

***Explorations #1***

# **The Vegetable Industry in Tropical Asia: *Thailand***

**An Overview of Production and Trade**

Greg I. Johnson  
Katinka Weinberger  
Mei-huey Wu

## **About *Explorations***

AVRDC – The World Vegetable Center’s *Explorations* series seeks to inform discourse on the convergence of science, technology, and practice in vegetable breeding, production, and marketing. Envisioned as a catalyst for enterprise and research, the series enables diverse communities to explore expertise, ideas, and common frameworks.

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AVRDC – The World Vegetable Center  
P.O. Box 42  
Shanhua, Tainan 74199  
TAIWAN

Tel: +886 6 583 7801  
Fax: +886 6 583 0009

Email: [info@worldveg.org](mailto:info@worldveg.org)  
Web: [www.avrdc.org](http://www.avrdc.org)

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– *Greg I. Johnson*  
Horticulture 4 Development  
PO Box 412  
Jamison, ACT 2614  
Australia

– *Katinka Weinberger*  
– *Mei-huey Wu*  
AVRDC – The World Vegetable Center  
P.O. Box 42  
Shanhua, Tainan 74199  
Taiwan

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# 1 Summary

*This report examines the role of the vegetable industry as a key asset for productivity improvement, export market development, income generation, and livelihood improvement in Thailand.*

## 1.1 Key statistics for Thailand

*Statistics gathered from DOAE, 2007a; FAOSTAT, 2007; UNFPA, 2007.*

<b>Land area:</b>	51.1 million ha.
<b>Latitude:</b>	5° 37' - 20° 27' N
<b>Longitude:</b>	97° 22' - 105° 37' E
<b>Climate:</b>	Tropical; average temperature 29°C. Three seasons: Summer (February-May), Rainy (June-Sept), Winter (October-January). Central plain annual average rainfall: 1200 mm.
<b>Population:</b>	65.3 million (UNFPA, 2007).
<b>Global Hunger Index Ranking:</b>	1981-23.4%>1992-17.8%>1997-13.8%>2003-12.4%
<b>Child mortality:</b>	M/F/1000 (2004): 23/20
<b>Vitamin A deficiency:</b>	Preschool (1998): 8%
<b>Production:</b>	4.7 million tonnes.
<b>Area:</b>	0.47 million ha. (DOAE, 2007b)
<b>Per capita availability:</b>	215 g/day (1998-2000) (Vanit-Anunchai, 2006)

- Main crops:** (area) chili (22.4%), sweet corn (9.0%), baby corn (8.1%), yard-long bean (3.8%), Chinese kale (3.6%), watermelon (3.3%), cucumber (3.0%), water spinach (3.0%), and pumpkin (2.3%) ( $\Sigma$  9 crops = 58.5% production) (DOAE, 2007a).
- Exports:** 0.47 m t (fresh/processed) in 2005 worth US\$ 414.6 million (FAOSTAT-Appendix 4). Fresh exports - Japan, Taiwan, HK, Malaysia: asparagus, okra, baby corn, shallot, and ginger. Frozen vegetables - Japan, USA, European Union (EU): French bean, sweet corn, and okra. Canned vegetables - EU, USA: baby corn, sweet corn, mushroom, and tomato (DOAE, 2007a).
- Imports:** 0.22 m t (fresh/processed) in 2005 worth US\$ 89.2 million (FAOSTAT-Appendix 4). Imported seed - Australia, Japan and USA: coriander, Chinese kale, and cabbage. Fresh vegetables - Australia and China: carrot, broccoli, salad crops, sweet pepper. Dried vegetables - China: dried chili, dried bean, dried mushroom (DOAE, 2007a).

## 1.2 Industry issues

<p><i>Expanding trade</i></p>	<ul style="list-style-type: none"> <li>• WTO and Sanitary and Phytosanitary (SPS) compliance constraints hamper access.</li> <li>• Terrorism and security issues slow clearances and add to costs.</li> <li>• Maintaining competitiveness and competing with imports are key challenges.</li> <li>• Logistics and transport are improving; quality management is the key to success.</li> <li>• Airfreight and fuel costs are rising.</li> </ul>
<p><i>Assuring quality</i></p>	<ul style="list-style-type: none"> <li>• Compliance capabilities and the slow uptake of ThaiGAP, ASEANGAP and EurepGAP.</li> <li>• Food safety, quality, and contaminant management need improvement.</li> </ul>
<p><i>Improving production and marketing</i></p>	<ul style="list-style-type: none"> <li>• Climate change and natural disasters add to production challenges.</li> <li>• Seasonality, environmental stresses, pest and disease losses, germplasm cost and variability, input costs, labor access, land availability, and water access affect productivity.</li> <li>• Replacement of aging farmer population and literacy of migrant workers will need longer-term attention.</li> </ul>
<p><i>Increasing consumption</i></p>	<ul style="list-style-type: none"> <li>• Urbanization, rising incomes, and convenience foods are enhancing demand.</li> <li>• Vitamin and mineral deficiencies are declining, but remain high in some regions.</li> <li>• Diet-related obesity, diabetes, and cancer are increasing; increased vegetable consumption could lower risk.</li> </ul>

## 1.3 Recommendations for development

### *Marketing and economics*

- Enhance collection and analysis of local and international production and trade data, as well as domestic and international supply and demand trends, to enhance industry planning and preparedness.
- Develop capacities in economic, business, and industry modeling, as tools for planning and development.
- Continue to streamline policy and planning processes and enhance the effectiveness of regulatory enforcement, with emphasis on regional and global dialogue and harmonization.
- Strengthen engagement between supply chain sectors and investment in infrastructure.

### *Industry development*

- Strengthen the engagement between government, industry, and consumers in vegetable sector development.
- Develop overarching and crop specific industry maps, which articulate current supply chains and identify key strengths, weaknesses, opportunities and threats.
- Encourage more extensive and more effective cooperation at micro (farmer groups) and macro (industry/supply chain) levels.
- Foster industry innovation through funding and investment incentives.
- Strengthen advocacy capacity, especially at the farm and community level.
- Improve information access and delivery, and strengthen “transitional” training.
- Review and reform education curricula to meet the modern needs of agriculture, and to foster more participatory approaches to teaching and learning.

### *Systems and technology*

- Strengthen attention to sustainable production systems. Focus on income-enhancing options for smallholders.
- Boost assistance in technology adaptation and uptake, and the development of non-chemical alternatives that provide practical and adequate pest and disease control.
- Collect and commercialize indigenous vegetable germplasm.
- Build capacity in biosecurity risk assessment and management.
- Strengthen capacity in postharvest and storage/transport technologies, in partnership with supermarkets and traders.

*Collaboration and funding*

- Make R&D funding more transparent and competitive.
- Foster stronger public/private partnerships in R&D, to enhance funding use and strengthen application of outcomes.
- Strengthen attention to integration of donor support into national plan priorities and reduce “donor pull.”

## 2 Introduction

Thailand is located wholly within the tropics, between 5° 37' - 20° 27' N and 97° 22' - 105° 37' E, with a land area of 51.3 million hectares and a population of 65.3 million (UNFPA, 2007). The climate is tropical with three seasons, summer (February-May), rainy (June-Sept), and winter (Oct-Jan). Rainfall averages 1700 mm, with about half of Thailand receiving < 80 rainy days/year, 28% receiving 80-120 rainy days/year and 22% receiving > 120 rainy days/year. Typhoons are rare.

Throughout his 60-year reign, H.M. King Bhumibol Adulyadej<sup>1</sup> has played a preeminent role in inspiring and encouraging Thailand's national efforts in agricultural development. Despite several political upheavals in the last 20 years and the 1997 economic crisis, Thailand has recovered well; by many measures it is no longer a "developing" country. The economy is fairly robust, with a healthy manufacturing sector and good agricultural productivity. In 2007 Thailand was ranked 17<sup>th</sup> for foreign exchange reserves, 4<sup>th</sup> after Singapore, Brunei, and Malaysia for Southeast Asian nations, and ahead of Australia and the USA. Poverty levels (such as the Global Hunger Index) declined from 23.4% in 1981 to 13.8% in 1997, to 12.4% in 2004 (Wiesmann, 2006), and have remained almost unchanged since. Development needs and the level of poverty is highest in the northeast and in hill tribe communities in northern border areas.

Thailand has been a strong supporter of regional and international bodies (ASEAN, WTO, APEC), and has sound agricultural R&D and education systems and a dynamic private sector that contribute effectively to national and regional development.

### 2.1 Significance of the vegetable industry in Thai agriculture

Of the total land area, 41% is used for agriculture, with half for rice and just 0.8% for vegetable and flower production (est. of DOAE, 2007a). In 2005, 4.7 million tonnes<sup>2</sup> of vegetables were produced from 468,320 ha, with production practices ranging from subsistence farming, to vegetable cropping after rice, to intercropping with plantation crops, to contract growing and intensive peri-urban

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<sup>1</sup> Guiding Thailand's current development policies is the philosophy of the "Sufficiency Economy" bestowed by H.M. King Bhumibol Adulyadej: to lead a balanced life, without excess. It encompasses three components: moderation; reasonableness, and the need to have a self-immunity system (i.e. contingency reserves for unforeseen events). It also involves knowledge and integrity (Chulanont, 2007).

<sup>2</sup> These figures are higher than the (FAOSTAT, 2007) data in **Table 1**, possibly reflecting the inclusion of baby corn, and sweet corn in DOAE (2007a) data.

systems (DOAE, 2007a). Between 1998 and 2001, average farm size declined from 3.9 to 3.7 ha<sup>3</sup>. Holdings in the central region were higher than in other regions (2001 data, (OAE, 2006)), and incomes were variable. Productivity and incomes are lowest in the northeast where soil fertility and water availability are more limiting (Konuma, 2005). Farmers in the northeast cultivate about 3 ha, divided in 2-3 blocks, with about half under rice, and 10-15% under vegetables for 4-5 crops/year (beans, cabbage, onion). The average farm may employ 4-7 people, and incomes and food production are often inadequate, with rice yields of 2.7-3.7 t/ha (with 10% used for home consumption) supplemented by other enterprises. When farmers adopt a more integrated approach, with mixed-cropping, livestock, and on-farm water storage (that also contain fish), self-sufficiency (68% vs 33%) and food species diversity (38 vs 17 respectively) can be much higher compared to more conventional approaches, and the system becomes more sustainable (Goto and Koike, 1997; Tipraqsa, 2006; Tipraqsa et al., 2007).

### *Production*

Between 1985 and 1990, gross production of vegetables<sup>4</sup> in Thailand averaged around 2.5 million tonnes per year, while from 1990 to 2005, production grew at 1.5% per year, and the area harvested grew by 1.2% per year (**Table 1; Figure 1**) (FAOSTAT, 2007). While production and area under vegetables has grown between 1990 and 2005, farm quality, price, and value indices have plateaued since 2000, with respective mean indices (2000-2005) around 1.5, 1.9, and 2.9 times the indices of 1988-89 set at 100 (**Figure 2**) (OAE, 2006).

### *Trade*

Between 1995 and 2005, the volume of vegetable exports, imports<sup>5</sup> (**Table 1**) and domestic per capita availability<sup>6</sup> increased, with the domestic market as both the main outlet and a sector with considerable unrealized potential.

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<sup>3</sup> Latest figures available from OAE (2006).

<sup>4</sup> N.B. This figure excludes baby corn, sweet corn, and watermelon, which are usually included in Thai national data for vegetable production.

<sup>5</sup> Imports have fluctuated, but are trending higher.

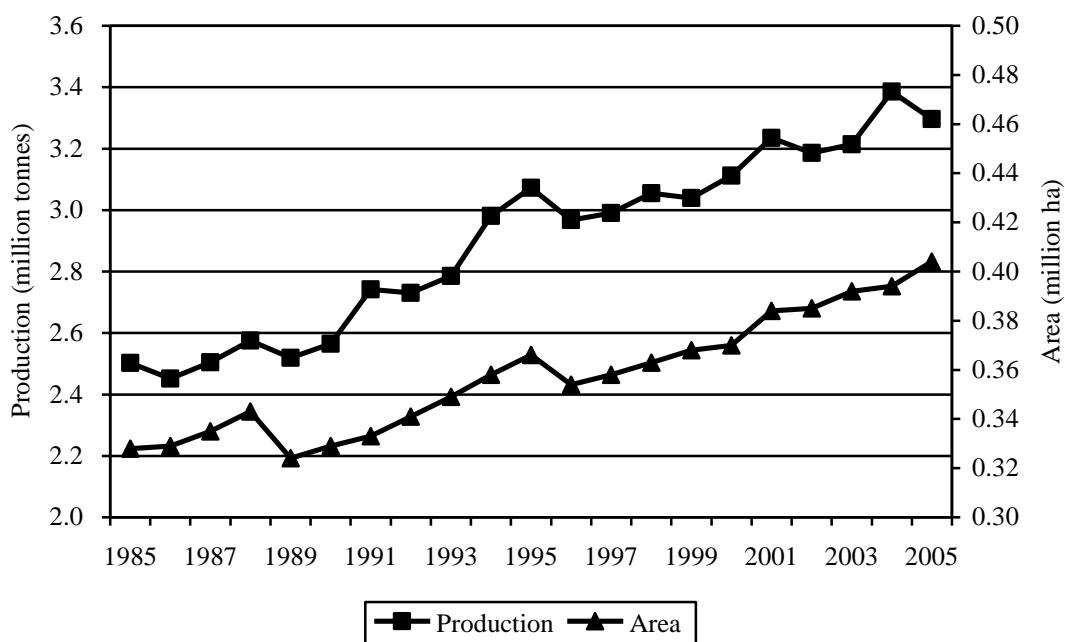
<sup>6</sup> In total volume/value, but not per capita.

**Table 1.** Thai vegetable production and area harvested, 1995-2005

	1995	1997	1999	2001	2003	2005
Population (1000)	57,522	58,830	60,091	61,191	62,126	63,002
Area harvested (ha)	366,060	358,169	368,415	383,602	391,676	405,971
Production (tonnes)	3,072,933	2,990,188	3,038,633	3,234,442	3,213,635	3,415,378
Exports* (tonnes)	657,220	643,360	790,420	744,710	1,075,090	1,315,130
Export as % of production*	21.4	21.5	26.0	23.0	33.5	38.5
Imports* (tonnes)	53,180	48,510	56,510	72,450	164,690	280,130
Import as % of export	8.1	7.5	7.1	9.7	15.3	21.3

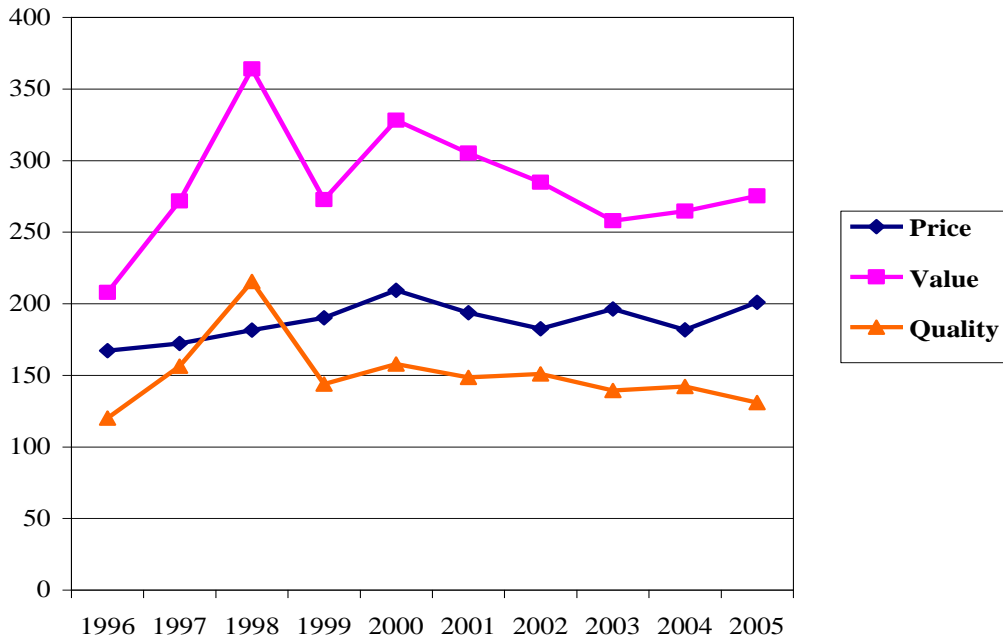
\*Raw and processed vegetables (including melons and chili) in primary equivalents.

Source: FAOSTAT (2007)



Source: FAOSTAT (2007)

**Figure 1.** Trends in vegetable production and area for Thailand 1985-2005



Source: OAE (2006)

**Figure 2.** Comparison of farm price, value and quality indices for Thailand 1996-2005, with indices for 1988-89 as 100

The growth in production and exports reflects farmer efforts for diversification and income enhancement, increased uptake of technology improvements, and explicit attention by government and the private sector to industry development under Thailand’s five-year National Economic and Social Development Plans (NESDP) (BOI, 2007a). For example under the 6<sup>th</sup> NESDP (1987-1991), to promote export-led development, the Ministry of Agriculture and Co-operatives (MOAC) proclaimed 15 districts as asparagus cultivation areas (Manarungsan et al., 2005). And while earlier plans emphasized self-sufficiency, the 8<sup>th</sup> (1997-2001), and the current 10<sup>th</sup> (2007-2011) plan have explicitly promoted “commercial” farming in addition to subsistence production (Sanchai Tontyaporn, personal communication). The 10<sup>th</sup> Plan proposes five strategies: fostering human and social development; building strong communities; strengthening the national economy through improved competitiveness, value-adding, and enhancement of infrastructure and investment; enhancing

environmental sustainability; and promoting good governance (NESDB, 2006)<sup>7</sup>. Improvements in the vegetable industry will contribute to these strategies.

## 2.2 Vegetable demand

Thai cuisine reflects the climate and the crops of the people—hot and spicy, rice-based, and of the forest, the *klong*, and the farm—and the Thai proverb: *Eat simply, live easily*. Core ingredients of a basic meal are spicy relishes served with raw or cooked vegetables; fish, simply cooked; and a soup of bamboo shoot and pork. Meals are served with plenty of rice. Regional specializations reflect climate and lifestyle differences (Thompson, 2002).

The traditional diet, with ingredients originally sourced from home gardens, canals, and waysides, is the basis of the vegetable industry. It has been complemented by more recent developments, such as intensive cropping in peri-urban areas or after rice, and contract growing of export crops such as asparagus, baby corn, and okra.

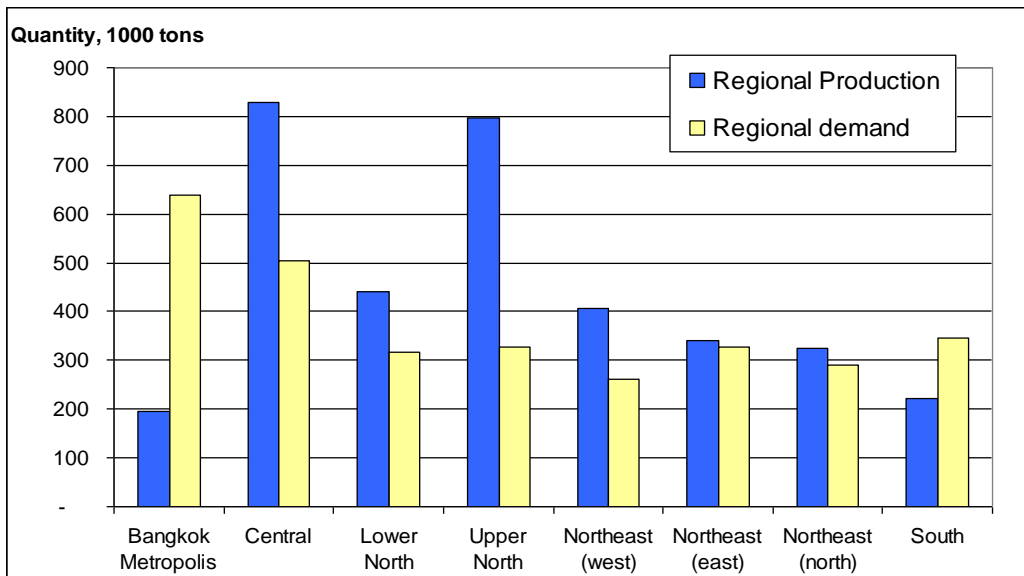
### *Drivers of demand*

While 77.7% of the Thai population live in rural areas (2005 est. United Nations, 2004), the urban population, growing at 2% annually, represents a key driver of domestic demand. The population of Bangkok is 10-13 million<sup>8</sup>, and Chiang Mai is about 1 million. The processing, export, and catering sectors, as well as healthy domestic and international tourism industries (13.8 million international visitor arrivals in 2006 (TAT, 2007)) also provide good market opportunities for Thai vegetables.

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<sup>7</sup> <http://www.itd.or.th/en/node/308> ; See also Termittayapaisith (2007).

<sup>8</sup> Bangkok metropolitan area (>7,700 km<sup>2</sup>) has a registered population of 9.988 million (4/4/2007), and a daytime population > 13 million, with a population density > 1,200/km<sup>2</sup> (Wikipedia, 2007a).



Source: Figure reproduced with permission, Hardeweg and Waibel (2006)

**Figure 3.** Regional production and demand for vegetables in Thailand

Total demand for vegetables is highest in the Bangkok metro area, and production surpluses are highest from the Central and Northern regions, with the demand gap largest in Bangkok (**Figure 3**). Produce flows are greatest from the central region to Bangkok (> 300,000 tonnes/year), but there are also significant two-way internal produce flows (Hardeweg and Waibel, 2002, 2006) (Figure 4).

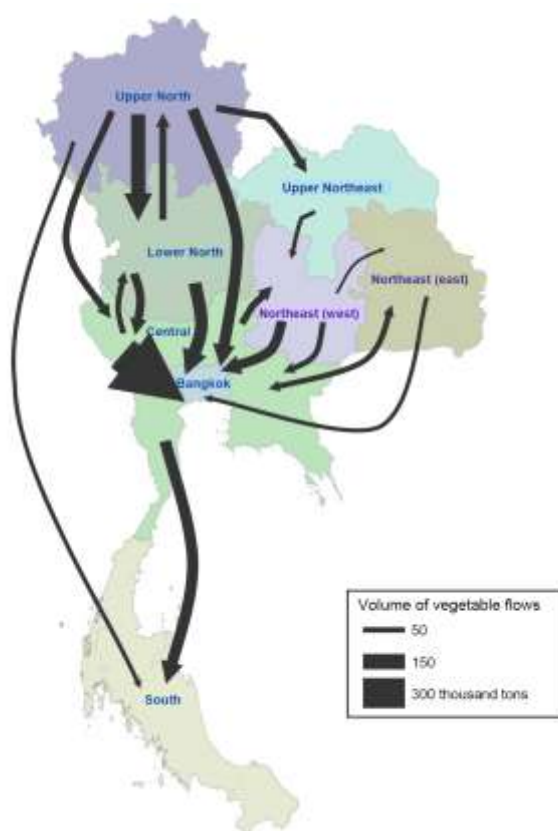
#### *Future demand*

While the industry is diverse—more than 72 categories of vegetable are cultivated (>50 kinds commercially) (Appendix 1) and production is increasing, average per capita intakes are well below half of the WHO recommended intake (Table 2) (FAOSTAT, 2007). Data from Vanit-Anunchai suggests this may be an underestimate, with per capita availability levels exceeding half of WHO recommended levels for fruit and vegetables in 1998-2000.

**Table 2.** Per capita availability of vegetables (g/capita/day) in Thailand

Source	1983-85	1986-88	1989-91	1992-94	1995-97	1998-00	2001-03
Vanit Anunchai (2006)	158	110	137	131	188	215	
FAOSTAT (2007) <sup>a</sup>	122	112	107	110	112	112	116
FAOSTAT (2007) <sup>b</sup>	-	-	-	108	108	106	104

<sup>a</sup> Based on archives data. <sup>b</sup> Based on core per capita availability data.



Source: Figure reproduced with permission from Hardeweg and Waibel (2006)

**Figure 4.** Vegetable supply flows within Thailand

Although poverty levels and the incidence of dietary deficiencies are declining, they remain a concern in some regions. An increase in “western” dietary habits and junk food consumption is contributing to rising levels of obesity and diet-related illnesses such as diabetes and some cancers.

Greater consumption of vegetables (in volume and variety) is potentially part of the solution to these problems. In the immediate future, demand will continue to grow, but production areas may change and intensify as cost-structures change and technological and infrastructure improvements enhance quality maintenance in produce shipped from more distant and overseas production areas.

Hardeweg and Waibel (2002; 2006) predicted that a 10% increase in demand in metro Bangkok would boost production in all regions, with greatest increases in Bangkok metro, central, and the lower north. Similarly, a 20% reduction in transport losses<sup>9</sup> (through improvements in postharvest technology and logistics) would favor increased production in the upper north, and lower production in Bangkok, central, lower-north and the northern part of the northeast. Conversely, higher fuel prices (e.g. 50%) would stimulate production in the central, lower northern, and the western part of the northeast, and depress production in Bangkok, other parts of the northeast, and the upper north.

Demand will also become more differentiated in variety, quality, safety, and convenience. For example specialization in “safe” or “organic” vs. regular vegetable production is a growing area of value-adding market differentiation that could boost profit potential by a factor of 30, to more than 200% (**Table 3**) (Poapongsakorn, 2006).

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<sup>9</sup> Postharvest diseases and quality deterioration cause serious losses during transport and marketing, and are a major factor reducing profitability.

**Table 3.** Price differentials between safe, organic, and regular vegetables in Thailand

Type	Average organic price (baht/kg)	Average safe price (baht/kg)	Average regular price (baht/kg)	Difference between organic and regular (%)	Difference between safe and regular (%)
Hot chili	250.0	211.3	65.0	284.6	225.0
Cucumber	58.2	48.7	19.0	206.1	156.1
Kale	89.3	86.3	45.2	97.8	91.0
Cabbage	60.5	79.5	28.5	112.3	178.9
Shallot	-	210.0	139.8	-	50.3
Water spinach	52.0	52.0	33.4	55.6	55.6
String bean	85.0	102.8	54.1	57.2	90.0
White beans	59.0	77.3	41.7	41.6	85.4
Flowering cabbage	85.0	67.8	38.3	121.7	76.7

Source: Poapongsakorn (2006)

However, pricing of organic and “safe” products will probably decline as more produce becomes available and the market becomes more competitive. Although the markets for safe and organic vegetables currently provide a price premium that is accepted at the current demand level, oversupply of either type could erode these margins. Growers need to build contingency strategies for boosting demand into their future plans for industry development.

### *Issues*

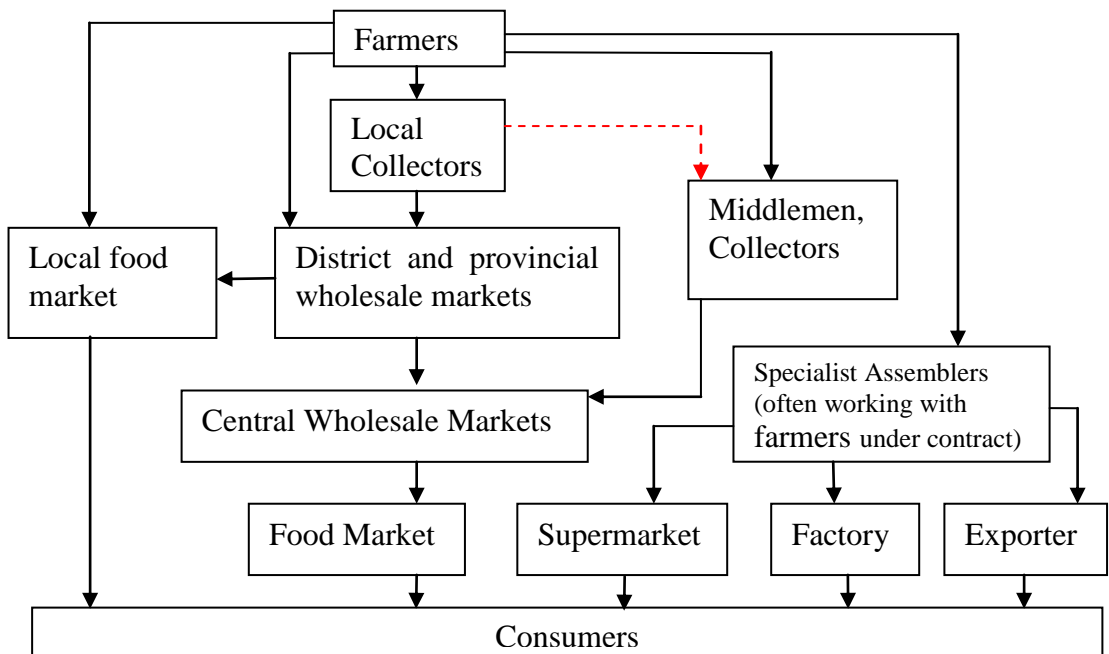
With strong growth likely in domestic demand, and healthy export and processing sectors, the Thai vegetable industry has good prospects. The challenge will be to adjust policy and industry development to contain costs, address quality management and loss reduction, and enhance market competitiveness. Support for industry innovation can enable growth and enhance profitability through the development of novel crops, value-adding, and niche products.

### 3 The vegetable supply chain

#### 3.1 Industry status

While individual farm size has been decreasing, a key trend in the production sector has been the development of cooperative and contract production and marketing arrangements. Under contract to processors, exporters, or supermarket suppliers, farmers usually gain increased market security—but they must also improve quality management, production efficiency, and cost control.

The traditional marketing chain is characterized by many steps and players, while the modern trend is toward simplification, fewer steps, improvements in transport, logistics, and cool-chain handling (Figure 5) and increasing use of returnable containers (DOAE, 2007a).



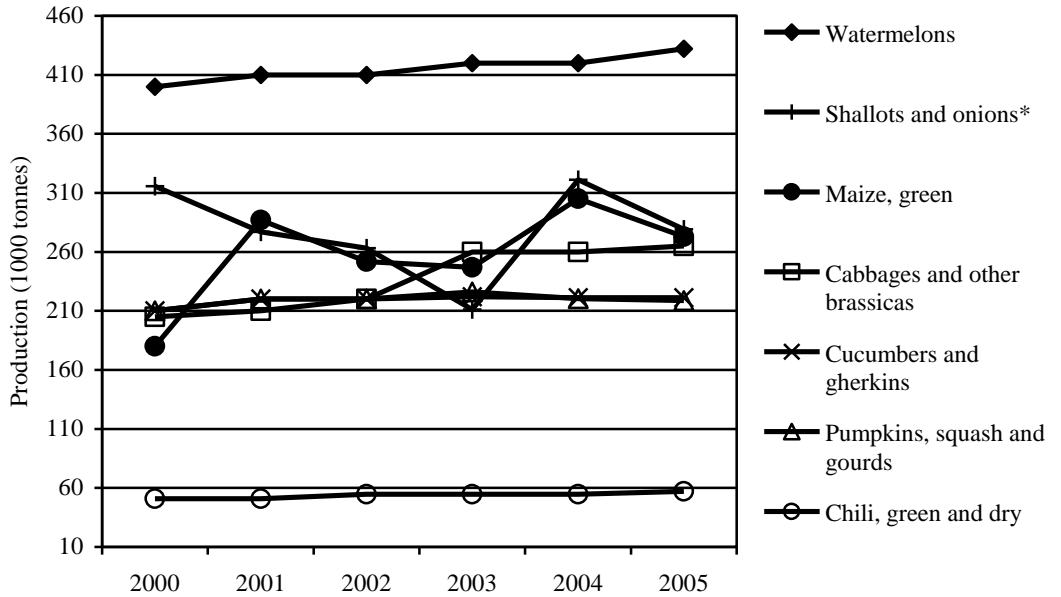
**Figure 5.** Vegetable distribution channels in Thailand. Middle: Traditional multi-step chain through local collectors and middlemen. Right: Contract farming with fewer steps to end-markets

### 3.2 Production sector

Nath et al. (1999) and Sootsukon et al. (2000) provide concise accounts of the vegetable industry in Thailand, focusing on more traditional types, with useful information about key production issues and the nutritional contents of major vegetables. Vanit-Anunchai (2006) has reviewed the opportunities and risks in producing and marketing “safe” vegetables in Thailand. Between 2000 and 2006, ongoing R&D, investment by the private sector, and the stimulation of export crop development has further improved industry status.

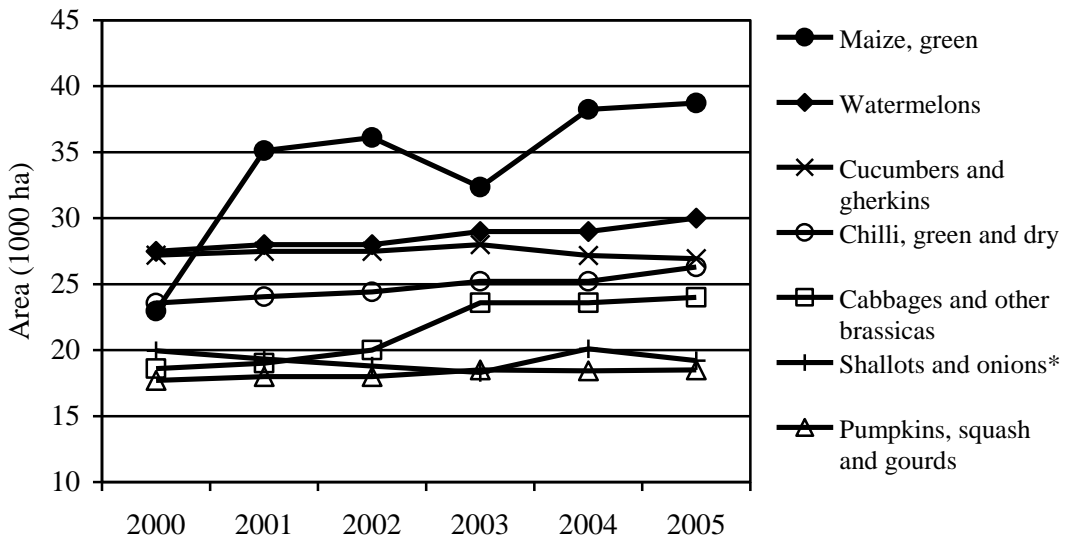
The current industry is based on several production sectors, with differing needs, threats, and opportunities (**Table 4**). Major crops (by production area) are chili (22.4%), sweet corn (9.0%), baby corn (8.1%), yard-long bean (3.8%), Chinese kale (3.6%), watermelon (3.3%), cucumber (3.0%), water spinach (3.0%) and pumpkin (2.3%) ( $\Sigma$  9 crops = 58.5% production) with considerable R&D support coming from the private sector (especially the seed industry). Newer export crops (baby corn, okra, asparagus, green soybean) contribute significant export income and are a focus of public sector R&D (% estimates from DOAE, 2007b). **Figure 6** and **Figure 7** show trends in area and production of vegetables from 2000-2005 based on FAOSTAT detailed data (Appendix 2).

Comprehensive statistics on production are also available from the Thai government (DOAE, 2007b) (Appendix 3). Note, however, that there appears to be an anomaly in data for 2005-06 and 2006-07 compared to earlier years. DOAE was unable to clarify the anomaly, and for this reason, its data was not been used to prepare **Figure 6** and **Figure 7**.



\*For Thailand, shallot is the more significant crop (G. Grubben, personal communication)  
 Source: FAOSTAT (2007)

**Figure 6.** Trends in production under major vegetables in Thailand



\* Shallot is the more significant. (G. Grubben, personal communication)

Source: FAOSTAT (2007)

**Figure 7.** Trends in area under major vegetables in Thailand

**Table 4.** Production sectors and key issues in the Thai vegetable industry

Sector	Trends and issues
<b>Subsistence farming and home gardens</b>	
	Production mainly for family use – producing hot chili, galangal, lemongrass, and leafy vegetables. Gradually declining as a proportion of national production, those dependent on excess “subsistence” production for income will face increasing difficulties and marginalization in marketing as quality and safety standards rise and resource access becomes more limiting, especially if integrated systems are not adopted <sup>10</sup> (Tipraqsa, 2006; Tipraqsa et al., 2007).
<b>Peri-urban intensive systems supplying the cities</b>	
<i>Open air cultivation</i>	Production systems are highly intensive, with commercial agricultural inputs (F1 and hybrid seeds, fertilizers, pesticides). Production areas range from 0.16-2.4 ha, for producing fast-growing crops to meet market demands (Chinese kale, water spinach, chili, Pak Choi, lettuce, chives, Chinese radish, cauliflower, loofah, yard-long bean, cucumber), with some farms having specific areas for export crops such as asparagus, okra and chili. Supermarkets and exporters favor more progressive growers who can meet Thai GAP <sup>11</sup> (for local) or EUREPGAP (EurepGAP, 2007) certification. Around Bangkok, the sector is declining in area as improvements in cooling and transport make production in more distant provinces more economically feasible.
<i>Protected cultivation</i>	Fewer growers are involved and production costs are higher, but the area and investment levels are likely to increase. Some combine ‘rain-out’ shelter with hydroponics. Plastic or nylon netting may be used to exclude insects. Evaporative cooling systems in plastic houses can be used for high-value crops such as sweet pepper, table tomatoes, and cantaloupe. Often only a proportion of a farm, with additional open cultivation and areas under temporary shelters for wet-season cropping. Lower-cost technologies are needed. Mites can be more of a problem than in open cultivation, and extended use can lead to a build-up of soil-borne diseases.
<i>Hydroponic production systems</i>	Hydroponics enable intensive production with high turnaround (e.g. salad leaves), efficient use of water and fertilizer, minimal use of land, early and regular harvesting, with fewer pests. Hydroponic systems are being used for salad crops (which replace imports from Australia), sweet capsicum, and cherry tomato. The high cost of systems is a constraint, but further expansion is inevitable as product demand grows.
<b>Farms cropping vegetables after rice (especially in northeast Thailand)</b>	

<sup>10</sup> Tipraqsa (2006) considered that farms with a low level of integration combined rice production with poultry and vegetables, while highly integrated farms also had fish, livestock, trees and mushrooms.

<sup>11</sup> GAP = Good Agricultural Practice: certifiable guidelines for safe and ecological production and marketing. EUREPGAP is a European model of GAP.

	Fewer inputs are used (open pollinated (O.P.) seed, less fertilizer). Some crops are grown for processing factories (tomato, French bean, carrot). Some are regional specialties such as garlic, onion, and shallot. Import competition (especially garlic, chili) is affecting viability, and new alternatives are needed. This sector will continue to be involved in vegetable production, but crops will diversify.
<b>Organic production</b>	
	Chemical-free and organic certified production is increasing rapidly, with products selling at higher prices and demand growing in both the domestic and export sectors. Sources of reliable organic fertilizers and reliable pest/disease control strategies are needed (Ellis (Ellis et al., 2006; Kramol et al., 2006; Vanit-Anunchai, 2006).
<b>Large-scale commercial farming</b>	
	Focused on exports and processing, with crops grown by farmer groups under contract (baby corn, sweet corn, okra, and asparagus). Costs need to be contained and logistics improved to enhance competitiveness. EUREPGAP certification is becoming essential. This sector is consolidating and enhancing certification compliance capabilities (GTZ-CMU, 2006).
<b>Royal Project sites</b>	
	Focused on crop diversification and opium substitution in remote communities in northern border areas. Supported by advice from 37 extension stations, 3000 families in five provinces of northern Thailand produce 140 kinds of vegetable crops. Production increased from 235 tonnes in 1997 to 7,655 tonnes in 2004 (Boonyakiat, 2003; Jayamangkala, 2004). May face market competition from larger scale and more consistent producers in other areas. Novel marketing strategies could capitalize on "Fair Trade" and "Royal" loyalties of customers, or sell direct to caterers and specialist provedores/restaurants. Perhaps lessons could be exchanged with Duchy Originals (2007) in Cornwall, UK, the organic food business of H.R.H The Prince of Wales.
<b>Vegetable seed production</b>	
	Open-pollinated and hybrid cultivars for domestic and export markets are produced by farmers under contract or by seed companies themselves. Seed companies provide training and advice to growers. Plant variety rights (PVR) protection is needed in Thailand/region to protect seed sector R&D investments. The sector has benefited from government incentives for agribusiness development. Companies are linking to supply of other inputs for intensive cultivation systems.

### *Contract farming*

Farmers who specialize in higher value crops or market segments have greater investment costs and more demanding quality management standards, but data cited by Poapongsakorn (2006) suggests growing vegetables under contract can be more profitable, with net revenue to farmers growing baby corn under contract twice the return from alternative revenue options.

### **3.3 Inputs, finance, and utilities**

#### *Inputs and supply chain logistics*

Growth and improvements in the input and supply chain logistic sectors and better access to finance and utilities have been key factors enabling expansion and diversification of the vegetable industry. The key sectors are:

#### *Seed*

The seed sector has been a major contributor to industry development and is a major exporter. Several major seed companies and the Asia Pacific Seed Association (APSA) are headquartered in Thailand. Thai farmers have good access to a wide range of quality seed of superior cultivars (OP and hybrid), but the cost of some hybrid seed deters use. The sector is very competitive, some breeding challenges remain (e.g. disease resistance gaps, cheaper methods for hybrids), and there is scope to enhance seed exports. Some companies are developing and offer a range of inputs and services to farmers to improve competitiveness. An overview of the Thai seed sector has been provided by Sagwansupyakor et al. (2003).

#### *Agricultural chemicals*

Monitoring and regulation of quality standards of registered products is reasonable, but weedicide use is increasing and traceback systems are needed (Salakpetch, 2007; Thailand Chemical Safety Website, 2007). Overuse by some farmers and “overpromotion” by some chemical companies contribute to excess residue problems. Vanit-Anunchai (2006) presents data on total use of insecticides, fungicides, and herbicides in Thailand and suggests their use in vegetables follows the same upward trend as overall use. Use of illegally imported chemicals of uncertain quality can cause additional problems (ineffective control, toxic contaminants, hazards to workers, disposal). Work-safe education for migrant laborers that apply the chemicals is a key need. More resistant cultivars and natural pest and disease strategies are needed to reduce reliance on chemicals. CropLife Asia is headquartered in Thailand.

#### *Fertilizers*

Almost all chemical fertilizer is imported. Total imports increased from 3.7 million tonnes in 2000, to 4 million tonnes in 2005, but use for vegetable and flower production fell from 420,000 tonnes in 2000, to 363,000 tonnes in 2005, with further declines forecast<sup>12</sup>. Thailand Central Chemical Public Company Ltd produces more than 90% of locally formulated granular fertilizers (Osotsapar

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<sup>12</sup> Osotsapar and Sakulyong (2006) do not indicate a reason for the drop, but it may reflect greater use of organic fertilizers and increased cropping of vegetables on residual moisture and fertilizer after rice.

and Sakulyong, 2006). There are industry and consumer concerns about overuse of fertilizers. More options are needed for organic alternatives (e.g. formulated for specific purposes). Development of fertigation rates and industry expertise for microirrigation require attention.

### ***Farm machinery***

Adaptive technology development by the private sector and research agencies is enabling change. Fuel efficiency, user safety, and labor-saving innovations need attention.

### ***Irrigation and watering systems***

Thailand has an abundance of water, but growing demand, regional deficiencies and problems with contamination have placed pressure on the resource. Large-scale deforestation also has increased watershed degradation (UNESCO, 2006a, 2006b). Only 5.76 million ha are irrigated (mostly for rice), with 46% in central, 26% in the northern, 17% in the northeast and 12% in the southern regions (DOAE, 2007a). With increasing pressures on supply, cost-effective strategies are needed to ensure sustainability. Improved technologies are available but costs (and also access in some areas) are a constraint. Strategic use of on-farm storage can lift productivity in dry areas (Tipraqsa et al., 2007).

### ***Labor***

In 2002, 42% of workers were in the agricultural sector (13.8 million) vs 52.5% (15.5 million) in 1993 (Mephokee, 2003). Some farmers capitalize on the availability of migrant laborers willing to accept lower wages and conditions, but language difficulties and inadequate education hamper their effectiveness in modern production and handling. Labor-saving technologies are needed, along with capacity building for farm and supply chain workers, to assist the transition to greater technology use and adoption of GAP.

### ***Good Agricultural Practice (GAP), EurepGAP (2007) and quality certification***

Thailand has a major focus on development of farmer compliance with ThaiGAP/QMark and EurepGAP, and the development of appropriate local and internationally recognized certification schemes (Salakpetch, 2007). Success in export development depends on efficient technologies and logistics, and the capability of exporters to supply the standard of quality required by customers. The experience in application of integrated pest management (IPM) is helping farmers to reduce pesticide residue risks and meet EurepGAP and traceability requirements (Poapongsakorn, 2006).

### ***Postharvest technology***

Technologies are available, but commodity-specific tailoring and cost savings are needed, along with capacity building for harvest, packhouse, storage, and transport personnel. Access to forced-air cooling and cold storage/refrigerated transport can be a constraint; their use will add to costs.

### ***Logistics***

Infrastructure is generally adequate, but transit times could be reduced and delays minimized. Freight handling is being strengthened through attention to logistics, facilities, and infrastructure/technology, with improvements in airports, the deep-sea port, multiple transport links, and moves to e-logistics and “paperless” customs (Crawford, 2005). Costs and bureaucratic requirements need to be reduced or streamlined. Strategies for consolidation of small consignments and use of environmentally acceptable packaging need to be explored. Cross-border trade with China could be improved (e.g. by allowing through transport on Thai trucks with Thai drivers, to reduce handling and time in transit), as the China market has good growth potential, particularly for the supply of tropical spices/medicinals and vegetables during winter (November to February).

### ***Financial services and utilities***

#### ***Fuel, water, and electricity***

Thailand currently has adequate utility supplies; the biggest future challenge will be meeting peak demands and cost containment. Rising fuel prices affect the profitability of produce marketing from more distant production areas. Thailand’s electricity-generating capacity is generally adequate; additional supplies can be sourced from Laos to meet peak demand (TMCNET, 2007). Cost-reduction strategies and improvements for more efficient use of fuel and utilities are the most important variables for attention, along with a focus on the use of renewable energy sources (WEC, 2001).

#### ***Financial services***

In recent years, attention by government to land ownership issues has helped farmers improve security of tenure and access to finance. Access to finance (micro and macro) has improved opportunities for small and medium enterprises (SMEs). E-commerce is emerging, but bureaucratic procedures still complicate trade and marketing.

Direct and indirect taxation of the agriculture sector has been reduced and direct public support has increased since 1980 (Fuglie, 2001; Siamwalla et al., 1991). The Bank for Agricultural Co-operatives, a state-owned institution, provides

subsidized loans to farmers; under banking regulations, private banks must also lend some funds to the agriculture and food sectors (Fuglie, 2001). The German Technical Agency (GTZ) in partnership with local institutions is pioneering novel approaches to financing for farmers.

In line with government priorities for development, the Thailand Board of Investment (BOI) [www.boi.go.th/english/default.asp](http://www.boi.go.th/english/default.asp) fosters investment in the Thai vegetable industry. BOI support reduces the risks and costs associated with investments to enhance prospects for better returns. BOI priority areas for agri-industry include: plant propagation and grafting, hydroponics, the manufacture of biological or organic fertilizers, food and beverage preservation and manufacture, packaging, postharvest handling and cold storage, farm management, the inspection, analysis and certification of plants, products, soil and water for quality, pests and diseases, and the establishment of trading centers and processing zones.

#### *Value adding for food processing and catering services*

Thailand has at least 30 companies manufacturing or distributing frozen fruit and vegetables, and 64 manufacturers or distributors of canned, pickled, or pureed fruit and vegetables<sup>13</sup>. The majority of companies are in outer Bangkok, and in the production areas of Rayong, Chantaburi, Chiang Mai, and Lamphun (BOI, 2007b).

In 2005, major frozen vegetable exports (French bean, sweet corn, and okra) were to Japan, USA, and the European Union (EU). Major exports of canned vegetables (baby corn, sweet corn, mushroom, and tomato) were to the EU and USA. While most processors focus on the export sector, opportunities exist in building the domestic market for processed products.

As a major transport hub and tourist destination, Thailand also has opportunities for supplying air and shipping services, and the food catering and hospitality industries. Key challenges are to develop a reputation as a reliable supplier of safe produce, achieve international accreditation for HACCP<sup>14</sup> certification, and encourage more import replacement in the hospitality and catering industries.

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<sup>13</sup> Est. based on BOI (2007b) 2007 lists.

<sup>14</sup> HACCP = Hazard Analysis and Critical Control Points (Wikipedia, 2007c).

## *Marketing fresh produce: wholesale and retail sectors*

### ***Wholesale***

The fresh produce sector is based upon major wholesale markets supplying the retail and catering sectors, and distribution centers supplying supermarkets and processors. The wholesale sector includes 17 large markets (with three in Bangkok—including Talaad Thai Wholesale Market and the Pak Klong Talad market—covering 80 ha and handling 15,000 tonnes of transactions/day,) (DOAE, 2007a). As a major fresh produce sector, improvement of wholesale market facilities and operations has been a priority for government. Efficiency has been improved by modernization of infrastructure and supply chain management, and attention to quality management, cleanliness, and access (Hau and von Oppen, 2004).

### ***Retail***

Significant growth has occurred in the supermarket sector, which has now overtaken the traditional trade (Poapongsakorn, 2006). This is driving change in supplier-and-farmer practices and relationships, with a two-tier approach to retailing to extend market penetration (supermarkets/hypermarkets and neighborhood convenience stores).

Retailers established in Thailand include [7-Eleven](#) (franchise of CP Group<sup>15</sup> - 3,700 stores (2006)), [Carrefour](#) (72 stores), [Royal Ahold](#) (no longer in Thailand; all operations sold to partner the Central Group in 3/2004), [Tesco Lotus](#) (366 stores open: 57 hypermarkets; 17 value stores; 23 Talad Lotus stores; 269 Express stores), [Makro](#) (29 stores in 2006) (Pingali, 2004 - with updates on store numbers obtained during 2007 from Wikipedia listings and company sites).

Smallholders are integrated into supermarket supply chains via contract farmers and buyers who are preferred suppliers, and via farmer associations (Pingali, 2004). Although supermarkets tend to source from preferred suppliers, they are also providing training in quality and supply requirements for new suppliers. Inevitably, the emphasis on quality standards by supermarkets will lead to improvement of quality in the traditional markets due to spillover effects and higher customer expectations.

Due to concerns about growth of the supermarket sector and its impact on small retailers, a Retail Business Act is being fast-tracked in Thailand; if the

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<sup>15</sup> The Charoen Pokphand (CP) Group, the largest business group in Thailand, has CP Foods (with the slogan “Kitchen of the World”) as its major subsidiary. The group also includes Chia Tai Seeds (the basis of the group’s establishment in 1921), 7-Eleven stores and telecommunications businesses (Wikipedia, 2007b).

legislation is passed, this may slow investment, at least in the short term (Planet Retail, 2007; Thailand Law Forum, 2007; The Nation, 2007).

### Trade development

Exports and import quantity and value are shown in **Table 5**.

#### Exports

Export of fresh and processed vegetables accounted for 30-40% of production between 1995 and 2005 for the FAOSTAT vegetable category (**Table 1**). Trading partners included Japan, USA, EU, Malaysia, Indonesia, and Singapore for the 30 categories of product exported, including fresh, frozen, chilled, canned, and preserved products and juices. The fresh okra, asparagus, and onion sectors were highest value (each > 100 m baht (aboutUS\$ 6 million) /year). Processed products included baby corn, bamboo shoot, sweet corn and chili sauce (DOAE, 2007a; Thai Customs, 2007).

**Table 5.** Trade data – imports and exports of vegetables (including melon) and chili (green and dry)

	2000	2001	2002	2003	2004	2005
<b>Exports Quantity (tonnes)</b>						
Vegetables, fresh	73,000	84,000	87,000	83,000	150,000	147,000
Vegetables, processed	233,000	245,000	270,000	315,000	319,000	327,000
Tot. veg.	306,000	329,000	357,000	398,000	469,000	474,000
<b>Exports Value (1000 US \$)</b>						
Vegetables, fresh	40,596	55,410	65,081	71,474	101,937	112,112
Vegetables, processed	214,254	205,397	215,686	245,454	286,391	302,502
Tot. veg.	254,850	260,807	280,767	316,928	388,327	414,615
<b>Imports Quantity (tonnes)</b>						
Vegetables, fresh	13,000	15,000	38,000	95,000	126,000	154,000
Vegetables, processed	23,000	26,000	44,000	46,000	63,000	67,000
Tot. veg.	36,000	40,000	81,000	141,000	189,000	221,000
<b>Imports Value (1000 US \$)</b>						
Vegetables, fresh	8,011	9,486	10,503	19,366	29,858	33,447
Vegetables, processed	25,903	24,413	32,339	34,895	50,681	55,731
Tot. veg.	33,914	33,899	42,842	54,261	80,539	89,178

Source: FAOSTAT (2007)

In 2005, 1.3 billion tonnes of fresh and processed vegetables were exported. Fresh exports were mainly to Asia (Japan, Taiwan, Hong Kong, Malaysia) and major crops were asparagus, okra, baby corn, shallot, and ginger.

One example of success in the vegetable sector is the case of Swift Co., Ltd., which, with UK partner Exotic Farm Produce, formed Exotic Farm Produce (Thailand) Co., Ltd in 1990. Swift now claims to be “one of Southeast Asia’s leading fresh produce exporters within the niche market of quality Asian and Southeast Asian organic, chemical free, and EUREP GAP-compliant, conventionally farmed vegetables and fruit” (Exotic Farm Produce (Thailand) 2007). Core vegetable lines for Swift include asparagus, baby corn, ginger (galangal, and lemongrass that are processed and packed for sale to retail and food service markets and exported to Japan and the EU. Their major production base is in Nakorn Pathom, where the original contract farmers in their supply group now enjoy improved incomes (49,900 baht/rai (US\$ 10,203/ha) growing vegetables c.f. 1,240 baht/ rai (US\$ 254 /ha) growing cassava); membership has grown from 47 farmers with 94 rai (15 ha) in 2001 to 493 farmers with 1,100 rai in 2004 (Uathavikul, 2004).

### ***Imports***

While imports can be regarded as a competitive threat for Thai farmers, they contribute a significant component of business returns to many exporters and are thus a significant component of industry development<sup>16</sup>. In 2005, 280,200 tonnes of vegetables and chili (dried and green) worth US\$ 88.0 million were imported. Commodities included vegetable seeds and temperate and dried vegetables. While the volume of imports is approaching that of exports, the value of imports is still substantially lower than the value of exports. Imported seed included coriander, Chinese kale, and cabbage from Australia, Japan, and the USA. Fresh temperate vegetable imports included carrot, broccoli, salad crops, and sweet pepper from Australia and China. Dried vegetable imports included dried chili, dried bean, and dried mushroom for the retail and food processing sectors, with most imports from China (DOAE, 2007a).

## **3.4 Institutional framework and operational environment**

### *Policy and regulatory agencies*

Key framework policy issues for agriculture (and the vegetable sector) encompass [Thailand’s commitments](#) (WTO, 2007) as a member of the World Trade Organization (WTO), and as signatory to international agreements, regional agreements (such as those on water and land management), and bilateral free trade agreements (BOI, 2007c) (currently with Australia, China, India, New Zealand and ASEAN (Association of Southeast Asian Nations), and an [Economic Partnership Agreement with Japan](#) (MOFA, 2007), with impacts

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<sup>16</sup> It can be easier and more profitable to repatriate funds as imported goods rather than money.

felt in the vegetable sector in terms of attention to GAP certification, sanitary and phytosanitary (SPS) issues and WTO/export access and import competition.

The National Economic and Social Development Board (NESDB) takes the lead in national planning<sup>17</sup> and (along with MOAC) influences the relative attention by government to the vegetable industry sector. Responsibilities of the NESDB Board are: providing advice on national economic and social development to Cabinet; reviewing the National Economic and Social Development Plan and considering other NESDB proposals, especially in the areas of infrastructure development, before submitting to Cabinet for approval; providing recommendations to the Prime Minister on economic and social development issues as requested; and coordinating between the NESDB and related government agencies and state enterprises to formulate plans and implement development projects. The Office of NESDB also coordinates progress on the four national agendas: alleviation of poverty and income distribution problems; enhancing Thailand's competitiveness; promoting social capital development; and promoting sustainable development.

The NESDB and Office also commission policy research through agencies such as the Thailand Development Research Institute (TDRI). Topical issues of relevance to the vegetable sector include: natural resource degradation and review of price support policies; structural adjustment programs for industries affected by import competition, underpinned by an effective integrated rural development policy; planning for climate change impacts and environmental sustainability; logistics and transport: cross-border trade, airfreight and fuel costs; WTO and SPS obligations and European Union/Japanese regulatory restrictions; and transport and communication improvements to enhance responsiveness and delivery of vegetables to meet market needs (Poapongsakorn, 2006).

Thai government ministries and agencies also are involved in formulating policy and regulatory measures and providing services in line with portfolio responsibilities, in addition to supporting research and development initiatives that meet international and regional obligations and national planning objectives. Interfacing with the government agencies are a range of national and regional

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<sup>17</sup> A 99-member [National Economic and Social Advisory Council](http://www2.nesac.go.th/english/) (NESAC, 2006) (<http://www2.nesac.go.th/english/>) (with 16 members from the agriculture sector), also provides background and advice to government on national planning. Responsibilities of the NESAC are to: (i) provide advice and make suggestions to cabinet on economic and social issues, to facilitate policy development; (ii) comment on the National Economic and Social Development Plans and other plans as required by applicable laws prior to the proclamation of such plans; (iii) provide advice in accordance to the cabinet's request; and (iv) conduct studies and to publish an annual report on the economic and social states of the country.

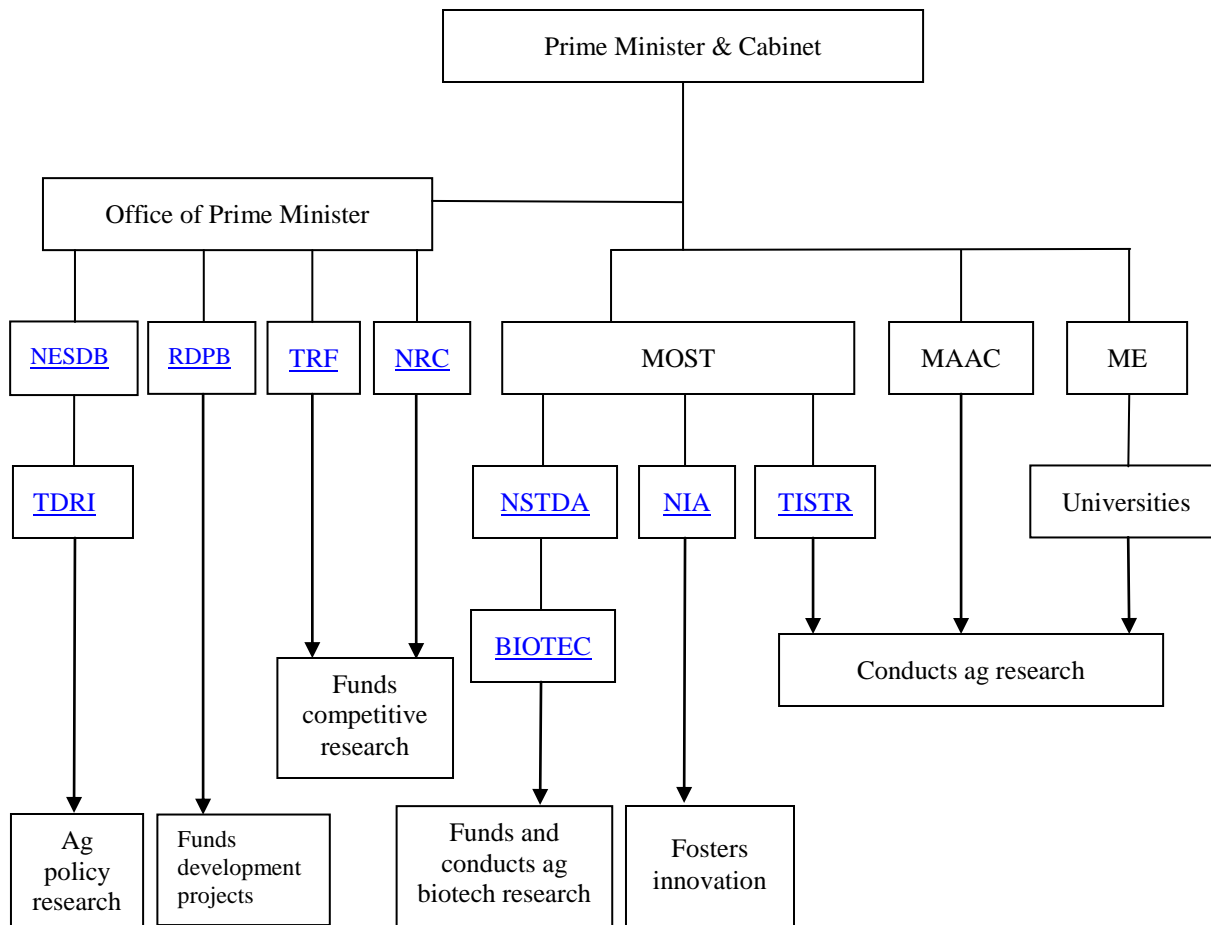
industry bodies that provide representation and voices for change, moderation, and “government with government.” As the King of Thailand, and as an individual with a passion for the agricultural development of the country, His Majesty King Bhumibol Adulyadej also takes a strong interest in the development of the Thai agriculture sector.

#### *Research, development, human resources*

In Thailand, the government’s vegetable industry research, development, and extension annual plan is overseen by the Vegetable Research and Development Group under the National Research Council (NRCT, 2007) as part of the National R&D annual plan, which determines areas of critical focus for sectoral planning. The plan for 2006 articulated five strategies: national security, foreign relations and justice; national competitiveness; social capital, poverty alleviation, and quality of life; sustainable development; and governance (NRCT, 2006).

A large proportion of the agriculture R&D initiatives flowing from the National Plan are funded by the government, although donor assistance still provides significant support, especially in policy, quality management, GAP certification and contaminant management, with donor and international collaboration coordinated through the Thailand International Cooperation Agency (TICA) within the Ministry of Foreign Affairs (TICA, 2007).

The NESDB, the Thailand Research Fund (TRF) and the National Research Council (NRC) undertake R&D priority setting and fund research, operating under the Office of the Prime Minister. The development of remote and disadvantaged communities receives particular attention through the Royal Projects Development Board (RPDB) under the Office of the Prime Minister. The private sector also undertakes R&D to support industry needs with some incentives from government for priority areas (Fuglie, 2001). Agencies funding and undertaking public sector agricultural R&D are shown in **Figure 8**.



Source: Adapted from Fuglie (2001)

**Figure 8.** Agencies funding and undertaking public sector agricultural research in Thailand

The Ministry of Agriculture and Co-operatives (MOAC) uses about 95% of the public sector support for agriculture R&D<sup>18</sup>, which grew by 9% per annum between 1983 and 2003. In 2003, 13,500 million baht (US\$ 346 million), representing 1.99% of agricultural GDP and 0.41% of GDP was provided for MOAC research and extension (Poapongsakorn, 2006). Research and extension covered technical issues, infrastructure, services (such as irrigation), marketing, and economics. While expenditure for research and extension, and for irrigation, averaged 23% and 50% respectively, Poapongsakorn (2006) considered that research planning and priority setting were inadequate, and as a consequence funds and resources were not being optimized.

Key agencies under the MOAC (2007) providing support for the vegetable sector include:

**Department of Agriculture** (DOA, 2007), whose support for horticulture focuses on plant breeding, soil and nutrition management, sustainable production, crop protection, postharvest technology, food science, safety, and plant quarantine.

**Office of Agricultural Economics** (OAE), which contains the Bureaus of Agricultural Development Policy and Planning, Agricultural Economics Research, International Agricultural Economics, and Centers for Agricultural Information and for Project and Program Evaluation, and regional offices for Agricultural Economics. The Center for Agricultural Information of the OAE publishes the *Agricultural Statistics of Thailand* annually in English (based on surveys conducted by OAE, MOAC partners, and other government agencies) (OAE, 2006). The published/online vegetable statistics only include garlic, baby corn, shallot, onions, chili, tomatoes, and potatoes, and on-farm price, value, and quality indices for vegetables c.f. 1988-89 as 100. Production area maps for major vegetables are also produced (in Thai) ([www.oae.go.th/English/statE.htm](http://www.oae.go.th/English/statE.htm)).

**Department of Agriculture Extension** (DOAE) focuses on participatory development (farmer and community participation in learning and development), with extension personnel acting as facilitators/coordinators among state officials, relevant organizations, and farmers. Agricultural Technology Transfer Centers (ATTC) have been established at the subdistrict level to

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<sup>18</sup> The 95% figure (2003) probably refers to production-focused research as other agencies also make substantial investments in postharvest, marketing, and policy research.

serve as a coordinators and link activities of all relevant agencies. The DOAE is also involved collecting agricultural statistics at the district and subdistrict levels, and publishes in Thai more extensive statistics than those from OAE on a larger range of crops (DOAE (2007b) and MOAC (2007) websites).

**Cooperative Promotion Department** oversees both agriculture and non-agriculture sector cooperatives through the [Cooperative League of Thailand](#), with agricultural cooperatives focusing on savings and credit, consumer and input supplies, marketing and extension.

**Land Development Department** is responsible for soil and land management and extension of conservation and sustainable soil and land management: [www.ddd.go.th/indexEng50.htm](http://www.ddd.go.th/indexEng50.htm) (Land Development Department, 2007).

National Bureau of Agricultural Commodity and Food Standards (ACFS)<sup>19</sup> is the focal point for conformity to international standards, especially for export commodities. The bureau has published standards for okra, asparagus, and chili peppers, GAP for food crops, and Maximum Residue Limits (MRL) for pesticide residues. Within the ACFS, the Office of Commodity and System Standard Accreditation has published (in Thai) *Food Consumption Data of Thailand 2006*, the most recent account of food consumption patterns in Thailand.

The Ministry of Science and Technology (MOST) also funds the Thailand Institute of Scientific and Technological Research (TISTR), which undertakes basic and applied research in selected areas of agriculture, and the National Innovation Agency (NIA), which has a mandate to foster innovation in Thai R&D (**Figure 8**). A well-resourced biotechnology program is funded through the National Science and Technology Development Agency.

Public universities undertake agricultural research and extension in policy, marketing, business planning, and crop and technology improvement, funded through the Ministry of Education (ME) (formerly Ministry of University

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<sup>19</sup> The ACFS (established in 2003-04) is the national regulatory body for food safety, with MOAC and the Ministry of Public Health as core agencies involved. The ACFS has the following roles: (a) establishing national standards, (b) participating in international/regional standard establishment, (c) facilitating utilization of standards by stakeholders (farmer, trader, manufacturer, exporter, authorities, CB), (d) accrediting certification/inspection bodies, and (e) negotiating with other countries on standardization.

Affairs), and through project funds from the Thailand Research Fund (TRF), the National Research Council (NRC) and other agencies. The education sector also teaches the vegetable industry by educating future farmers, researchers, policy makers, and other industry personnel. However, the effectiveness of university contributions to research can be hampered by requirements of academic staff to meet teaching commitments.

In addition to attention to technical aspects in support of the vegetable industry under MOAC, MOST and ME, other ministries share responsibilities for marketing and trade promotion, food safety and health, and the regulation of imports and exports.

In addition to the efforts of national agencies and the private sector in agriculture R&D for the vegetable industry, several international and regional agencies contribute substantially<sup>20</sup> to industry development and policy analysis: AVRDC – The World Vegetable Center, the Food and Agriculture Organization (FAO), the Asian Development Bank (ADB), the World Bank, the United Nations Commission for Trade and Development (UNCTAD), USAID and UNDP, the International Food Policy Research Institute (IFPRI), the French International Research Centre for Agriculture Research and Development (CIRAD), the German Technical Agency (GTZ), the European Commission and other European agencies, the Japan International Cooperation Agency (JICA) and the Japan International Research Center for Agricultural Sciences (JIRCAS). Support also comes from industry bodies, such as the Asia and Pacific Seed Association (APSA), CropLife Asia, and numerous non-governmental organizations (DAD Thailand, 2007)<sup>21</sup>.

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<sup>20</sup> The location of regional centers for some organizations in Bangkok contributes to an apparent overemphasis by donor agencies for Thailand's development needs, compared to regional neighbors that are arguably more needy, but these efforts also reflect the large in-kind support from the Government of Thailand for hosting agencies and are balanced by the growing level of Thailand's support for regional development.

<sup>21</sup> The Development Assistance Database (DAD) Thailand currently focuses on listing tsunami-related relief, but it has potential to be developed as an ongoing site that lists all development support. This approach has been taken by DAD Vietnam (2007).

## 4 Achievements and Lessons Learned: Case Studies

The challenges for the Thai vegetable industry and some of the lessons learned can be highlighted by examples from selected industries: green soybean, asparagus, and baby corn, and the organic sector.

### 4.1 Green soybean (edamame)

**Lesson 1:** Understand and capitalize on market opportunities, and adjust systems to meet changes in customer requirements.

The green soybean is one of the highest value Thai export crops. With just three Thai companies in joint ventures with Japanese and Taiwanese companies, the industry is focused in Chiang Mai, Chiang Rai, and Lampung to export almost all production to Japan (to supply 12.7% by volume of Japan's imports). In the latest available data (2000-2002) (**Table 6**) production and exports fluctuate from 8,000–10,000 tonnes and represent about one-third of frozen vegetable exports from Thailand. Because of precise weather conditions required for growth, the prospects for expansion of the production area are limited despite unfulfilled demand (Manarungsan et al., 2005).

**Table 6.** Green soybean production and marketing data compared to total fresh vegetable exports.

	2000	2001	2002	2003	2004
Production area (ha)	1275	3009	na	na	na
Production (tonnes)	10,305	8,250	9,392	na	na
Domestic consumption (tonnes)	206	165	188	na	na
Export volume (tonnes)	10,099	8,085	9,204	na	na
Frozen green soybean exports to Japan (t) <sup>a</sup>	8,690	7,768	8,836	11,285	11,215
Total fresh vegetable exports (tonnes) <sup>b</sup>	75,350	86,666	89,925	82,960	150,410
Total frozen vegetable exports (tonnes) <sup>b</sup>	31,316	27,357	29,906	34,480	44,870
Share (by value) of green soybean exports to Japan compared to total frozen vegetable exports (%) <sup>c</sup>	33.7	30.5	33.9	39.3	32.2

Source: 2000-2002 data after Manarungsan et al. (2005)

<sup>a</sup>2003-2004 mirror data from Trade Statistics of Japan, (Customs and Tariff Bureau - Japan, 2007); <sup>b</sup>2003-2004 data from FAOSTAT (2007); <sup>c</sup>2003-2004 data estimated based on data from Customs and Tariff Bureau - Japan (2007) and FAOSTAT (2007)

The key issues for green soybean production and processing have been maintenance of physical and chemical quality, and compliance with Japan's plant protection and food sanitation laws. The crop is grown under contract, with the processor or exporter controlling standards and quality, but the farmer remains responsible for costs associated with compliance. For example, farmers have reduced pesticide use, adopted "softer" treatments, and improved record-keeping to meet Japanese compliance with residue and traceability requirements.

Production costs rose in 2003 due to the adoption of the improved chemical treatments and greater use of organic fertilizers, but farmer returns also increased. The farm-gate price rose by 6.3% (to US\$ 0.31/kg), and net income rose from US\$ 1,242 to US\$ 1,324/ha in 2003. Exporters also had to invest more in regulatory and quality control technologies and personnel, with a 33% increase in technology costs, a 200% increase in QA and testing personnel, and a 15% increase in farm advisors, as well as additional costs for training and capacity building (Manarungsan et al., 2005).

In moving rapidly to meet the new requirements for the Japanese market, Thailand has kept and improved its market share by adjusting production and regulatory practices to meet market needs. To strengthen competitiveness further, the industry will need to further promote GAP, food chain HACCP and regulatory enforcement; improve information access for all chain members in relation to changes in food safety and regulatory requirements; and enhance the private sector's capacity in quality management, traceability systems, and in accessing information and networking. To expand market opportunities in the longer term, the development of varieties and production technologies that improve yield, broaden growth range, and reduce reliance on chemicals will be necessary; additional high-end markets could be sought.

## **4.2 Asparagus**

*Lesson 2:* Focus government support to encourage foreign investment, concentrate on quality, and promote cooperative and niche marketing.

The Thai industry is one of the Top 10 global asparagus exporters. It has grown at > 10% per year from 2000 to 2005, with the industry's foundation boosted by specific promotion from MOAC under the 6<sup>th</sup> National Plan (1987-1991).

Concentrated in Thailand's western provinces (Kanchanaburi, Nakorn Pathom, Suphanburi, and Ratchaburi = 80% production in 2003), with a focus on export markets in Japan, Taiwan, and the UK, export volumes and value grew at 27 and

33% annually between 2000 and 2005) (**Table 7**). The industry provides small-scale farmers (< 1 ha) an alternative reliable income. It is well-organized, and most of the 4,655 farmers (2003) are in grower groups that have contracts with exporters (GTZ-CMU, 2006).

**Table 7.** Asparagus production and export statistics

	2000	2001	2002	2003	2004	2005
Export quantity (1000 tonnes)	3.83	7.43	8.02	6.98	11.96	15.76
Export value (1000 US \$)	6,476.00	10,790.79	13,807.72	15,611.24	24,568.00	28,165.00

Source: FAOSTAT (2007)

However, the crop uses high levels of fertilizer, takes 2-3 years to reach full production, and is prone to Fusarium root rot disease. Yields average 3.7 t/ha, and prices range from baht/kg 90 for organic to 60 for A+ grade, 35 for B grade, and 10-15 for off-grade. Market insistence on low residue levels means the crop is increasingly being grown under eco-production principles.

The industry has benefited from proactive support from government (tax incentives to foreign investment, R&D, marketing) and the promotion of contract growing, but to further strengthen competitiveness the industry needs to retain and expand high-end markets by optimizing production, enhancing food safety and quality standards, improving supply chain handling and logistics, and reducing the cost and complexity of certification. It also needs to build the medium and low-end markets (such as Taiwan) by improving cost control, handling and logistics. In the longer term it has to address production and crop protection problems to improve sustainability and develop new markets in Asia, the Pacific, and domestically through promotion and produce innovation (GTZ-CMU, 2006; Manarungsan et al., 2005).

### 4.3 Baby corn

**Lesson 3:** Promote the processing sector through streamlined production and market development, and focus on production advantages and customer requirements.

Baby corn is a small- to medium-sized industry concentrated in the same region as the asparagus industry. In 2005 it earned US\$ 50.5 million for canned, and

US\$ 9.1 million for fresh product<sup>22</sup> (**Table 8**). It has been a great success story, with Thailand the world leader in exports (80%).

**Table 8.** Baby corn production and export data

	2000	2001	2002	2003	2004	2005	2006
Area harvested (ha)	22,946	35,108	36,109	32,644	38,200	38,700	
Production (tonnes)	179,914	286,883	251,906	241,428	305,000	273,000	
Export (tonnes) (Fresh)	3,544	4,544	3,955	8,444	3,583	4,860	5,878
Export value (Fresh) (1000 US\$)	4,400	3,300	4,100	4,700	5,800	9,165	13,067
Export value (Canned) (1000 US\$)	42,500	37,400	29,100	39,200	39,800	50,509	56,470

Source: OAE (2006; 2007); Dept Export Promotion 2005 (after GTZ-CMU, 2006), with updating from Trade Statistics (Thai Customs, 2007)

Most exports are to the UK and Japan, but those to the US are the highest value. The Thai industry advantages include year-round supply, R&D capability (including the strong seed sector), good infrastructure and processing, reasonable shipping and logistics, and an established reputation for consistent and safe processing standards (GTZ-CMU, 2006).

In 2003, the industry involved 9,300 farms covering 26,500 ha (production area - 0.8-1.6 ha per farm), with total production averaging 200,000 t/year<sup>23</sup>. Crop yields range from 190 to 290 kg/ha (of de-husked cobs), with farm-gate values of US\$ 0.33 to 0.38/kg (GTZ-CMU, 2006).

The sector supports about 5 packing houses, 20 exporters (3 dominate), 30 domestic traders supplying three wholesale markets in Bangkok, and around 100 manufacturers/exporters of canned baby corn (usually in brine). Collectors (about 100), who provide additional services to growers (machinery and labor, and credit to buy seed and fertilizers at high prices), have dominated the sector and may overcharge for their services, while prices have remained static. Value-adding breakdown for fresh baby corn is: 8% from growers, 6% from collectors, 26% from manufacturers and 60% from exporters. Value-adding breakdown for canned baby corn is: 12% for growers, 2.3% for collectors, 74% for manufacturers, and 11.8% for exporters (GTZ-CMU, 2006).

<sup>22</sup> With a further 5% of production as frozen baby corn.

<sup>23</sup> The difference in the figures c.f. **Table 8** is because data in **Table 8** is for the entire country.

The industry has been able to capitalize on access to level, well-drained fields that remain productive in the rainy season, the region's proximity to international airports, and the professionalism of manufacturers, packers, and shippers. Pesticide residue testing is a major cost borne by exporters (about US\$ 7,000 to certify a 0.8 ha sample of the total farm area under contract).

To strengthen competitiveness, the industry needs to improve quality maintenance and reduce damage by: improving on-farm mechanization and labor skills; introducing better storage technologies at collection sites; providing cooling for airport vehicles; introducing product traceability systems (from point of cob-dehusking); developing and enforcing industry standards; overcoming inconsistencies in supply (labor availability, seasonal peaks); and providing greater incentives to growers to harvest at optimal maturity. In the longer term the industry will need to stimulate customer demand using more targeted marketing to overcome price sensitivity and develop strategies (including brand loyalty and cross-marketing) to counter the pricing strategies of competitor countries (GTZ-CMU, 2006).

#### **4.4 The organic sector**

***Lesson 4:*** Provide frameworks and support for identification and development of niche markets and foster private/public sector working relationships.

Thailand's organic sector is still at an early stage of development, with most investment in rice and other field crops. Ellis et al. (2006) estimated Thai organic vegetable production in 2005 at 4,618 tonnes (1-2% total vegetable production) from 2,375 ha (< 1% of total area under vegetables) (**Table 9**). The government is strongly supportive of the sector, and NGOs have played key roles in helping its establishment (Ellis et al., 2006).

**Table 9.** Production statistics for organic fruit and vegetables in Thailand

	2000	2001	2002	2003	2004	2005
Production area Vegetables (ha)	563 <sup>24</sup>	563	3,581	3561	2,125	2,375
Production area Fruit (ha)					2,944	799
Production volume Vegetables/herbs (tonnes)	-	-	-	2,671	2657	4618
Production volume Fruit (tonnes)	-	-	-		3833	3746
Production value Vegetables/herbs (m Baht)	-	-	-	160.28	159	256
Production value Fruit (m Baht)	-	-	-		77	75

Source: Green Net/Earth Net Foundations (after Ellis et al., 2006)

There is a substantial premium paid for organic produce in the domestic sector, but there is also a premium paid for the less-stringent “hygienic” produce (**Table 10**). While returns from organic vegetables can be profitable, conversion may take 1-3 years, with losses in yield and income. Often farmers lack the expertise in organic technologies and in maintaining certified status, and they cannot label produce as organic in the transition period.

**Table 10.** Price comparisons between conventional, hygienic, and organic vegetables – average prices (baht/kg) at survey times

	Dec 2001	Jul 2002	Mar 2003	Dec 2003	Mar 2004	Aug 2004	Feb 2005
Conventional vegetables	40.2	41.3	39.0	57.5	29.5	34.9	29.9
Hygienic vegetables	54.8	60.3	35.3	56.8	46.3	83.3	48.2
Organic vegetables	88.4	67.0	65.9	64.3	76.8	135.3	52.4
Premium of organic over hygienic	61%	11%	46%	12%	40%	38%	8%
Premium of organic over conventional	120%	62%	69%	11%	62%	74%	43%

Source: Ellis et al. (2006)

To strengthen the customer base and maintain competitiveness the industry needs to: develop uniform and reliable standards for organic produce that distinguishes organic produce from “safe” produce, and obtain “Third Country

<sup>24</sup> Statistics for 2000-2003 combine data for fruit and vegetables.

List” status (European Commission, 2003) using internationally-recognized private certification agencies in Thailand; provide farmers who move to organic production with transition incentives that take account of the time, cost, expertise, and capacity building that is needed for successful conversion to organic production; develop cooperative linkages and reliable technologies for organic production, crop protection and postharvest storage; and build supply chain linkages that reliably preserve organic produce integrity, maintain quality, and satisfy customers.

There are good opportunities for the sector to supply the domestic market, and for the export of fresh and processed product, particularly if attention is given to understanding the customer base and requirements. Ellis et al. (2006) described the typical domestic buyer of organic produce as mainly urban, middle class, health conscious, and often female, with access to information and sources of organic produce and health foods. But busy lifestyles impact customer preferences. Vanit-Anunchai and Schmidt (2006) noted that people who eat out more than two times a day are not interested in purchasing pesticide-free food. Key challenges for the industry are to build and expand customer loyalty to organic foods while ensuring the customer expectations for quality, safety, reliability, and variety are met, and to devise opportunities to develop an organic market for prepared and ready-to-eat meals.

## 5 Conclusions

### 5.1 Policy and human resource issues

Generally sound macroeconomic policy<sup>25</sup>, and the 1986 shift in trade policy from one that penalized farmers to a more neutral approach has benefited Thai agricultural development (Poapongsakorn, 2006).

To enhance industry viability and its contribution to the national economy while maintaining a pro-poor focus and generating employment in line with the National Agenda<sup>26</sup>, Thailand needs to build market-focus by enhancing understanding and responsiveness to global opportunities; strengthening business management skills; strengthening domestic demand by encouraging increased consumption of vegetables for community health and nutrition; supporting small and medium enterprise development to create innovative food products, add value, and provide employment; accelerating modernization by monitoring and encouraging industry restructuring towards systems that are more efficient and ecological in resource use, with the migration of bulk-vegetable production moving to areas where land costs are lower; enhancing competitiveness by continuing to stimulate technical innovation and supply chain efficiencies; developing transitional arrangements for those who are unable to compete in the modern industry; and fostering a more professional industry through training, capacity building, and attention to the education of tomorrow's industry personnel.

### 5.2 Industry issues

Technological improvement (seed and germplasm, crop protection, mechanization, and resource management), along with increasing farm size, enterprise specialization, and market diversification, have been key factors contributing to the development of the Thai vegetable sector. Change has been pioneered by “commercial” farmers, contract farming, the seed industry, and other agribusiness sectors, but many ordinary farm households have also diversified their income into non-rice agriculture and non-farm activities. The latter includes off-farm employment and remittances from family members, which have helped stabilize income to enable more risk-taking in on-farm diversification (Poapongsakorn, 2006). A key outcome has been increased fruit

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<sup>25</sup> Except the early 1980s and 1990s, and early in the 1997 crisis, (Poapongsakorn, 2006).

<sup>26</sup> (i) alleviation of poverty and income distribution problems, (ii) enhancing Thailand's competitiveness, (iii) promoting social capital development, and (iv) promoting sustainable development.

and vegetable cultivation and marketing as contributions to farm improvement and income.

Modernization of farming practices also has occurred in response to the growth of market supply chains (supermarket, processing, and export) and the affordability of technologies, which have enabled farmers to intensify production and meet more stringent quality and supply parameters. Revitalization over the last decade also has benefited from currency depreciations and the commodity boom, which have stimulated exports and buffered the adverse impacts of rising wages and resource constraints.

Strong emphasis on quality and meeting market requirements has been a key to industry development. As a consequence, trade in fresh and processed vegetables is healthy, with broad emphasis on quality and cost containment. The production sector has a major focus on GAP compliance—both to achieve Thai certification standards (Thai GAP or Q Mark) and internationally recognized standards (such as EurepGAP or various organic certification standards)—and WTO/SPS compliance, and it now needs to streamline procedures and build traceback capabilities.

Infrastructure improvements and strengthening supply chains have enhanced access and quality management capabilities for fresh and processed produce, but more can be done to improve efficiency and reduce losses. Consumers have appreciated access to the wider range of safe, affordable produce and convenience foods that have become available as a consequence of farm diversification, supermarket and food-industry expansions, and increased imports. Promoting the health benefits of vegetables among consumers will further enhance demand and deliver strong community benefits while improving farmer profits. But greater focus is required to stabilize and build profits from core markets through technological and supply chain innovation, seek novel and niche market opportunities, and improve customer satisfaction.

Within this process, some farmers/communities will become increasingly marginalized. Competition from imports is affecting the viability of some industries (e.g. garlic), and some farmers may be unable to meet the higher quality and safety standards required by markets. For those affected, transitional arrangements and new enterprise options will be needed to minimize dislocation and distress as agriculture modernizes.

### **5.3 Issues for focus**

Farmers in general do value and appreciate the roles of the input and finance industries, the food processing and trading sectors, the government and the consuming public in industry growth and development, and the critical underpinning provided by research, development, and extension. Building and maintaining farmer trust should be a key element of industry development strategies.

Farmers particularly appreciate and benefit from measures that improve farm efficiency and productivity and make their enterprises less risky. They are aware that investments in germplasm collection and development, breeding and seed supply, crop protection, and productivity improvement will remain critical as the industry evolves. Farmers are beginning to understand the challenges and benefits of globalization and the importance of satisfying markets; they are learning how to strengthen integration with other supply chain sectors including exporters and supermarkets. To assist farmers, support for policy and supply chain analysis and improvement should be strengthened.

## 6 Recommendations for R & D

### ***Enhance production and trade data***

Enhance collection and analysis of local and international production and trade data, and domestic and international supply-and-demand trends. This will sharpen capabilities for identifying and capitalizing on trade opportunities.

### ***Use modeling***

Develop capacities in economic, business, and industry modeling as tools for planning and development. This will strengthen capacity for stimulating and focusing investment in the vegetable sector.

### ***Streamline policy and planning***

Continue to streamline policy and planning processes and the effectiveness of regulatory enforcement, with emphasis on regional and global dialogue and harmonization. This will streamline and reduce costs of regulation and enforcement and strengthen policy synergies and dialogue.

### ***Strengthen supply chain engagement***

Strengthen engagement between supply chain sectors and investment in infrastructure, telecommunication, and utility delivery. This will improve profit shares, reduce costs, and improve system efficiencies.

### ***Link government and industry***

Build frameworks for more effective engagement of government with industry and consumers.

### ***Map industry***

Develop overarching and crop-specific industry maps that articulate current supply chains and identify key strengths, weaknesses, opportunities, and threats.

### ***Foster cooperation, innovation, advocacy, information access and re-skilling***

Encourage more extensive and more effective cooperation at both micro (farmer groups) and macro (industry/supply chain) levels. Greater emphasis is also needed on cooperative (or discount) buying and input use efficiency. Foster industry innovation through funding and investment incentives. This will allow industry to grow with less reliance on government. Strengthen advocacy capacity, especially at the farm and community level. This will ensure greater relevance and responsiveness of policy and R&D to industry needs. Improve information access and delivery, and strengthen transitional training.

### ***Enhance education and training***

Review and reform education curricula so that universities and technical colleges will be better able to meet the needs of modern agriculture and are equipped with the skills and training to foster more participatory approaches to teaching and learning. Diversify options for engagement by university personnel in R&D, and improve balance with their other commitments for teaching and administration.

### ***Improve productivity***

Strengthen attention to sustainable production systems, especially in more marginal environments where the pressures to enhance productivity despite water and land access constraints could seriously affect long-term sustainability. Focus on income enhancing options for smallholders including cooperative ventures and production technologies.

### ***Enhance uptake***

Boost assistance in technology adaptation and uptake, and promote the development of non-chemical alternatives to foster development of the protected cultivation and organic sectors.

### ***Innovate and enhance capacity***

Collect and conserve indigenous vegetable germplasm and commercialize the most promising. Build capacity in biosecurity risk assessment and preparedness and innovative crop protection technologies. Strengthen capacity in postharvest and storage/transport technologies in partnership with supermarkets and traders.

### ***Make funding more competitive***

Make R&D funding more transparent by providing the bulk of R&D funds via competitive bidding through an agency independent of line agencies (such as the Thailand Research Fund) rather than as part of budget grants to ministries. Encouraging cross-institutional collaboration would improve focus on outcomes, with increased synergies and less duplication of effort.

### ***Encourage partnerships and collaboration***

Foster stronger public/private partnerships in R&D to enhance funding use and strengthen application of outcomes. Strengthen attention to integration of donor support and international collaboration opportunities into Thailand's National Plan priorities, and reduce "donor pull." Develop the Development Assistance /International Collaboration Database as a record of both donor/collaborator investment in Thailand, and Thai development assistance.

## 7 References

### Statistics

- DOAE. 2007b. Extensive production figures of vegetables (original data was in Thai). Department of Agricultural Extension (DOAE), Ministry of Agriculture and Cooperatives, Thailand. <http://production.doae.go.th/>.
- FAOSTAT. 2007. FAOSTAT On-line. Rome: United Nations Food and Agriculture Organization. <http://faostat.fao.org/default.aspx>.
- OAE. 2006. Agricultural Statistics of Thailand 2005. Agricultural Statistics No. 414121. Bangkok: Center for Agricultural Information, Office of Agricultural Economics (OAE).
- OAE. 2007. Agricultural Statistics of Thailand 2003. <http://www.oae.go.th/English/statE.htm>.
- Thai Customs. 2007. Trade Statistics. <http://www.customs.go.th/Statistic/StatisticIndex.jsp>.
- UNFPA. 2007. Demographic, Social and Economic Indicators. In: State of World Population 2007. Unleashing the Potential of Urban Growth. United Nations Population Fund (UNFPA). <http://web.unfpa.org/swp/2007/english/notes/indicators.html>.
- United Nations. 2004. World Urbanization Prospects: The 2003 Revision. Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. <http://www.un.org/esa/population/publications/wup2003/2003wup.htm>.
- Wiesmann, D. 2006. A Global Hunger Index: Measurement concept, ranking of countries, and trends. Food Consumption and Nutrition Division Discussion Paper 212. Washington D.C.: International Food Policy Research Institute. <http://www.ifpri.org/divs/fcnd/dp/papers/fcndp212.pdf>.

### Other references

- BOI. 2007a. 10th National Economic and Social Development Plan 2007-2011. Overview comments, BOI Investment Review, Thailand Board of Investment. [http://www.boi.go.th:8080/issue/200609\\_16\\_8/41.htm](http://www.boi.go.th:8080/issue/200609_16_8/41.htm).
- BOI. 2007b. Promoted Company Database. Thailand Board of Investment. [http://www.boi.go.th/english/about/form\\_promoted\\_companies.asp](http://www.boi.go.th/english/about/form_promoted_companies.asp).
- BOI. 2007c. Thailand's Free Trade Agreements. BOI Investment Review. Thailand Board of Investment. [http://www.boi.go.th:8080/issue/200507\\_17\\_6/17.htm](http://www.boi.go.th:8080/issue/200507_17_6/17.htm).
- Boonyakiat, D. 2003. Postharvest handling of vegetables in the Royal Project Foundation. *Acta Hort* 604:625-630.
- Chulanont, S. 2007. Keynote Address by His Excellency General Surayud Chulanont, (Ret.) Prime Minister of the Kingdom of Thailand at the 5th ASEAN Ministerial Meeting on Rural Development and Poverty Eradication 31 January 2007, Dusit Thani Hotel, Bangkok. [http://www.thaigov.go.th/en/News/New\\_ArgumentEn.aspx?Nid=A07000000027](http://www.thaigov.go.th/en/News/New_ArgumentEn.aspx?Nid=A07000000027).
- Crawford, S. 2005. Logistics - New facilities, technology to streamline logistics processes. Business-in-Asia.com. [http://www.business-in-asia.com/thailand\\_logistics.htm](http://www.business-in-asia.com/thailand_logistics.htm).
- Customs and Tariff Bureau - Japan. 2007. Trade Statistics of Japan. [http://www.customs.go.jp/toukei/info/index\\_e.htm](http://www.customs.go.jp/toukei/info/index_e.htm).
- DAD Thailand. 2007. Development Assistance Database - Thailand. <http://dadthailand.mfa.go.th/dad/>.
- DAD Vietnam. 2007. Development Assistance Database - Vietnam. <http://dad.mpi.gov.vn/dad/>.

- DOA. 2007. Department of Agriculture.  
<http://www.doa.go.th/onestop/pqir/Thailand%20Plant%20Quarantine%20Import%20Regulations.pdf>.
- DOAE. 2007a. Commercial production and marketing of vegetables in Thailand. PowerPoint presentation by Distaporn, O., Feb. 2007. Department of Agriculture Extension.
- Duchy Originals. 2007. <http://www.duchyoriginals.com/public/default.aspx>.
- Ellis, W., V. Panyakul, D. Vildoza, and A. Kasterine. 2006. Strengthening the export capacity of Thailand's organic agriculture. Final Report of Project TA/A1/01A (Asia Trust Fund, ITC, EC). National Innovation Agency, MOST, MOAC.  
<http://www.intracen.org/organics/documents/Action-Plan-Thailand.pdf>.
- EurepGAP. 2007. <http://www.eurepgap.org/Languages/English/index.html>.
- European Commission. 2003. General guidance for third country authorities on the procedures to be followed when importing live animals and animal products into the European Union.  
[http://ec.europa.eu/food/fs/inspections/special\\_topics/guide\\_thirdcountries\\_en.pdf](http://ec.europa.eu/food/fs/inspections/special_topics/guide_thirdcountries_en.pdf).
- Exotic Farm Produce (Thailand). 2007. Exotic Farm Produce (Thailand) Co., Ltd.  
<http://www.thaifreshproduce.com/aboutus.htm>.
- Fuglie, K.O. 2001. Chapter 3 - Thailand. In: C.E. Pray and K. Fuglie (eds.). Private Investment in Agricultural Research and International Technology Transfer in Asia. Agricultural Economics Report No. (AER805). Economic Research Service/USDA. pp. 76-98.  
<http://www.ers.usda.gov/publications/aer805/aer805d.pdf>.
- Goto, J. and M. Koike. 1997. Ten farmer interview case study in Khon Kaen 1996. JIRCAS publication. Bangkok, Thailand: JIRCAS Bangkok Office.
- GTZ-CMU. 2006. Western vegetables asparagus and baby corn. GTZ and Chiang Mai University Interim Report (unpublished report).
- Hardeweg, B. and H. Waibel. 2002. Economic and environmental performance of alternative vegetable production systems in Thailand. Presented at the International Symposium entitled Sustaining Food Security and Managing Natural Resources in Southeast Asia - Challenges for the 21st Century, Chiang Mai, Thailand, January 8-11, 2002.  
[http://www.uni-hohenheim.de/symposium2002/pa\\_full/Full-Pap-S3B-1\\_Hardeweg.pdf](http://www.uni-hohenheim.de/symposium2002/pa_full/Full-Pap-S3B-1_Hardeweg.pdf).
- Hardeweg, B. and H. Waibel. 2006. A simulation model of vegetable production systems in Thailand: Selected results and some policy implications. PowerPoint presentation from Tropentag, Bonn, October 11-13 2006. Unpublished presentation provided by the Author (B. Hardeweg).
- Hau, A.M. and M.von Oppen. 2004. The efficiency of the vegetable market in Northern Thailand. Conference on International Agricultural Research for Development, Berlin, 5-7 October 2004. <http://www.tropentag.de/2004/abstracts/full/341.pdf>.
- Jayamangkala, N. 2004. Sustainable highland vegetable production: The Royal Project Foundation, Thailand. Proceedings of Food Security and Vegetables: a global perspective, Bangalore, India.
- Konuma, H. 2005. Opening speech. Mid-term Workshop: Sustainable use of problem soils in rainfed agriculture (TCP/THA/2906), Khon Kaen, Thailand, 18 to 21 April 2005, FAO RAP. <http://www.fao.org/world/regional/rap/meetings/2005/Apr18/20050418.html>.
- Kramol, P., K. Thong-ngam, P. Gypmantasiri, and W.P. Davies. 2006. Challenges in developing pesticide-free and organic vegetable markets and farming systems for smallholder farmers in North Thailand. *Acta Hort* 699:243-252.
- Kuo, C.G. and H. Toxopeus. 1993. Brassica rapa L. cv. group Chinese cabbage. In: J.S. Siemonsma & Piluek Kaem (eds.). Plant resources of South-East Asia. No. 8: Vegetables. Bogor, Indonesia: PROSEA Foundation. pp. 127-130.

- Land Development Department. 2007. Soil management for baby corn on organic farms. [http://www.ldd.go.th/Eng-detail/babay\\_corn.pdf](http://www.ldd.go.th/Eng-detail/babay_corn.pdf).
- Manarungsan, S., J.O. Naewbanij, and T. Rerngjakrabhet. 2005. Shrimp, fresh asparagus and frozen green soybeans in Thailand. Agricultural Research and Development Discussion Paper 16. Washington D.C.: World Bank. [http://siteresources.worldbank.org/INTARD/Resources/ThailandCountrySurveyF\\_final.pdf](http://siteresources.worldbank.org/INTARD/Resources/ThailandCountrySurveyF_final.pdf).
- Mephokee, C. 2003. Thai labour market in transition toward a knowledge-based economy. In: M. Makishima, and S. Suksiriserekul (eds.). Human Resource Development Toward a Knowledge-Based Economy: The Case of Thailand. ASED No.66. Chiba, Japan: Institute of Developing Economies, Japan External Trade Organization. pp. 1-40.
- MOAC. 2007. Ministry of Agriculture and Co-operatives. <http://www.moac.go.th/builder/moac/eng/mission.htm>.
- MOFA. 2007. Text of agreement between Japan and the Kingdom of Thailand for an economic partnership. Ministry of Foreign Affairs, Japan. <http://www.mofa.go.jp/region/asia-paci/thailand/epa0704/agreement.pdf>.
- Nath, P., M. Papademetriou, K. Piluek, and E. Herath. 1999. The vegetable sector in Thailand, A Review. FAO RAP Publication 1999/38. Bangkok: FAO RAP.
- NESAC. 2006. National Economic and Social Advisory Council. [http://www2.nesac.go.th/english/Main\\_highlight/pdf/the\\_national\\_economic.pdf](http://www2.nesac.go.th/english/Main_highlight/pdf/the_national_economic.pdf).
- NESDB. 2006. Summary of a seminar given by the NESDB Secretary General at the IITD 1/6/2006. National Economic and Social Development Board. <http://www.itd.or.th/en/node/308>.
- NRCT. 2006. Summary of integrated research plan for fiscal year 2006. National Research Council of Thailand. <http://www.nrct.net/downloads/251104integrated2006.pdf>.
- NRCT. 2007. National Research Council of Thailand. <http://www.nrct.net/eng/>.
- Osotsapar, Y. and K. Sakulyong. 2006. Overview of agriculture and fertilizer consumption in Thailand. IFA Crossroads ASIA-PACIFIC 2006 Conference "Growing Markets, Nurturing Success", Chiang Mai, Thailand, 13-16 November 2006. IFA. [http://www.fertilizer.org/ifa/publicat/PDF/2006\\_crossroads\\_osotsapar.pdf](http://www.fertilizer.org/ifa/publicat/PDF/2006_crossroads_osotsapar.pdf).
- Pingali, P. 2004. Westernisation of Asian diets and the transformation of food systems: implications for research and policy. In: T. Fischer, et al. (eds.). Proceedings of the 4th International Crop Sciences Congress, Brisbane, Australia, 26 September - 1 October 2004. [http://www.cropscience.org.au/icsc2004/symposia/5/1/1408\\_pingalip.htm](http://www.cropscience.org.au/icsc2004/symposia/5/1/1408_pingalip.htm).
- Planet Retail. 2007. Draft Retail Act unlikely to be passed in Thailand. Planet Retail 25 September 2007, SE Asia, Regoverning Markets. [http://www.regoverningmarkets.org/en/news/se\\_asia/thailand\\_council\\_wants\\_retail\\_bill\\_revised.html](http://www.regoverningmarkets.org/en/news/se_asia/thailand_council_wants_retail_bill_revised.html).
- Poapongsakorn, N. 2006. The decline and recovery of Thai agriculture: causes, responses, prospects and challenges. Policy Assistance Series 1/3 - Rapid growth of selected Asian economies. Lessons and implications for agriculture and food security: Republic of Korea, Thailand and Viet Nam. Bangkok: FAO RAP. <http://www.fao.org/docrep/009/ag089e/AG089E04.htm>.
- Sagwansupyakorn, C., M. Thongjium, K. Pileuk, and S. Sukprakarn. 2003. The seed industry in Thailand. APSA Country Report No. 28, presented at Asian Seed 2003, Bangkok, Thailand, November 2003. <http://www.apsaseed.org/docs.php?cid=12>.
- Salakpetch, S. 2007. Quality management system: Good Agricultural Practice (GAP) for on-farm production in Thailand. Food and Fertilizer Technology Center (FFTC). <http://www.agnet.org/library/bc/54004/>.

- Siamwalla, A., S. Sethboonsang, and P. Werakarnjanapongs. 1991. Changing comparative advantage in Thai agriculture. Working Paper No. 35. Paris: OECD Development Centre. <http://www.oecd.org/dataoecd/14/61/1919534.pdf>.
- Sootsukon, B., S. Dechates, and M.H. Wu. 2000. Thailand. In: M. Ali (ed.). Dynamics of vegetable production, distribution and consumption in Asia. AVRDC Publication 00-498. pp. 417-443. <http://www.avrdc.org/pdf/dynamics/Thailand.pdf>.
- TAT. 2007. Statistical update of Thaitourism situation 2006. Tourism Authority of Thailand. [http://www.tatnews.org/tat\\_release/detail.asp?id=3301](http://www.tatnews.org/tat_release/detail.asp?id=3301).
- Termpittayapaisith, A. 2007. Opening Address. At the Consultation Workshop on GMS-Sustainable Development Strategy (GMS-SDS), Bangkok, Thailand, 30-Jan-2007. NESDB. <http://www.nesdb.go.th/LinkClick.aspx?fileticket=xQcFEkZNIo%3D&tabid=256&mid=738>.
- Thailand Chemical Safety Website. 2007. Report of National Priority Setting Workshop 2005. [http://ipcs.fda.moph.go.th/e\\_ipcs/report.htm](http://ipcs.fda.moph.go.th/e_ipcs/report.htm).
- Thailand Law Forum. 2007. Thailand Law Forum News. <http://www.thailawforum.com/news.html>.
- The Nation. 2007. Legislature to fast track retail bill in govt's term. The Nation. <http://www.nationmultimedia.com/search/page.news.php?clid=6&id=30053142>.
- Thompson, D. 2002. Thai Food. California, Ten Speed Press. 672 pp.
- TICA. 2007. Thailand International Cooperation Agency. <http://www.mfa.go.th/web/2199.php?id=1792>.
- Tipraqsa, P. 2006. Opportunities and constraints of integrated farming system in Northeast Thailand: a case study of the Huai Nong Ian catchment, Khon Kaen province. Ecology and Development Series No. 35. Cuvillier Verlag Gottingen.
- Tipraqsa, P., E.T. Craswell, A.D. Noble, and D. Schmidt-Vogt. 2007. Resource integration for multiple benefits: multifunctionality of integrated farming systems in Northeast Thailand. *Agricultural Systems* 94:694-703.
- TMCNET. 2007. Thailand: Energy and electricity profile. Technology Marketing Corporation. <http://www.tmcnet.com/submit/2007/05/29/2670303.htm>.
- Uathavikul, P. 2004. Poverty reduction through contract farming: Lessons from Srakaew Province, Thailand. ADB-ESCAP Regional Workshop on Contract Farming and Poverty Reduction, Bangkok, Swift Co. Ltd.
- UNESCO. 2006a. National Water Development Report: Thailand. Case study of Thailand prepared within the 2nd phase of WWAP (World Water Assessment Programme). United Nations Educational, Scientific and Cultural Organization (UNESCO). [http://www.unesco.org/water/wwap/wwdr2/case\\_studies/pdf/thailand\\_full\\_cs.pdf](http://www.unesco.org/water/wwap/wwdr2/case_studies/pdf/thailand_full_cs.pdf).
- UNESCO. 2006b. Thailand case study summary from WWDR2 (The 2nd UN World Water Development Report). United Nations Educational, Scientific and Cultural Organization (UNESCO). [http://www.unesco.org/water/wwap/wwdr2/case\\_studies/pdf/thailand.pdf](http://www.unesco.org/water/wwap/wwdr2/case_studies/pdf/thailand.pdf).
- Vanit-Anunchai, C. 2006. Possibilities and constraints of marketing environmentally friendly produced vegetables in Thailand. Doctoral Dissertation. Gottfried Wilhelm Leibniz Hannover University.
- Vanit-Anunchai, C. and E. Schmidt. 2006. Consumer purchase decisions for pesticide-safe vegetables using logistic regression: the case of Thailand. *Acta Hort* 699:457-464.
- WEC. 2001. Thailand. In: Electricity Market Design and Creation in Asia Pacific. London, World Energy Council. pp. 68-72. <http://www.worldenergy.org/wec-geis/global/downloads/emd/emd.pdf>.
- Wikipedia. 2007a. Bangkok Metropolitan Area. [http://en.wikipedia.org/wiki/Bangkok\\_Metropolitan\\_Area](http://en.wikipedia.org/wiki/Bangkok_Metropolitan_Area).

Wikipedia. 2007b. CP Group. [http://en.wikipedia.org/wiki/Charoen\\_Pokphand](http://en.wikipedia.org/wiki/Charoen_Pokphand).

Wikipedia. 2007c. HACCP. <http://en.wikipedia.org/wiki/HACCP>.

WTO. 2007. Thailand Country Profile. World Trade Organisation.

<http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=TH>.

## 8 Appendixes

### Appendix 1. List of vegetables grown in Thailand

Vegetable type	Scientific name
Onion Family	<a href="#">Alliaceae J.G. Agardh</a>
Leek	<i>Allium ampeloprasum</i> L. var <i>porrum</i> , <i>A. porum</i>
Shallot	<i>Allium cepa</i> L. var. <i>ascalonicum</i> .
Chinese chive	<i>Allium tuberosum</i> Rotter-ex
Onion	<i>Allium cepa</i>
Garlic	<i>Allium sativum</i> L. var <i>sativum</i>
Multiplier onion	<i>Allium cepa</i> var. <i>aggregatum</i>
	<a href="#">Amaranthaceae Juss.</a>
Amaranthus	<i>Amaranthus viridis</i> L.
Chinese amaranthus	<i>Amaranthus</i> sp.
Asparagus Family	<a href="#">Asparagaceae Juss</a>
Asparagus	<i>Asparagus officinalis</i> var. <i>altilis</i> L.
Daisy family	<a href="#">Asteliaceae Dum</a>
Lettuce	<i>Lactuca sativa</i> L.
Garland chrysanthemum	<i>Chrysanthemum coronarium</i> L. var <i>spatiosum</i> Bailey
	<a href="#">Convolvulaceae Juss.</a>
Water spinach (grow in water)	<i>Impomoea aquatica</i> Forsk.
Other kinds of water spinach	<i>Impomoea aquatica</i> Forsk.
Chinese water spinach	<i>Impomoea aquatica</i> Forsk.
Cabbage and Mustard Family	<a href="#">Cruciferae Juss.</a>
Brassica	<i>Brassica</i> spp.
Kale	<i>Brassica oleraceae</i> L.
Mustard green	<i>Brassica juncea</i> L.
Cauliflower	<i>Brassica oleracea</i> L. var <i>botrytis</i> L.
Chinese cabbage	<i>Brassica rapa</i> L. subsp. <i>pekinensis</i>
Cabbage	<i>Brassica oleracea</i> L. var <i>capitata</i>
Chinese mustard/Pak Choi	<i>Brassica rapa</i> L. subsp. <i>chinensis</i> , <i>B. chinensis</i>
Broccoli	<i>Brassica oleraceae</i> L. var. <i>italica</i> Plenck.
Chinese radish	<i>Raphanus sativus</i> L. var. <i>longipinnatus</i>
Melon and Gourd Family	<a href="#">Cucurbitaceae Juss.</a>
Watermelon	<i>Citrulus lanatus</i> (Thunb.) Mansf, ABOUT <i>vulgaris</i>
Bitter gourd	<i>Momordica charantia</i> L.
Muskmelon	<i>Cucumis melo</i> L.
Cantaloupe	<i>Cucumis melo</i> L. var. <i>cantaloupensis</i>
Bottle gourd	<i>Lageneria siceraria</i>
Pumpkin	<i>Cucurbita pepo</i> L. var. <i>pepo</i>

Wax gourd	<i>Benincasa hispida</i> (Thunb.) Cogn.
Angle loofah	<i>Luffa</i> spp.
Zucchini	<i>Cucurbita pepo</i> L. var. <i>itrates al Pans.</i>
Cucumber	<i>Cucumis sativus</i> L.
Grasses	<a href="#">Gramineae Juss.</a>
Lemongrass	<i>Cymbopogon citrates</i> L.
Corn	<i>Zea mays</i> L.
Sweet corn	<i>Zea mays</i> L. var. <i>saccharata</i>
Baby corn	<i>Zea mays</i> L.
Wild rice	<i>Zizania latifolia</i>
Mint and Basil Family	<a href="#">Labiatae Juss.</a>
Sweet basil	<i>Ocinum basilicum</i>
Hairy basil	<i>Ocinum canum</i> L.
Kitchen mint	<i>Mentha cordifolia</i> Opiz ex Fresen
Sacred basil	<i>Ocinum sanctum</i>
Bean and Pea Family	Leguminosae Juss. (Fabiaceae)
Acacia	<i>Acacia pennata</i> ( L. ) Willd.
Wing bean	<i>Psophocarpus letragonlobus</i> (L.) DABOUT
Garden pea	<i>Pisum sativum</i> L.
Yard-long bean	<i>Vigna unguiculata</i> var. <i>sesquipedalis</i>
Ivy gourd	<i>Coccinia grandis</i> (Linn.) Voigt.
Green bean	<i>Phaseolus vulgaris</i>
Water mimosa	<i>Neptunia oleracea</i> Lour.
Hibiscus Family	<a href="#">Malvaceae Juss.</a>
Okra	<i>Abelmoschus esculentus</i> ( <i>Hibiscus esculentus</i> L.)
Rosella	<i>Hibiscus sabdariffa</i> Linn.
Waterlilies and Lotuses	<a href="#">Nelumbonaceae Dum.</a>
Lotus	<i>Nymphaea lotus</i> L.
	<a href="#">Phyllanthaceae</a>
Pak-wan	<i>Sauropus androgynus</i> Merr.
Nightshade Family	<a href="#">Solanaceae Juss.</a>
Sweet pepper	<i>Capsicum annum</i> L.
Hot pepper, bird pepper	<i>Capsicum frutescens</i> L.
Devil's fig, Plate brush	<i>Solanum torvum</i> Swartz.
Eggplant	<i>Solanum melongena</i> L.
Other kinds of eggplant	<i>Solanum</i> spp.
Tomato	<i>Lycopersicon esculentum</i> Mill
Banana pepper	<i>Capsicum annum</i> L. var. <i>longum</i>
Chili pepper	<i>Capsicum annum</i> var. <i>minimum</i>
Carrot Family	<a href="#">Umbelliferae Juss</a>
Coriander	<i>Coriandrum vulgare</i> Mill.
Parsley	<i>Petroselinum crispum</i>

Carrot	<i>Daucus carota subsp. sativus</i>
Celery	<i>Apium L. var. dulce (Mill.) DC. syn. Apium dulce Mill</i>
Ginger Family	<a href="#">Zingiberaceae Lindl</a>
Galangal	<i>Languas galanga(L) Stun. Alpinia galanga(L) Sw.</i>
Ginger	<i>Zingiber officinale Rosabout</i>
Kra-chai	<i>Boesenbergia rotunda (L.) Mansf.</i>
Turmeric	<i>Curcuma longa L.</i>
Mushrooms	Fungi
Mushrooms	<i>Agaricus spp. and others</i>

Source: Nath et al. (1999); Kuo and Toxopeus (1993).

**Appendix 2.** Production statistics for vegetables and spices in Thailand

Crops	Harvested area (ha)						Production (tonnes)					
	2000	2001	2002	2003	2004	2005	2000	2001	2002	2003	2004	2005
Asparagus	1,300	2,200	2,300	2,000	2,036	2,042	5,000	8,500	8,800	7,600	7,671	7,635
Beans, green	21,600	21,600	21,700	22,000	22,000	23,000	86,500	86,500	87,000	88,000	88,000	92,000
Cabbages and other brassicas	18,600	19,000	20,000	23,600	23,600	24,000	205,000	210,000	220,000	260,000	260,000	265,000
Cauliflowers and broccoli	5,800	5,800	6,000	6,000	6,176	6,305	40,000	40,000	41,000	41,000	42,543	43,566
Chilies and peppers, dry	22,560	23,040	23,200	24,000	24,000	25,000	37,000	37,000	38,000	38,000	38,000	39,000
Chilies and peppers, green	1,000	1,000	1,200	1,200	1,200	1,300	14,000	14,000	16,800	16,800	16,800	18,200
Cucumbers and gherkins	27,200	27,500	27,500	28,000	27,168	26,916	210,000	220,000	220,000	222,000	221,072	221,236
Eggplants	11,000	11,000	11,500	11,500	11,500	12,000	66,000	66,000	67,000	67,000	67,000	68,000
Garlic	23,520	22,080	21,802	20,808	15,516	16,831	132,000	126,423	104,832	104,832	95,909	106,598
Leeks, other alliaceous veg.							60	60	60	60	60	60
Leguminous vegetables, nec	180	180	190	190	207	218	1,300	1,300	1,400	1,400	1,442	1,473
Lettuce and chicory	32	35	35	38	38	40	520	550	550	560	560	580
Maize, green	22,946	35,108	36,109	32,357	38,240	38,720	179,914	286,883	251,906	247,000	305,000	273,000
Mushrooms and truffles							9,500	9,800	9,800	9,800	9,842	9,884
Onions, dry	19,947	19,320	18,802	18,303	20,103	19,200	315,599	277,002	263,191	211,217	321,037	279,000
Other melons							108	300	497	497	497	497
Peas, green	2,700	2,700	2,900	2,900	2,900	3,000	5,900	5,900	6,300	6,300	6,300	6,500
Pumpkins, squash and gourds	17,700	18,000	18,000	18,500	18,419	18,504	210,000	220,000	220,000	226,000	220,298	218,839
Spinach							5	5	5	5	5	5
Tomatoes	9,420	10,039	8,127	10,280	11,040	11,500	224,082	244,584	241,974	248,126	266,000	197,682
Vegetables, nec	137,000	137,000	138,000	141,000	141,000	145,000	970,000	970,000	977,000	998,000	998,000	1,015,000
Watermelons	27,500	28,000	28,000	29,000	29,000	30,000	400,000	410,000	410,000	420,000	420,000	432,000

Source: FAOSTAT (2007) (last accessed November 2007).

### Appendix 3. Production statistics for vegetables and spices in Thailand

Crops	Harvested area (ha)				Production (tonnes)			
	2003-04	2004-05	2005-06	2006-07	2003-04	2004-05	2005-06	2006-07
Chili	81,146	90,146	28,367	32,782	538,869	762,380	204,099	334,763
Sweet corn	30,200	43,759	13,877	27,129	328,040	480,031	110,567	270,442
Baby corn	33,775	38,295	3,878	26,956	246,710	305,095	42,347	223,822
Watermelon	18,774	22,668	3,823	11,121	360,528	446,814	69,993	162,967
Cucumber	21,473	22,241	6,980	10,268	263,473	271,841	84,289	126,022
Shallot	16,581	20,560	1,376	8,779	206,847	289,870	41,985	125,375
Cabbage	13,342	11,129	4,238	4,046	280,341	245,755	50,676	83,571
Kale	17,452	18,402	5,969	7,187	184,146	203,051	58,710	82,514
Tomato	5,924	7,253	4,352	3,300	115,475	169,420	40,572	77,189
Yard-long bean	17,034	21,145	12,961	10,158	150,629	190,929	122,798	76,965
Chinese mustard	12,533	13,946	14,573	5,215	119,506	140,392	90,076	61,483
Eggplant	9,223	10,507	8,201	7,201	110,237	112,498	66,742	56,660
Garlic	13,624	11,237	4,311	5,406	140,474	155,507	40,754	54,691
Corn	15,662	19,100	4,255	5,598	169,888	211,400	26,206	45,160
Chinese radish	3,304	2,743	2,863	2,168	54,354	46,195	25,092	44,657
Asparagus	17,204	20,046	2,112	3,867	78,464	98,180	28,761	42,942
Onion	12,379	14,032	5,624	3,602	153,539	183,025	72,143	39,914
Pumpkin	7,904	11,612	1,743	3,055	108,981	173,000	20,963	37,915
Ginger	12,058	7,592	1,333	2,661	206,341	114,679	17,165	34,322
Water spinach (Kang kong)	25,608	28,525	2,956	4,701	147,456	175,753	28,680	33,496
Chinese cabbage	6,988	4,137	2,379	1,571	111,591	68,336	11,493	28,721
Bottle gourd	1,910	2,648	1,032	1,762	21,026	30,275	12,161	25,632
Coriander	6,227	5,799	1,062	2,679	42,694	38,771	4,590	18,802
Cauliflower	3,269	3,875	334	991	40,642	58,484	3,822	17,494

Cantaloupe	670	1,206	184	809	12,054	22,165	2,807	16,440
Angle loofah	4,678	5,833	2,335	2,214	30,435	37,109	36,245	14,204
Other kinds of vegetable	-	8	947	1,384		20	7,249	13,229
Galangal	-	9	1,681	970		33	10,345	12,903
Lettuce	2,929	3,576	522	1,226	24,985	30,383	4,683	12,056
Lemongrass	-	7	2,028	1,217		22	15,479	11,961
Parsley	-	-	120	719			47	10,734
Celery	2,565	3,869	450	877	17,731	30,664	4,119	10,617
Mustard green	3,729	3,988	480	1,236	59,011	59,914	10,756	10,043
Chinese chive	9,384	10,379	680	890	28,369	25,681	1,347	7,303
Wax gourd	3,467	4,249	1,029	617	50,848	54,323	16,029	6,826
Watermelon for seed	1,671	589	874	1,049	4,227	1,009	1,279	6,538
Finger Root ( Kra-chai)	-	-	96	311			1,420	5,095
Basil	-	46	1,360	673	-	155	3,967	4,692
Water mimosa	-	2,608	170	229	-	20,895	891	4,341
Okra	2,454	2,168	573	497	13,192	9,562	6,334	3,763
Acacia	-	14	1,260	1,220		36	2,279	3,306
Amaranthus	-	-	105	136	-	-	2,293	2,879
Green bean	721	630	426	124	6,476	5,049	730	2,198
Nymphaea	-	-	6	44			2	648
Mushroom	-	-	2,438	16,780			358	553
Garden pea	405	383	140	99	4,432	4,139	257	436
Winged bean	-	-	20	52			194	326
Muskmelon	-	-	24	23			377	314
Devil's fig ( <i>Solanum torvum</i> )	-	-	5	56			32	282
Brassica	-	-	42	82			45	251
Broccoli	204	336	8	18	2,445	3,246	94	209
Carrot	2,329	496	106	19	46,772	7,472	1,989	128

Turmeric	-	-	20	21			128	108
Pak-wan	-	1	148	57		8	739	74
Kitchen mint	-	-	176	13			652	64
Leek	49	46	-	6	402	464	-	34
Bottle gourd	-	-	-	5				23
Garland chrysanthemum	-	-	1	1			6	13
Ivy gourd	-	-	14	2			0	4
Rosella	1,844	3,157	970	2	694	717	538	2
Wild rice	-	-	-	1				1

*Note:* there appears to be an anomaly in data for 2005-06 and 2006-07 compared to earlier years. DOAE was unable to clarify reason for the problem.

Source: DOAE (2007b).

**Appendix 4.** Trade data of vegetables (including chili) 1995-2005

	1995	1997	1999	2001	2003	2005
<b>Exports Quantity (tonnes)</b>						
Vegetables, fresh	53,600	45,010	64,620	83,960	82,960	147,120
Vegetables, processed	253,710	256,770	242,750	245,080	314,540	327,020
Total	307,310	301,780	307,370	329,040	397,500	474,140
<b>Exports Value (1000 US \$)</b>						
Vegetables, fresh	38,484	28,975	32,618	55,410	71,474	112,112
Vegetables, processed	250,589	252,947	224,570	205,397	245,454	302,502
Total	289,073	281,923	257,189	260,807	316,928	414,615
<b>Imports Quantity (tonnes)</b>						
Vegetables, fresh	1,750	5,710	12,140	14,730	94,960	153,860
Vegetables, processed	13,440	15,160	16,000	25,510	46,340	66,700
Total	15,190	20,870	28,140	40,240	141,300	220,560
<b>Imports Value (1000 US \$)</b>						
Vegetables, fresh	13,099	5,884	8,433	9,486	19,366	33,447
Vegetables, processed	18,366	18,654	19,742	24,413	34,895	55,731
Total	31,465	24,539	28,176	33,899	54,261	89,178

Source: FAOSTAT (2007)

## Appendix 5. Selected Thai laws relevant to the vegetable industry

### Sources

Guide to Law on Line: <http://www.loc.gov/law/guide/thailand.html>

IPFSAPH, 2007. International Portal on Food Safety, Animal and Plant Health.

<http://www.ipfsaph.org/En/default.jsp>

Thailand Law Source: <http://members.tripod.com/asialaw/database.html>

World Law Guide: <http://www.lexadin.nl/wlg/legis/nofr/oeur/lxwetha.htm>

### Laws

#### *Commercial law*

Consumer Protection Act (No.2), B.E. 2541 (1998)

[http://chanyakomol.com/thailaws/law/t\\_laws/tlaw0064\\_2.htm](http://chanyakomol.com/thailaws/law/t_laws/tlaw0064_2.htm)

Consumer Protection Act, B.E. 2522(1979)

<http://www.krisdika.go.th/pdfPage.jsp?page=eng&type=laws&lawType=law2&lawCode=%25a434&lawID=%25a434-20-2522-001>

Export And Import Of Goods Act, B.E. 2522 (1979)

<http://www.krisdika.go.th/pdfPage.jsp?page=eng&type=laws&lawType=law2&lawCode=%25a160&lawID=%25a160-20-2522-001>

Export Promotion Act, B.E. 2503 (1960)

Export and Import of Goods Act, B.E. 2522 (1979)

[http://chanyakomol.com/thailaws/law/t\\_laws/tlaw0080.htm](http://chanyakomol.com/thailaws/law/t_laws/tlaw0080.htm)

Foreign Business Act B.E. 2542 (1999)

[http://www.dlo.co.th/law/foreign\\_business\\_act.doc](http://www.dlo.co.th/law/foreign_business_act.doc)

Rice Trading Act, B.E. 2489 (1946)

<http://www.krisdika.go.th/lawHtmStaticContent01.jsp?frm=tmp&page=eng&lawType=law2&lawCode=%a112&lawID=%a112-20-2489-001>

#### *Health law*

Hazardous Substance Act, B.E. 2535 <http://www.diw.go.th/law/hazae.html>

Hazardous Substance Act, B.E. 2535 (1992)

[http://chanyakomol.com/thailaws/law/t\\_laws/tlaw0120.htm](http://chanyakomol.com/thailaws/law/t_laws/tlaw0120.htm)

Health Promotion Foundation Act 2001 B.E. 2544 [http://www.hp-](http://www.hp-foundations.net/members-thaihealth.aspx)

[foundations.net/members-thaihealth.aspx](http://www.hp-foundations.net/members-thaihealth.aspx)

Public Health Act, B.E.2535 (1992)

[http://chanyakomol.com/thailaws/law/t\\_laws/tlaw0223a.htm](http://chanyakomol.com/thailaws/law/t_laws/tlaw0223a.htm)

[Food Act \(B.E. 2522\).\( Legislation/ Regulation \) 1979](#)

<http://www.ipfsaph.org/servlet/BinaryDownloaderServlet/FAOLEX064932>  
[http://faolex.fao.org/pdf?filename=\kopool\\_data\FAOLEX\\_0\unknown\\_tha64932.pdf&refID=FAOLEX064932](http://faolex.fao.org/pdf?filename=\kopool_data\FAOLEX_0\unknown_tha64932.pdf&refID=FAOLEX064932)

*Tax law*

[Customs Act B.E. 2543](http://www.customs.go.th/Law/law17.htm) <http://www.customs.go.th/Law/law17.htm>

*Intellectual property law*

[Act on the Protection of Geographical Indication B.E.2546 \(2003\)](#)

[http://chanyakomol.com/thailaws/law/t\\_laws/tlaw0017\\_1.htm](http://chanyakomol.com/thailaws/law/t_laws/tlaw0017_1.htm)

[Plant Varieties Protection Act \(1999, in force\)](#)

[http://www.grain.org/brl\\_files/thailand-pvp-1999-en.pdf](http://www.grain.org/brl_files/thailand-pvp-1999-en.pdf)

*Agriculture law*

[Agricultural Economics Act, B.E. 2522 \(1979\)](#)

[http://www.oae.go.th/English/act\\_1.htm](http://www.oae.go.th/English/act_1.htm)

[Agricultural Futures Trading Act, B.E. 2542 \(1999\)](#)

[http://chanyakomol.com/thailaws/law/t\\_laws/tlaw0018a.htm](http://chanyakomol.com/thailaws/law/t_laws/tlaw0018a.htm)

[Bank For Agriculture And Agricultural Cooperatives Act, B.E. 2509](#)

<http://www.krisdika.go.th/pdfPage.jsp?page=eng&type=laws&lawType=law2&lawCode=%25b802&lawID=%25b802-20-2509-001>

[Plant Quarantine Act, B.E. 2507 \(1964\).\( Legislation/ Regulation \) May 1999](#)

<http://www.ipfsaph.org/servlet/CDSServlet?status=ND1jdGh0dHB3d3dmYW9vcmdhb3NpcGZzYXBoaW5mb3JtYXRpb25zb3VyY2VmYW9sZXguRkFPTEVYMDcwODc3JjY9ZW4mMzM9Zm9ybWFsX3RleHQmMzc9aW5mbw%7E%7E>

[Plant Quarantine Act BE 2507 \(1952\)](#)

<http://www.doa.go.th/onestop/pqir/Thailand%20Plant%20Quarantine%20Import%20Regulations.pdf>

*E-commerce*

[Electronic Transactions Act, B.E. 2544 \(2001\)](#)

[http://chanyakomol.com/thailaws/law/t\\_laws/tlaw0073.htm](http://chanyakomol.com/thailaws/law/t_laws/tlaw0073.htm)