the TG-PEC component 1. Business and Financial Services Component and 2. Eco-efficiency in Small and Medium Enterprises Component. In addition, a range of specialized projects add to the sub-sectors contribution on the TG-PEC goal and component levels. These projects are

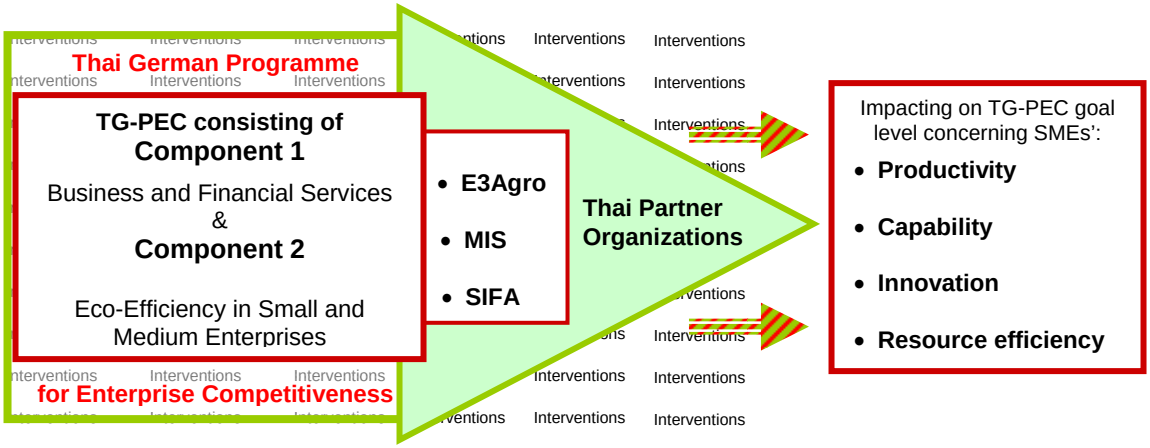
A. The E3Agro Project under the Ministry Energy

B. MIS (**M**anagement **I**nformation **S**ystems) under the Ministry of Industry

C. SIFA (**S**ervices for **I**mproving **F**inancial **A**ccess) under the Ministry of Finance

The individual components and projects are linked to and closely cooperate with Thai partner organizations to maximize impact and achieve the targets on all levels of the programme. All activities of TG-PEC contributing to the tapioca sub-sector are conducted as interventions. The constituent parts of the programme and the activities contributing to the tapioca-sub-sector can have different numbers of interventions.

**Figure 12: The Synergy and Links between TG-PEC, Thai Partner Organizations, Projects and TG-PEC Goal**




On the sub-sector level, the interventions are expected to increase individual value chains competitiveness by improving resource efficiency, supply chain management, value chain management, production management innovations and markets.

On the component level, the interventions of any tapioca value chains can contribute to either or both components simultaneously. Their combined results increase SME competitiveness through improved services and eco-efficiency. On the PEC goal level they contribute by addressing in particular productivity, innovation and resource efficiency.

**Main intervention approach:**

To achieve a tangible and measurable impact through interventions on the tapioca sub-sector, employed base-concepts and activities focus on the higher value added. This can either be achieved by addressing product quality, productivity, eco-efficiency and/or tapioca related policy frames. According to recommendations of TG-PEC internal and external cooperation partners the following constraint issues should be addressed while tailoring interventions for the seven main actors of the sub-sector given below.

### Stakeholder 1: Tapioca Growers

- Stakeholder's constraints
  a. On-farm productivity, mechanization and technology
  b. Eco-efficient and eco-friendly operational on farm management and utilization of biomass
  c. Socio-economic and financial aspects of on-farm productivity

**Stakeholder 2: Native Starch Producers**

- Stakeholder's constraints
  a. Supporting technologies
  b. Operational management and Management Information System
  c. Benchmarking in eco-efficiency and productivity

**Stakeholder 3: Modified Starch Producers**

- Stakeholder's constraints
  a. Exclusive and expensive technologies

**Stakeholder 4: Bio-Plastics**

- Stakeholder's constraints
  a. Research & Development
  b. Technologies
  c. Standards

**Stakeholder 5: Ethanol Producers**

- Stakeholder's constraints
  a. Model of cooperation between tapioca growers and ethanol producer
  b. Cleaner and aggregate technologies
  c. Financing options

**Stakeholder 6: Brokers/Chipperies**

- Stakeholder's constraints
  a. Product quality
  b. Environmental management

**Stakeholder 7: Policy, Law and Regulation Makers and Implementers - Governmental Agencies/Organizations and Associations**

- Stakeholder's constraints
  a. Research and development support
  b. Facilitation of public discussions and knowledge distribution

**Table 5: Contributions of TG –PEC's interventions to addressed issues from each stakeholder**

| Stakeholders | Addressed issues | Intervention |
|---|---|---|
| **1. Tapioca Growers** | • On-farm productivity, mechanization and technology<br>• Eco-efficient and eco-friendly operational on farm management and utilization of biomass<br>• Socio-economic and financial aspects of on-farm productivity | **Intervention 1:** Tapioca growers/ethanol producers cooperation pilot project – A concept development for sustainable supply of tapioca and energy efficiency for ethanol production<br>**Intervention 2:** Tapioca growers/ethanol producers/ethanol producers cooperation pilot project – Operation management at the farming level (Following up on intervention 1)<br>**Intervention 3:** Financing for cooperation models of sustainable tapioca supply for ethanol production<br>**Intervention 4:** Low-cost rental mechanization investment for tapioca growers<br>**Intervention 5:** Financial services to tapioca growers for mechanization and technology aggregation<br>**Intervention 6:** Financing Services to tapioca growers for higher yield tapioca varieties<br>**Proposal 3:** A model development of post harvest bio-mass utilization for energy fuel and fertilizer |
| **2. Native Starch Producers** | • Supporting technologies<br>• Operational management and Management Information System<br>• Benchmarking in eco-efficiency and productivity | **Intervention 7:** MIS for Native starch producers for industrail pollution prevention control project intervention<br>**Intervention 8:** Benchmarking and bets practice programme for starch producers<br>**Intervention 9:** Adding value to waste: introduction of eco-efficient waste to energy conversion technology of native starch producers<br>**Intervention 10:** Finances services for biomass power plant investment for native starch and ethanol producers<br>**Proposal 4:** A model development of maintenance management on native and modified starch machineries |
| **3. Modified Starch Producers** | • Exclusive and expensive technologies | **Proposal 4:** A model development of maintenance management on native and modified starch machineries<br>**Proposal 6:** Modified starch technology support for SMEs |
| **4. Bio-Plastics** | • Research & Development<br>• Technologies<br>• Standards | **Intervention 11:** Benhmarking of bio-plastics feasible technologies and facilities<br>**Intervention 12:** Establishment of bio-plastics standard regulations and certification system<br>**Proposal 2:** Standard regulations and environmental friendly |

| | | |
|---|---|---|
| | | certificating system |
| **5. Ethanol Producers** | • Model of cooperation between tapioca growers and ethanol producer<br>• Cleaner and aggregate technologies<br>• Financing options | **Intervention 1:** Tapioca growers/ethanol producers cooperation pilot project – A concept development for sustainable supply of tapioca and energy efficiency for ethanol production<br>**Intervention 2:** Tapioca growers/ethanol producers/ethanol producers cooperation pilot project – Operation management at the farming level (Following up on intervention 1)<br>**Intervention 3:** Financing for cooperation models of sustainable tapioca supply for ethanol production<br>**Intervention 9:** Adding value to waste: introduction of eco-efficient waste to energy conversion technology of native starch producers<br>**Intervention 10:** Finances services for biomass power plant investment for native starch and ethanol producers. |
| **6. Brokers/Chipperies** | • Product quality<br>• Environmental management | **Intervention 1:** Tapioca growers/ethanol producers cooperation pilot project – A concept development for sustainable supply of tapioca and energy efficiency for ethanol production<br>**Intervention 2:** Tapioca growers/ethanol producers/ethanol producers cooperation pilot project – Operation management at the farming level (Following up on intervention 1)<br>**Proposal 5:** A model development of profitable environmental management for chipperies industry |
| **7. Policy, Law and Regulation Makers and Implementers - Governmental Agencies/Organizations and Associations** | • Research and development support<br>• Facilitation of public discussions and knowledge distribution | **Intervention 12:** Establishment of bio-plastics standard regulations and certification system<br>**Proposal 1:** Policy based support for Eco-efficient tapioca industry<br>**Proposal 2:** Standard regulations and environmental friendly certificating system |

***Brief Intervention Appendix:***

**Intervention 1: Tapioca Grower/Ethanol Producer Cooperation Pilot Project – A Concept Development for Sustainable Supply of Tapioca and Energy Efficiency for Ethanol Production**

***Likely internal cooperation partners:*** *E3agro, SIFA and Component 1*
***Organization partners:*** *Korat Tech, Co. Ltd., Cooperatives?*
***Target groups:*** *Tapioca growers and ethanol producer*
***Length of intervention:***
***Status:*** *Completed*
***Partner interventions:*** *Intervention 2, 3*
***Geographical areas:*** *Nakorn Ratchasrima province*

***Rationale:*** Under the interest of alternative energy promotion, E3agro aims to develop a concept of sustainable feedstock supply between tapioca growers and ethanol producers. The drastic fluctuation in tapioca feedstock demand and supply is a classic issue that instigates a low price crisis, or on the other hand a lack of feedstock supply to producers. The E3agro project on developing the concept of sustainable supply is subjected to present a model that potentially secure reasonable and sustainable profit return to the growers, while responding to sufficient tapioca supply at affordable price to ethanol producers.

At this stage, a co-operation among participated co-operatives who represent the tapioca growers in the target area, an Ethanol plant operator and the GTZ as an project advisor and mediator has been committed. In the meanwhile, the study of sustainable supply concept has also been developed into the final version and is ready to be implemented among the stakeholders and in a close consultation with the GTZ (see intervention 2).

***Expected output/outcome:*** A successful model study that secures reasonable and sustainable profit return to the tapioca growers and in the meanwhile it also responds to sufficient tapioca supply at affordable price to the ethanol producer.
***Measurement Indicators:*** Acceptance of the concept among the stakeholders
***Contribution to the TG-PEC indicators at goal/component Levels:*** Productivity, Capability, Innovations and Resource Efficiency/ K2.1, K2.2 and K2.3

**Intervention 2: Tapioca Grower/Ethanol Producer Cooperation Pilot Project – Operation Management at the Farming Level (Following up on Intervention 1)**

***Likely internal cooperation partners:*** *E3agro, SIFA, Component 1 and IS*
***Organization partners:*** *Korat Tech Co. Ltd., Cooperatives?*
***Target groups:*** *Tapioca growers and ethanol producer*

***Length of Intervention:***
***Status:*** *Pipeline*
***Partner intervention:*** *Intervention 1, 3*
***Geographical area:*** *Nakorn Ratchasrima province*
***Rationale:*** The study of sustainable supply concept (see intervention1) describes that on-farm productivity among tapioca growers is considerably low in eco-efficiency methods and standards, as well as average crop yields. Awareness and capacity building to tapioca growers in crop-cycle management, which include soil preservation, species selection, producer/customer cooperation and new harvesting techniques, are just some of the pressing issues. Since the sustainable cooperation/market between tapioca growers and ethanol/starch producers has been established (see intervention 1), crop-cycle management and its related issues will be an important incentive for tapioca cultivation to increase productivity and thus profit returns over investment.

A pilot project can be set up based on an existing cooperation model together with the private sector (form intervention 1). Options for a possible public-private partnership (PPP) can be considered for the implementation structure. The pilot focuses on on-farm productivity on 3 different activity levels:

- Crop-cycle management
- On farm data-based operational management
- Aggregate technology/mechanization options for the farmer/ethanol producer cooperation

***Expected output/outcome:*** The intervention is expected to impact directly to tapioca growers on a number of key problems and generates quantifiable data concerning revenues, savings, innovation, production increase, environmental impact and others. In the result of that, the feedstock supply for ethanol producer will also be secured constantly.
***Measurement Indicators***:
***Contribution to the TG-PEC indicators at goal/component Levels***: Productivity, Capability and Resource Efficiency/ K.1.2 and K1.3

**Intervention 3: Financing for Co-operation Models of Sustainable Tapioca Supply for Ethanol Production**

***Likely internal cooperation partners****: SIFA, E3Agro, component 1 and component 2*
***Organization partners:***
***Target group:*** *Tapioca growers, ethanol producer*
***Length of intervention:***
***Status:*** *Ongoing; since*
***Partner interventions:*** *Intervention 1, 2*
***Geographical areas:*** *Nakorn Ratchasrima province*

***Rationale:*** To increase financing options and *services* of selected SMEs especially for ethanol producers and tapioca growers, as well as to improve the legal and regulatory framework surrounding financial service delivery. SIFA has identified a lack of options in financing for tapioca growers, as well as an opportunity to increase tapioca cultivation productivity and eco-efficiency through new financing mechanisms.

The new model of cooperation is designed with the Thai SME bank to allow a refinery to act as a lender to finance tapioca growers so as to secure a stable, high-quality and predictable tapioca feedstock flow to the plant. The impact is quantifiable in terms of changes to the debt-cycle of farmers.

***Expected output/outcome:*** An innovation of apex loan system advocating between the selected Tapioca growers and the ethanol producer.

**Measurement indicators:**

***Contribution to the TG-PEC indicator at goal/component levels:*** *Productivity, Capacity and Innovations/K1.1, K1.2 and K1.3*

**Intervention 4: Low-Cost Rental Mechanization Investment for Tapioca Growers**

***Likely internal cooperation partners:*** *Component 1, SIFA*
***Organization partners:*** *Cargill Siam*
***Target groups:*** *Local service providers, tapioca growers*
***Length of intervention:***
***Status:*** *Pipeline*
***Partner interventions:*** *Intervention 5*
***Geographical areas:*** *Mahasarakham province*

***Rationale***: The concept of mechanization is to encourage tapioca growers to rent planting and harvesting machinery at affordable prices. An available study indicates that rental planting and harvesting machinery can reduce production cost for tapioca by one third. The intervention will seek for interested investors and play an advocacy role and applied the mechanization concept to the investors and tapioca growers.

***Expected output/outcome:*** A successful pilot model of a mechanization system in place.

***Measurement indicators:***

***Contribution to the TG-PEC indicators at goal/component levels***: *Capacity, Productivity and Resource Efficiency/K1.1, K1.2 and K1.3*

**Intervention 5: Financial Services to Tapioca Growers for Mechanization and Technology Aggregation**

***Likely internal cooperation partners****: SIFA, tapioca intervention mangers component 1 and component 2*
***Organization partners:***
***Target groups:*** *Tapioca growers, local service providers*
***Length of intervention:***
***Status:*** *Ongoing; since…*
***Partner intervention:*** *Intervention 4*
***Geographical areas:*** *Mahasarakham province*

***Rationale:*** A pilot case in Mahasarakham province developing new financing model of cooperation aiming to provide a safe option to tapioca growers while encouraging them to use eco-efficiency approaches and increase productivity of the cultivation. A decisive aid to reach this goal is providing easy access to financing for improved and cost saving technologies. Impact is quantifiable in terms of savings, increase of available services and increase in applied technology.

***Expected output/outcome:*** To provide a financing service option to the machinery rental SMEs in the pilot site of a mechanization system in the region.
***Measurement indicators:***
***Contribution to the TG-PEC indicators at goal/component levels:*** Productivity, Capacity and Resource Efficiency/K1.1, K1.2 and K.2.3

**Intervention 6: Financing Services to Tapioca Growers for Higher Yield Tapioca Varieties**

***Likely internal cooperation partners****: SIFA, E3Agro, component 1 and component 2*
***Organization partners:*** *Cargill Siam*
***Target groups:*** *Tapioca growers*
***Length of intervention:***
***Partner interventions:*** *Intervention 4, 5*
***Status:*** *Pipeline*
***Geographical areas:*** *Mahasarakham province*

***Rationale:*** SIFA is considering working with Cargill Siam, a multinational nutritional supplement corporation. The project envisions a loan to Cargill, who in turn will on-lend to tapioca growers to finance the planting and growing of higher-yielding roots, thus improving tapioca growers' starch content yields and thereby growers' overall incomes. Intervention impacts on average yield/rai.

***Expected output/outcome:*** To increase a financing option to tapioca growers.
***Measurement indicators:***

***Contribution to the TG-PEC indicators at goal/component levels***: Productivity, Capacity and Resource Efficiency/K1.1, K1.2 and K.2.3

**Intervention 7: MIS for Native Starch Producers for Industrial Pollution Prevention and Control Project Intervention**

***Likely internal cooperation partners:*** *MIS, E3Agro, component 2*
***Organization partners:***
***Target groups:*** *Starch producers*
***Length of intervention:***
***Status:*** *Ongoing; since*
***Partner interventions:*** *Intervention 8*
***Geographical areas:*** *Participated starch producers*

***Rationale:*** To implement suitable *MIS* tools for analyzing the production process and material flow at native starch producing companies. Facilitate the use of MIS tools to identify gaps and simulate the impacts of possible improvements in the production process to improve competitiveness and process efficiency through better use of raw materials, water, energy and by-products. Impact is quantifiable in terms of savings.

***Expected output/outcome:*** Analyzed data of the starch production process by using the MIS tool.
***Measurement indicators:***
***Contribution to the TG-PEC indicators at goal/component Level:*** *Productivity, Capacity, Innovations and Resource Efficiency/K2.1, K.2.2 and K.2.3*

**Intervention 8: Benchmarking and Best Practice Programme for Starch Producers**

***Likely internal cooperation partners****: E3agro, MIS and Component 2*
***Organization partners:***
***Target groups****: Starch Producers*
***Length of Intervention:***
***Status:*** *Ongoing**; since …***
***Partner interventions:*** *Intervention 7*
***Geographical areas:***

***Rationale:*** To identify performance gaps within the starch production process of selected factories and seek best practice, potential drivers and tools for the industry's production through benchmarking activity. Results will be used to design improved and eco-efficient operation management.

***Expected output/outcome:*** Evaluated data from the participated starch producers identified by selected key performance indicators (KPI). The data from the participants

will be benchmarked for the best eco-efficient practices and thus developed into a guideline.

***Measurement indicators:***

***Contribution to the TG-PEC indicators at goal/component Levels:*** *Productivity, Capacity, Innovation and Resource Efficiency/ K2.1, K2.2 and K2.3*

**Intervention 9: Adding Value to Waste: Introduction of Eco-efficient Waste-to-Energy-Conversion-Technology to Native Starch Producers**

***Likely internal cooperation partners****: E3agro, MIS*

***Organization partners:***

***Target groups****: Starch and Ethanol Producers*

***Length of Intervention:***

***Status:*** *Pipeline*

***Partner interventions:*** *Intervention 7 and 8*

***Geographical areas:*** *Participated starch producers*

***Rationale:*** Adding value to tapioca waste by introducing waste-to-energy conversion-technology is another intervention of the E3agro project which promotes eco-efficient practices and competitiveness. Tapioca waste has been produced abundantly from ethanol and starch industries and been one of the most important environmental problems of the sub-sector. By increasing its value, it will be not only an environmental sound practice but to save quite a production cost of the producers.

***Expected output/outcome:*** To add highest value to tapioca waste or by-product from starch and ethanol industries by introducing state of the arts waste-to-energy conversion-technology and practices.

***Measurement indicators:***

***Contribution to the TG-PEC indicators at goal/component levels***: Productivity, Capacity, Innovations and Resources Efficiency/ K2.1, K2.2 and K2.3

**Intervention 10: Finances Services for Biomass Power Plant Investment for Native Starch and Ethanol Producers**

***Likely internal cooperation partners:*** *SIFA, E3Agro, component 1 and component 2*

***Organization partners:***

***Target groups:*** *Starch and ethanol producers*

***Length of project:***

***Status:*** *Pipeline*

***Partner interventions:*** *Intervention 2, 7*

***Geographical areas:*** *Nakorn Ratchasrima province*

***Rationale:*** SIFA seeks opportunity to design a financing service for ethanol or starch SMEs who wish to invest in small biogas (and/or biomass) power plant if the Thai government finalizes a Baht 3.6 per kilowatt-hour feed-in tariff for small power producers. Impact is quantifiable in terms of savings and innovation.

***Expected output/outcome:*** To increase a financing option for biogas power plant investment to ethanol and starch producers.
***Measurement indicators:***
***Contribution to the TG-PEC indicators at goal/component levels***: Productivity, Capacity, Innovations, and Resources Efficiency/K1.1, K1.2 and K.1.3

**Intervention 11: Benchmarking of Bioplastics Feasible Technologies and Facilities**
***Likely internal cooperation partners:*** *Component 2, SIFA*
***Organization partners:***
***Target groups:*** *Bio-plastics industry*
***Length of intervention:***
***Status:*** *Pipeline*
***Partner interventions:*** *Intervention 12*
***Geographical areas:***

***Rationale:*** Bio-plastics are high tech innovations that are hoped to bring in line an increase in the demand of tapioca as raw material as well as introduce tapioca utilization as an eco-friendly substances easing dependence on fossil fuels. Bio-plastics are considered an intelligent option to increase the value of tapioca production and products and generate additional income to the sub-sector.

This intervention defines economically feasible technologies and facilities for tapioca based bio-plastic production by focusing on research & development on the production of lactic acid and of polylactic acid, as well as research & development of compounding technologies. Impact is measured on the level of potential for Thai SMEs.

***Expected outcome/output:*** Benchmarked bio-plastics production technologies
***Measurement indicators:***
***Contribution to the Indicators at goal and component level:*** Productivity, Capacity and Innovations/K.2.1, K.2.2 and K2.3

**Intervention 12: Establishment of Bio-plastics Standard Regulations and Certification System**
***Likely internal cooperation partners:*** *component 2, component 1*
***Organization partners:***

***Target groups:*** *Bio-plastics industry, Regulations, law & policy makers and implementators*
***Length of project:***
***Status:*** *Pipeline*
***Partner interventions:*** *Intervention 11, Proposal 2*
***Geographical areas:***

***Rationale:*** Bio-plastics are high tech innovations that are hoped to bring in line an increase in the demand of tapioca as raw material as well as introduce tapioca utilization as an eco-friendly substances easing dependence on fossil fuels. Bio-plastics are also considered an intelligent option to increase the value of tapioca production and products and generate additional income to the tapioca industry. A suitable certification and guideline will strengthen the industry in many areas.

***Expected output/outcome:*** The intervention is to study and seek for a suitable standard policy and regulation/certification on environmental friendly, quality guarantee and safety product that suit and should be the best potential certification standard that the bio-plastics industry in Thailand can apply.
***Measurement indicators:***
***Contribution to the TG-PEC indicators at goal/component levels***: *Capacity and Resource Efficiency/K1.1, K1.2 and K1.3*

## *Brief Proposal Appendix:*

**Proposal 1: Policy-Based Support for Eco-efficient Tapioca Industry**
***Likely internal cooperation partners:*** *all constituent parts of the TG-PEC*
***Organization partner:***
***Target group:*** *Government institutions, tapioca feedstock dependent industries*
***Length of project:***
***Status:*** *Proposal*
***Partner intervention:*** *input from related interventions*
***Area:*** *National policy and regulations*

***Rationale:*** The use of tapioca as bio-mass will increase in Thailand, rapidly. However, growth, its pace, and development options of the sector will depend on support programs and clearly outlined frames and regulations. Tapioca export opportunities are likely to depend on a strong regiment of standards and certification. This intervention promotes policy & strategy to support the ongoing GTZ interventions and the sub-sector by additional measures.

***Expected output/outcome:*** The intervention will generate/improve policy, regulation, and quantifiable data, as well as government initiatives to promote and support the tapioca sub-sector and the ongoing GTZ interventions.
***Contribution to the Indicator, Goal/Component Level:*** Capacity, Innovations and Resource Efficiency/K2.1 and K 2.2
List of publications
Overview and list of organizations, contact, government, private, international
References

**Proposal 2: Standard Regulations and Environmental Friendly Certificating System for Tapioca Agriculture and Downstream Industry**

***Likely internal cooperation partners:*** *all constituent parts of the TG-PEC*
***Organization Partners****:*
***Target group:*** *Tapioca feedstock dependent sub-sector players and stakeholders in general*
***Length of intervention:***
***Status:*** *Proposal*
***Partner interventions:*** *Intervention 12*
***Geographical areas:*** *All area*

***Rationale:*** In many countries, standard certifications in environmental friendly & socially responsible have become a strict regulation in the product import condition. Most of the tapioca related products from Thailand which include tapioca roots, native starch, derivatives and modified starch still lack traceable certifications that can ensure international customers of safety and environmental friendly & socially responsible. In the near future, this problem can potentially become a serious issue that will hold the native starch and chip stocks from Thailand to international market.

***Expected output/outcome:*** The intervention tends to study and seek best practices of environmentally friendly and socially responsible tapioca production, and suitable standard policy and regulation/certification since the root growing process through the industrial level. The results of the interventions are expected develop a guideline, implementation plans and later a pilot project.
**Measurement indicators:**
***Contribution to the TG-PEC indicators at goal/component levels***: *Capacity and Resource Efficiency/K1.1, K1.2 and K1.3*

**Proposal 3: A Model Development of Post-Harvest Bio-mass Utilization for Energy Fuel and Fertilizer**

***Likely internal cooperation partners:*** *Component 2, E3Agro and MIS*
***Organization partners:***

***Target groups:*** *Tapioca growers*
***Length of intervention:***
***Status:*** *Proposal*
***Partner intervention:*** *Intervention 2*
***Geographical areas:*** *Nakorn Ratchasrima province, Uthai Thani province*

***Rationale:*** Stems and leaves of the harvested tapioca plant contain a high percentage of Tannin. This post harvest bio-mass has, therefore, only limited use as raw-material for the production of bio-gas. However, through special and low-cost composting methods and technologies it is possible to turn this bio-mass into a valuable fertilizer that can be used on fields for the next crop cycle or sold on the open market. The other potential for tapioca biomass is to produce fuel tube.

***Expected output/outcome:*** The intervention introduces the relevant composting methods to tapioca growers. Its impact is quantifiable in terms of investment costs per crop-cycle and generated income/rai.
***Measurement indicators:***
***Contribution to the TG-PEC indicators at goal/component levels:*** Capability, Innovations and Resource Efficiency/K2.2 and K.2.3

**Proposal 4: A Model Development of Maintenance Management on Native and Modified Starch Machineries**

***Likely internal cooperation partner:*** *MIS, E3Agro, SIFA, component 1 and component 2*
***Organization partners:***
***Target groups:*** *Starch producers*
***Length of intervention:***
***Status:*** *Proposal*
***Partner intervention:*** *Intervention 7 and 8*
***Geographical areas:***

**Rationale:** This intervention addresses the machinery maintenance and cost analysis issues from native and modified starch factories. In Thailand, the native and modified starch factories spend a considerable amount of expensive equipment and maintenance cost on preventative and repairing/corrective. Since the factories are required to have a prompt stock of spare parts in order to react quickly to mechanical failure problems and avoid lengthy interrupted processes, it is estimated that the average cost of maintenance and spare equipment stock can cost as high as several million baht annually for a factory.

The idea of this intervention is to develop together with selected companies an information system to a) manage the stock and respective acquisitions (currently mainly done log sheets), and b) analyze through suitable performance indicators how much they spent monthly / annually on maintenance of their equipment in the different production stations. This would allow them to have better decision criteria when which

parts of the equipment shall be replaced by a new one, and furthermore to better plan their stock of spare parts.

The intervention can also be part of an implement activities for the intervention 3 – benchmarking. The starch production in Thailand are very much different in configurations of equipment for each production steps, benchmarking then would allow comparing which promotes configuration is more efficient.

***Expected output/outcome:*** A successful plant model and guideline development
***Measurement indicators:***
***Contribution to the TG-PEC indicators at goal/component Level:*** *Productivity, Capacity, Innovations and Resource Efficiency/K2.1, K2.2 and K2.3.*

**Proposal 5: A Model Development of Profitable Environmental Management for Chipperies Industry**

***Likely internal cooperation partners:*** *Component 1,E3Agro, MIS, PREMA*
***Organization partners****:*
***Target groups****: Local chipperies (stripping)*
***Length of intervention:***
***Partner intervention:*** *Intervention 2, 7*
***Status:*** *Proposal*
***Geographical areas:***

***Rationale:*** The local method of chip production (stripping) is low-tech but constitutes the only form of value-chain participation for farmers besides tapioca cultivation. The stripping process itself produces large amounts of dust which constitute an environmental problem due to its high starch content. PREMA helps to increase production efficiency in an affordable manner. Impact is directly quantifiable in terms of savings.

***Expected output/outcome:*** To increase efficiency of chip production as well as to reduce the pollution.
***Measurement indicators:***
***Contribution to the TG-PEC indicators at goal/component levels:*** Productivity, Capacity and Resource Efficiency/K2.2, K2.3

**Proposal 6: Modified Starch Technology Support for SMEs**

***Likely internal cooperation partners****: MIS, Component 1, SIFA*
***Organization partners:***
***Target groups****: Participated native starch producers*
***Length of intervention:***
***Status****: Proposal*

***Partner intervention:*** *N/A*
***Geographical areas:***

***Rationale:*** Modified starch is directly derived from native starch and is an important raw material that used for a wide range of products such as paper, paper board, processed food, derivatives, laundry starch, textile, plywood and monosodium glutamate (MSG). Modified starch industry is a high end and exclusive business and there are only few modified starch producers who have occupied the market in Thailand. The value added of this product chain is considerably very high compared to those upstream product chains as for example native starch and chips. Unfortunately, tapioca SMEs have an impossible passage through the expensive and exclusive technologies of modified starch even though the market shares for this type of products are still wide.

With a potential cooperation with Starch Development Center, Kasetsart University and the Ministry of Agriculture, this intervention can develop affordable technology on modified starch production and distribute to interested SMEs.

***Expected output/outcome:*** One or two technology transfer on Modified Starch to SMEs.
***Measurement indicators:***
***Contribution to the TG-PEC indicators at goal/component Level:*** Productivity, Capacity, Innovations and Resource Efficiency/K2.2, K2.3

## List of Agencies, Organizations, Associations and Institutes

**1. The Thai Tapioca Trade Association**
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Manager: Mr.Thira Tantipanichykul
Tel. 0-2234-0620, 0-2234-4724
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**2. Thai Tapioca Starch Association**
Add: 216/5 7th Floor, LPM Tower, 7th Floor, Chongnonthi,
Yanawa, Bangkok 10120
Manager: Chalermyos Pasurapinyo
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**3. North-Eastern Tapioca Trade Association**
Add.: 126 Moo 3, Ratchasima-Chokchai (km.6) Rd.,

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Manager: Mr.Prapan Chiennok
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**4. The Thai Tapioca Products Factory Association**
Add.: 45/1 Moo 1 Saisethakij Rd., Bansuan,
Amphur Mueng, Chonburi 20000
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**5. The Thai Tapioca Development Institute**
Head Off: 15th Floor, Lumpini Tower, BKK
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