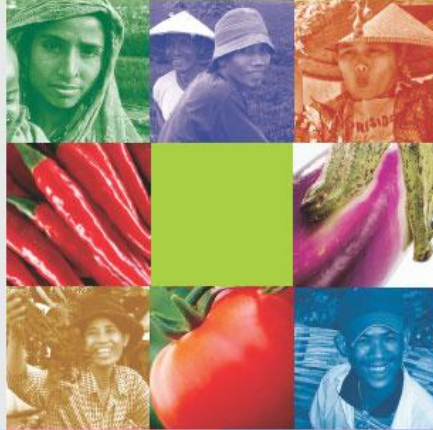


The Vegetable Industry in Tropical Asia



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Explorations Series No. 1
2008

Greg I. Johnson
Katinka Weinberger
Mei-huey Wu

Explorations #1

The Vegetable Industry in Tropical Asia

**An Overview of Production and Trade, with a
Focus on Thailand, Indonesia, the Philippines,
Vietnam, and India**

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.

AVRDC – The World Vegetable Center

AVRDC – The World Vegetable Center is an international not-for-profit organization committed to alleviating poverty and malnutrition through research, development, and training.

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
Web: www.avrdc.org

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On the CD

The attached CD contains detailed statistics and assessments for

- India
- Indonesia
- Thailand
- The Philippines
- Vietnam

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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

The Vegetable Industry in Tropical Asia

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1 Introduction

Tropical Asia contains about 30% of the world's population (UNFPA, 2007). Between 1990 and 2001, poverty levels¹ in South Asia dropped from 39.4% to 29.9%, and the region is on track to reach the Millennium Development Goal (MDG)² target of less than 19.7% of the population living in poverty by 2015. In Southeast Asia and Oceania, the poverty level dropped from 19.6% to 10.2%, almost reaching the MDG target for the region (United Nations, 2005). Despite rising incomes, a substantial portion of the population lives below the poverty line, with those affected concentrated in disadvantaged regions and rural areas. How to lift these disadvantaged people out of poverty will be a key challenge for policymakers in the years to come. Urbanization in tropical Asia is on the rise; delivering adequate food supplies to cities while maintaining quality and reducing losses is another challenge for many countries in Asia's tropics.

In countries where grain self-sufficiency is being reached and for remote and marginalized communities, vegetables are a key option to diversify marketing opportunities, enhance community nutrition, and boost income for farmers and traders. A clear action agenda for industry development is needed to optimize progress and use of resources. Consolidation of information and statistical data on the vegetable sector in tropical Asia from diverse sources and references provides baseline and background information on trade, and priority recommendations for industry, policymakers and researchers. The country focus chapters and case studies (on the accompanying CD) highlight trends and issues for countries at various stages of development, with lessons learned in one country or region potentially applicable elsewhere.

1.1 Beyond the Green Revolution

Most of the countries in tropical Asia have undergone far-reaching sociopolitical transformations since their emergence from colonial rule after World War II³. Several have endured natural disasters, and national

¹ Portion of the population that lives on less than US\$1 per day.

² Goal 1: To halve, between 1990 and 2015, the proportion of people whose income is < \$1 a day (United Nations, 2005).

³ Countries that were not colonized include Thailand and Nepal.

or regional schisms and conflicts⁴, but generally, economic and social development has advanced significantly throughout the region. Although population, food needs, and urbanization continue to increase, population growth has generally slowed, and per capita food availability has increased. Since 1981, hunger levels have decreased, as assessed by the *Global Hunger Index*⁵ (Table 1) with 1981 and 2003 levels highest in Cambodia, Bangladesh, Nepal, and India (and absolute numbers living with hunger highest for India). Levels have declined most rapidly in Indonesia and Thailand and most slowly in Laos and the Philippines.

Table 1. Global Hunger Index (IFPRI)

Country	1981	1992	1997	2003	Per annum decline (%)
Bangladesh	44.40	36.33	35.73	28.27	2.0
Cambodia	46.43	32.93	36.03	30.73	1.9
India	41.23	32.73	25.73	25.73	2.1
Indonesia	28.17	18.53	15.60	12.47	3.6
Laos	29.53	25.70	26.73	23.83	1.0
Malaysia	12.67	10.10	7.72	7.75	2.2
Myanmar	25.20	19.27	15.53	16.17	2.0
Nepal	43.30	27.77	27.77	24.50	2.6
Pakistan	33.60	25.97	23.60	21.77	2.0
Philippines	22.40	21.99	19.63	17.55	1.1
Sri Lanka	24.90	22.40	21.87	16.63	1.8
Thailand	23.37	17.83	13.80	12.36	2.9
Timor Leste	-	-	-	22.29	-
Vietnam	32.20	25.90	22.37	18.37	2.5

Source: Wiesmann (2006b)

The Green Revolution had a seminal role in the agricultural transformation and enhancement of food security in tropical Asian countries (Hazell and Ramasamy, 1991). Many are now self-sufficient in grains, and the region as a whole is a net exporter of rice. The Green Revolution encompassed the development and uptake of higher yielding, disease-resistant crops, and (later), improved productivity of the livestock, fisheries, forestry, and postharvest technology sectors. The

⁴ The Partition of India, the Indochina wars, civil insurgencies, and coups in several countries.

⁵ The International Food Policy Research Institute's (IFPRI) Global Hunger Index (GHI) captures three dimensions of hunger: a) insufficient availability of food, b) shortfalls in the nutritional status of children, and c) the mortality level among children under 5, which is often attributable to undernutrition. (Wiesmann, 2006a).

success of the Green Revolution came about due to changes in agricultural policy, sociopolitical and trade frameworks, better land and water management, the enhancement of extension, training and farmer skills, improvements in agricultural systems, rural infrastructure, and mechanization, and greater input use.

The increase in productivity was critical for food security, but it came at a cost. Today the excessive use of fertilizer and chemicals to boost yields is cause for concern. Land and water resources are increasingly limited, and environmental sustainability and climate change are emerging as future threats. Trade liberalization, while generally positive for the region, has enhanced competition and affected market access for farmers.

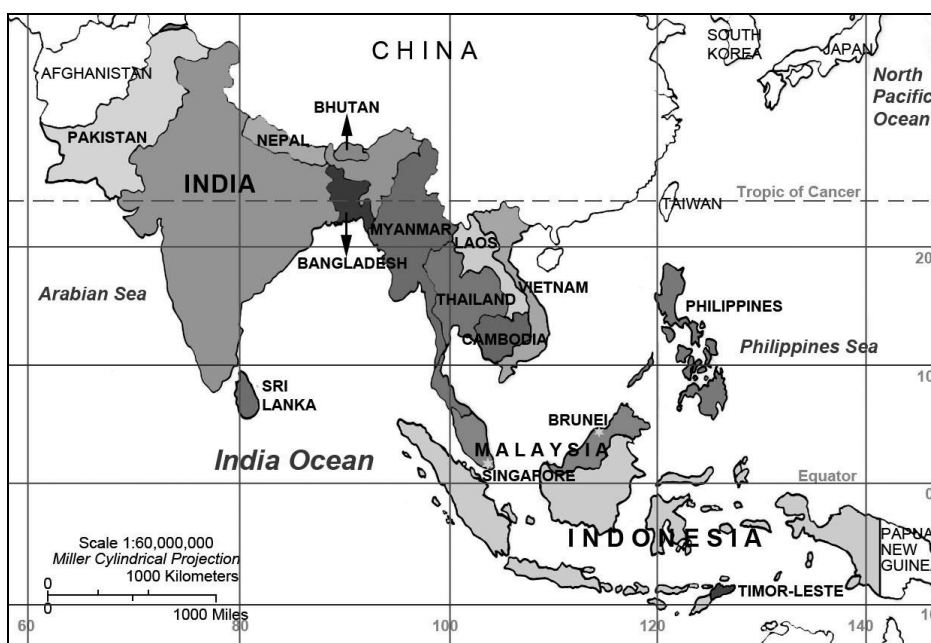
While average farm size generally increased in developed countries as agriculture modernized, the trend has been the reverse in tropical Asia (Hazell et al., 2006). Average farm size has decreased (most < 2 ha), and production costs have risen, so it has become increasingly difficult for farmers to earn an adequate income from staple crops alone. To remain viable without the support of subsidies, farmers need to diversify into higher value industries (livestock, aquaculture, fruit and vegetables) and increase off-farm income.

The increased interest and opportunities for high-value industries throughout tropical Asia reflect changing food preferences and customer requirements favoring high-quality meat, fisheries products, and fruit and vegetables, and better access to markets. Farmers are able to profit from high-value industries because of increased demand and improved market access, and because of increased productivity when advanced production and marketing technologies are available and adapted to the local situation. Increasing and more diverse production, processing and trade in vegetables has been part of the transformation of the rural sector, fostered through proactive policy changes by some national governments, and through attention to the vegetable sector by national agricultural research systems (NARS), the international agricultural research centers (IARCs), and the private sector.

Vegetables represent a two-pronged contribution to development. They provide additional income for farmers and traders, and they enhance the health and nutrition of consumers. While they offer critical opportunities for boosting income and nutrition, attention from international donors and from national and local governments has been less than their potential deserves (Weinberger and Lumpkin, 2007).

2 Snapshot of Tropical Asia

In this study, tropical Asia is taken to include 17 countries 6 of South and Southeast Asia (SEA), which range in size from Singapore (689 km²), Timor-Leste (14,870 km²), and Brunei (5,270 km²) to Indonesia (1.8 million km²) and India (3.0 million km²), as shown in Figure 1. India has the highest, and Indonesia the 4th highest populations in the world. In addition, tropical Asia includes 15 of the world's top 50 most populous urban areas⁷. Land areas, populations (2007 and 2050) and urbanization levels (2007, growth rate 2005-2010) are shown in Table 2.



Source: Based on map courtesy of the University of Texas Libraries,
The University of Texas, Austin

Figure 1. Map showing the 17 countries that are in or near tropical Asia

⁶ Pakistan is actually in the subtropics, but is included here because the climate in summer is tropical except in northern elevated areas.

⁷ "Urban area" is more useful in this context than "city," which is a distinct municipal government unit, but usually smaller in population and area than a larger urban area that shares food, infrastructure, utility, and governance needs with a city or cities.

Table 2. Tropical Asia: Land areas, population (2007 and 2050), and urbanization

	Country	Land area (000 ha)	Population in 2007(millions)	Estimated population in 2050 (millions)	Urban population in 2007 (%)	Urban growth rate 2005- 2010 (%)
1	Bangladesh	13,017	147.1	242.9	26	3.5
2	Bhutan	4,700	2.3	4.4	12	5.1
3	India	297,319	1,135.6	1,592.7	29	2.3
4	Nepal	14,300	28.2	51.2	17	4.8
5	Pakistan	77,088	164.6	304.7	36	3.3
6	Sri Lanka	6,463	21.1	23.6	15	0.8
	South Asia	412,887	1,498.9	2,219.5		
7	Brunei	527				
8	Cambodia	17,652	14.6	26.0	21	4.9
9	Indonesia	181,157	228.1	284.6	50	3.3
10	Laos	23,080	6.2	11.6	21	4.0
11	Malaysia	32,855	26.2	38.9	69	2.9
12	Myanmar	65,755	51.5	63.7	32	2.9
13	Philippines	29,817	85.9	127.1	64	2.8
14	Singapore	68.9	4.4	5.2	100	1.2
15	Thailand	51,089	65.3	74.6	33	1.8
16	Timor Leste	1,487	1.1	3.3	27	7.0
17	Vietnam	31,007	86.4	116.7	27	3.0
	Southeast Asia	434,495	569.7	751.7		
	Tropical Asia	847,382	2068.6	2971.2		

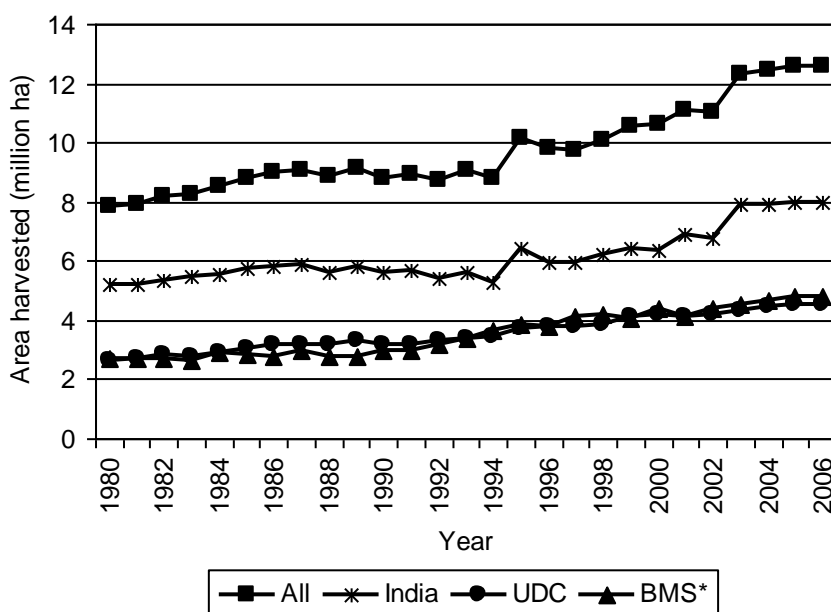
Source: FAOSTAT (2007); UNFPA (2007)

Key climatic features of the region are the tropical conditions and the monsoons (rainy seasons) from the northwest (December to early March) and the southwest (June-September) that affect different parts of the region, with intervening dry periods in most of the region, and cool seasons in more northern areas and highlands. Temperatures and humidity are generally high, but lower in northern and elevated areas. Some areas are also prone to hurricanes arising in the Indian Ocean or the Northwest Pacific. Rainfall varies across the region and is discussed in the individual country chapters.

3 Significance of the Vegetable Industry

3.1 Production trends

Production volumes and areas of vegetables in tropical Asia have risen steadily. Production area increased in two surges between 1994–1995 and 2002–2003 (Figure 2). Production area trends for developed countries and India are fairly similar between 1980 and 2006, but growth plateaued for India from 2003 to 2006.

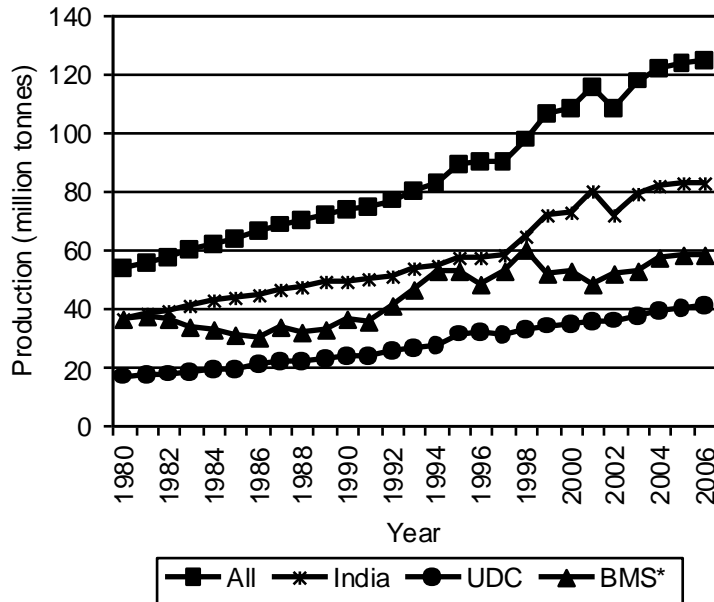


Source: FAOSTAT (2007). Note: * BMS in 10,000 ha.

Figure 2. Area of vegetables for all countries in tropical Asia, compared with more developed (BMS = Brunei, Malaysia, and Singapore), India, and other developing (UDC)⁸ countries in the region, 1980-2006

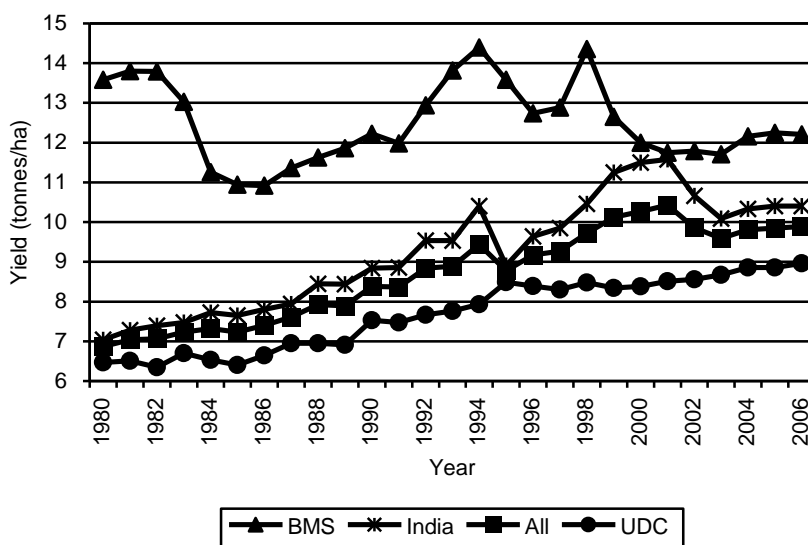
⁸ UDC = Developing countries of tropical Asia, except India: Bangladesh, Bhutan, Cambodia, Indonesia, Laos, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand, Timor-Leste, and Vietnam. India is shown separately because of its vast production.

Regional production volume has grown more rapidly in each successive decade (starting in 1980 up to 2005), with growth most rapid between 1997 and 2001 (Figure 3). Indian production dominates growth for the region, but the regional growth rate has been somewhat higher than that of India.



Source: FAOSTAT (2007). Note: * BMS in 10,000 tonnes.

Figure 3. Production of vegetables (million tonnes) for all countries in tropical Asia, compared with more developed (BMS = Brunei, Malaysia, and Singapore), India, and developing (UDC) countries in the region, 1980-2006



Source: FAOSTAT (2007)

Figure 4. Yield of vegetables for all countries in tropical Asia, compared with more developed (BMS = Brunei, Malaysia, and Singapore), India, and developing (UDC) countries in the region, 1980-2006

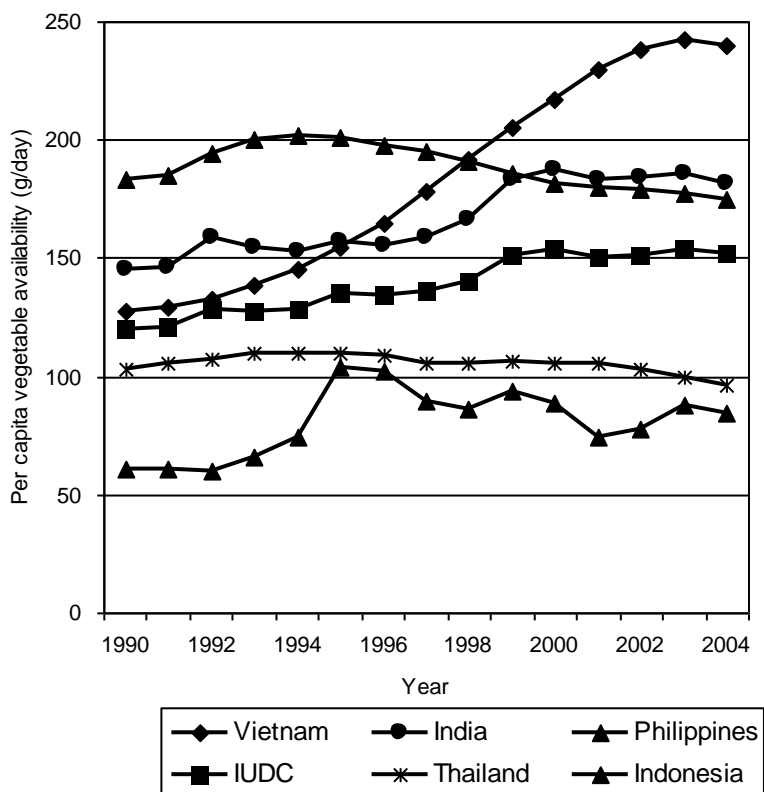
Average yields of vegetables in the more developed countries (BMS) have been substantially higher than the average for the less developed countries (UDC), India, and the regional average since 1980 (Figure 4). Average yields in the region rose steadily from 1980 to 1995, and after three years of lower yields in India, began to increase again up until 2001, when yields in India declined, then plateaued from 2004 to 2006. The higher mean yield for India compared to other countries may reflect differences in commodity predominance rather than better husbandry. Considerable scope remains for improving per-hectare productivity.

3.2 Per capita availability

Vegetables are acknowledged as an essential component of diets, yet until recently many countries in tropical Asia focused first on food security—attaining self-sufficiency in grains, and then on promotion of export industries, especially fruit cropping, fisheries, and livestock—with less emphasis on vegetables. Support for the vegetable sector has been variable, and often has focused on peri-urban production for domestic markets and demand-driven stimuli from the retail sector. But more explicit policy changes in some countries, and investment by the private

sector (seed industry, exporters, and processors), have enhanced the significance of the vegetable sector more in some countries (e.g. Thailand) than in others.

As examples of the relative consumption of vegetables in Asia, Figure 5 shows the trends in per capita vegetable availability in the five focal countries and of undeveloped countries in the region (IUDC, including India). Most notable is the steady rise in availability levels in Vietnam, the low consumption levels in Indonesia, and the recent downward trend in Thailand and the Philippines. Availability plateaued for the focal countries, the IUDC in 2000 to 2004, and even Vietnam, where growth in per capita availability was much higher from 1993-2004 compared to the rest of the countries shown. Per capita availability is discussed in more detail in the individual country chapters.



Source: FAOSTAT (2007)

Figure 5. Per capita vegetable availability for developing tropical Asia⁹ (IUDC) and India, Indonesia, Vietnam, Philippines, and Thailand in 1990-2004

⁹ India included for IUDC data.

4 Industry Support

Inputs are the technologies or treatments used in production and marketing of agricultural products (FAO, 2007). Key inputs include: seed, agricultural chemicals, fertilizers, farm machinery, irrigation and watering systems, labor, good agricultural practice and quality management certification, postharvest technology, and logistics. Finance and utilities are additional critical components of production and marketing systems, and are considered separately. As an index of development, the FAO publishes statistics on input resources for agriculture—investment, land, labor, machinery, fertilizers and agrochemicals (FAOSTAT, 2007)—but data is not disaggregated by commodity sector. The statistics provide a guide to national and regional trends in agricultural modernization. In this review, land use is considered under production, and agricultural policy and investment are considered under finance.

4.1 Seed

The development and supply of seed of improved germplasm (both hybrid and open pollinated) incorporating traits that enhance climatic adaption, yield, pest and disease resistance, and locally preferred characteristics, has had a significant impact on the development of the vegetable sector in tropical Asia. The private sector has played a significant role in research and development and supply/distribution, with government agencies concerned with varietal development, germplasm collection and evaluation, and oversight of seed standards and legislation. In some countries government agencies also are involved in seed purification/certification schemes, and production and distribution of seed.

Increasingly, the seed sector is providing training to farmers and facilitating the supply of technologies and other inputs to enhance productivity and performance in tropical environments. The Asia and Pacific Seed Association (APSA, 2007) is a largely private sector association of seed companies with significant associate membership from national and regional agencies. APSA provides a regional forum for discussion of seed policy issues and promotion of technical and economic cooperation among members. Key priorities for APSA are: harmonizing phytosanitary regulations in Asia, training in seed testing, Intellectual Property Rights (IPR) and other seed regulations,

accreditation of seed laboratories, seed industry interaction/exchange of expertise, and technical lab/field tours. New challenges include strengthening the seed industry in the region, helping establish seed industry associations in West and Central Asia, encouraging partnerships and cooperation between regional seed associations, and developing more effective communication tools (APSA, 2007).

4.2 Agricultural chemicals

Agricultural chemical use has improved management of pests, diseases, and weeds (Cooper and Dobson, 2007) and enhanced vegetable industry productivity. However, overuse and residual contamination are issues of concern. Government and private sector groups and international agencies (especially FAO and foreign donors) have been proactive in promoting integrated pest management practices and the safe use of chemicals, and have provided more stringent mechanisms for regulating and monitoring pesticide quality and use (Community IPM, 2007; CropLife Asia, 2007b). Chemical companies involved in the manufacture and distribution of agricultural chemicals are represented by CropLife Asia, a regional unit of CropLife International headquartered in Bangkok. CropLife Asia represents chemical company interests, and aims to promote responsible use of chemicals and the importance of sound regulatory frameworks and compliance. The total crop protection market in Asia was worth US\$ 7,405 million in 2006, which represented a 4.1% decline on industry worth in 2005 (CropLife Asia, 2007b). The vegetable sector is a significant user of pesticides, as are industrial crops such as oil palm.

The International Fertilizer Industry Association (IFA, 2007a), the Food and Fertilizer Center for the Asian and Pacific Region (FFTC, 2007) and the FAO are sources of information on fertilizer use and management in Asia. Generally, vegetables are a major user of fertilizer, either applied specifically for their production, or drawing on residual nutrients from previous crops. Across all agricultural commodities, India dominates Asian consumption of fertilizers, consuming roughly one-half of the nitrogen used in tropical Asia (Table 3). Major trends in recent years have been reductions in subsidies provided by governments, improvements in quality monitoring and precision of application, and a resurgence of interest in the use of natural fertilizers by organic and non-organic growers. In some farming systems, livestock are an important source of manure, but the primary use of manure is for fuel rather than for crop production (e.g. India).

Table 3. Consumption of total nitrogen (N) (tonnes) for all agriculture in selected countries of tropical Asia 2002–2005

Country	2002	2003	2004	2005
Bangladesh	1,079,064	1,097,304	1,159,952	1,196,089
Cambodia	7,765	5,218	7,468	na
India	10,517,019	10,641,106	11,609,879	12,597,930
Indonesia	2,533,079	2,232,056	2,580,523	2,529,232
Malaysia	462,425	474,063	829,102	696,716
Myanmar	3,127	8,552	6,575	2,109
Nepal	37,308	17,754	15,097	8,037
Pakistan	2,384,980	2,479,121	2,502,616	3,073,713
Philippines	445,244	612,933	679,355	561,554
Singapore	1,485	6,930	9,322	9,077
Sri Lanka	188,317	150,656	163,234	182,816
Thailand	1,018,849	1,253,605	1,153,141	1,045,129
Vietnam	1,150,277	1,231,476	1,299,330	1,098,756
TOTAL	19,828,939	20,210,774	22,015,594	23,001,158

Source: FAOSTAT (2008)

The International Fertilizer Industry Association (IFA, 2007b) provides access to on-line statistics of fertilizer production and use by region for 1999-2005. Apparent consumption of major fertilizers (across all uses) in all of South and East Asia ranges from 65.6% of global use of urea (increasing at 3.4% /annum) and 59.5% of phosphorus as di-ammonium phosphate (DAP) (increasing at 0.3% /annum), to 49.1% of ammonia and 40.4% of potash (Table 4).

Table 4. Selected data on apparent consumption of fertilizers ('000 tonnes) in South and East Asia 1999-2005 and global share in 2005

	1999	2000	2001	2002	2003	2004	2005	Mean annual increase (%)	Global share, 2005 (%)
Urea	31,743	31,269	31,426	33,721	33,321	36,335	38,815	3.4%	65.6%
Ammonia	47,721	48,457	48,488	49,500	50,894	55,844	58,565	3.5%	49.1%
Potash	7,783	7,845	7,817	8,278	9,318	11,149	13,260	9.3%	40.4%
Phosphorus									
as MAP	939	926	1,163	1,455	1,650	2,052	2,744	19.6%	36.0%
as DAP	7,294	6,408	6,343	6,826	6,402	6,754	7,426	0.3%	59.5%

Source: IFA (2008)

IFA also publishes an on-line *World Fertilizer Use Manual* (Wichmann, 1992). The manual provides detailed information on current fertilizer use and practice for a range of vegetables under temperate and tropical conditions, with some brief comments on cultivation requirements, and organic as well as inorganic fertilizer needs. Plant analysis data and selected country-specific information is also provided.

4.3 Irrigation and watering systems

Vegetables require good water supplies for optimal productivity. They have an advantage in being able to produce a crop during short periods of high moisture availability, and respond well to controlled delivery of water through microirrigation systems, which enhance water use efficiency. Some vegetable cultivars have been selected for greater drought or water stress tolerance, and the use of such cultivars in more marginal environments can boost returns.

Irrigation and water use in vegetable cropping varies with the production system and ecoregion. Intensive peri-urban systems, whether open field, protected cultivation, or hydroponics, are most productive where clean water is available all year, from irrigation channels, city supplies, underground or on-farm storage, or a combination of these. Vegetable cropping after rice usually coincides with the dry season and may make use of residual soil moisture, supplemented by irrigation, underground supplies, or tank storage. Farmers also may take advantage of the drop in river levels to cultivate riverbanks and seasonal “islands.” In rainfed areas cropping may be limited to rainy season intercrops, with production areas shrinking in the dry season to small plots for subsistence supplies. In remote communities, innovation in the safe recycling of household wastewater could provide additional opportunities for vegetable production.

The International Environmental Technology Centre (IETC) within the United Nations Environment Programme (UNEP), Division of Technology, Industry, and Economics has published a *Sourcebook of Alternative Technologies for Freshwater Augmentation in Some Countries in Asia* (IETC, 1998). The book details strategies for conserving and optimizing water use and recycling, with information on technology options and crop use, and several case studies relevant to the vegetable sector.

Within the Asian region, the World Vegetable Center promotes watering systems in some of their project activities, and the International Water Management Institute (IWMI, 2007), headquartered in Sri Lanka (and part of CGIAR, the Consultative Group on International Agricultural Research), has a focus on water and related land management challenges of poor rural communities. Their activities are complemented by other donor agencies and NGOs including AGRIDEV, a company affiliated with the Israeli Ministries of Foreign Affairs and Agriculture (AGRIDEV, 2007), and International Development Enterprises (IDE, 2007), an international nonprofit organization, which give particular emphasis to the introduction of water-saving technologies in developing countries. IDE is particularly active in the introduction of simple, low-cost, household level irrigation technologies to improve productivity, with an additional focus on necessary market connections.

4.4 Labor

Family labor is a significant resource in smallholder farming systems. Vegetable production and processing provide opportunities to make use of surplus labor, especially when rice cultivation becomes partly mechanized.

Otsuka and Yamano (2006) examined the role of rural labor markets in poverty reduction in Asia and concluded that agricultural labor markets alone will not significantly reduce poverty; increased non-farm income is the key factor in reducing rural poverty and can reduce the income gaps between land-rich and land-poor, between the educated and the uneducated, and between less and more favorable agricultural areas; and labor markets are segmented by schooling level, which influences occupation and non-farm income of the rural labor force.

Farrington et al. (2006) reviewed labor use in South Asia farming systems, focusing on the migration of rural people to the cities to seek employment and the benefits in terms of income, and the expansion of land-unit size as people leave farms. Policy implications from their findings include: it is vital that human resources be recognized in policy frameworks and developed through education, skills improvement, and health services; rural-urban links should be enhanced and mobility not impeded; support services should be provided to migrants to help their transition into urban communities; systems to improve remittance flow from migrants to their families are needed; and strategies are needed to make land-leasing easier, especially for the poor. In parallel with these

issues, attention should be given to improving access to rural credit, education, and health services, and to the improvement of rural infrastructure, communications, and transport.

4.5 Postharvest technology

Key elements of postharvest technology needed for the management of fruit and vegetable quality at a small-scale level have been described by Kitinoja and Kader (2002), and additional advice for tomato and chili described in a manual by Acedo and Thanh (2006). Issues affecting the postharvest management of vegetables in tropical Asia have been reviewed regularly at regional workshops and conferences (Johnson and Hofman, 2004; Rolle, 2006b; Batt, 2006). In many countries, the inadequacy of postharvest technologies and infrastructure are major contributing factors to the high levels of loss and deterioration in fresh produce. Selection and promotion of varieties with superior postharvest characteristics (such as longer shelf-life or being less prone to bruising) can reduce losses and improve market acceptability of vegetable varieties.

Modern retailing, which is emerging through the growth of supermarkets, convenience stores, and their supporting supply centers, offers a conduit for the introduction of technologies for improved vegetable handling and storage. Enhanced training of farmers and traders in handling and quality management practices is critical.

4.6 Logistics and infrastructure

Logistics can represent a significant source of cost and delay in produce marketing. De (2007a; 2007b) reviewed aspects of trade costs on trade generally (i.e. all trade, not just agricultural trade), and highlighted the significance of transport costs as a determinant of trade, especially as tariff barriers decline. De (2007b) noted freight costs in Asia were on average 116% higher than in developed countries, and this was a significant factor affecting trade viability and profits. De (2007a) found that international trade patterns in Asia were affected by the quality of infrastructure and by tariffs and transport costs, and suggested reducing tariffs and transport costs by 10% each could increase bilateral trade by two and six percent respectively.

De (2007b) compared national trade infrastructure improvements in selected Asian countries from 2000 to 2005, using a trade infrastructure

index (TII) calculated from a range of variables including railway and road length densities (km per 1000 sq km of surface area), air transport freight (million tonnes/km) and passengers (% population) carried, aircraft departures (% population), country's percentage share of world fleet, container port traffic (TEUs¹⁰ per terminal), fixed and mobile telephone line subscribers (per 1000 people), and electric power consumption (KWH per capita). Comparisons within Asia are shown in Table 5.

Table 5. Estimated trade infrastructure index in 2000 and 2005

	2000	2005
China	1.66	1.87
India	0.51	0.58
Indonesia	0.41	0.45
Japan	4.12	4.23
Korea	3.01	3.18
Malaysia	1.62	1.70
Thailand	0.86	0.91

Source: De (2007b)

Note: Higher number = better infrastructure.

Progress in the development of trade infrastructure 2000 to 2005 has been most rapid in China but relatively slow in the other countries in the study. According to the trade infrastructure index rankings, Thailand is ahead of Indonesia and India, but all lag behind China and Malaysia, which trail Korea and Japan.

As an additional index of comparative trade performance, De (2007b) compared changes in number of containers (TEUs) handled per hour, averaged across the top three container ports in a country and covering 80% of annual throughput (Table 6). Using this assessment, all countries except Indonesia have made significant progress between 2000 and 2005 in improving container handling efficiency, with handling rates of Thailand approaching and India exceeding that of Japan. Malaysia and Korea, however, remain significantly ahead of other countries in the study.

¹⁰ TEU = Twenty-foot equivalent units, refers to container size for freight volume estimates. The retention of imperial measure over metric for container size dimensions reflects the key role played by the US in container development, and the impracticality of changing container sizes when transport (ships and planes) have been designed for the traditional standard sizes (Wikipedia, 2007c).

Table 6. Number of containers (TEUs) handled per hour

	2000	2005
China	19	39
India	11	27
Indonesia	9	12
Japan	27	35
Korea	32	44
Malaysia	38	52
Thailand	12	30

Source: De (2007b)

4.7 Finance and utilities

While production of staples often can be managed by farmers from within their own financial resources (taking advantage of government subsidies, price supports, and purchase commitments where available), vegetable farming requires more inputs and labor than staple production and a greater degree of risk in relation to marketing and price. This means farmers may be more in need of credit to move into vegetable production and to manage the crop until it is sold (Weinberger and Lumpkin, 2007). More broadly, three areas of finance are critical in the development of the vegetable sector: 1) government and international donor investment in production systems, land distribution, transport and marketing infrastructure, communication, regulatory authorities, research and development, and education and training; 2) access to finance and “transaction costs” at farm, enterprise and trade levels; and 3) investment incentives, taxes and tariffs affecting trade and production. These are considered briefly:

Finance for infrastructure. There are deficiencies in infrastructure at many levels in the region. Key needs are in postharvest handling, storage, and transport, and in roads and communication. The international development banks (World Bank, Asian Development Bank) have been active in working with national planning authorities and governments in planning and investment, and the United Nations agencies play significant roles to stimulate development through infrastructure improvement. Critical elements include roads, air transport, shipping, utilities, irrigation and water supply, and wholesale markets, with construction undertaken by international and national construction companies. Close involvement of the private sector is also important for development of near-farm infrastructure, processing, and export

facilities. Country profiles, investment plans, and commissioned studies on economic and policy issues from the World Bank (World Bank, 2007), the Asian Development Bank (ADB, 2007) and national planning agencies and others can provide insight into policy and strategy issues underpinning the relative priority given by national governments for infrastructure investment focused on development of the vegetable industry at national and regional levels.

Farm, processing and trader finance. Access to finance and lower interest costs for farmers and traders are key issues affecting capabilities for enterprise development. Many farmers rely on traditional sources (e.g. traders, input suppliers, and family members for farmers; other wholesalers and family for traders), but innovations in credit arrangements through the support of government, banks, and development agencies is playing a significant role in industry modernization (APO, 2006). The example of the Grameen Bank in Bangladesh (Grameen, 2007) in providing access to microfinance for the poor, particularly to women, has been adopted or emulated in many countries. Another factor affecting access to farmer finance has been improvement in land access and ownership, as this has improved capabilities for farmers to use land or other assets (farm equipment, future crop) as collateral. Nongovernment organizations have played a key role in some areas, and the private sector—seed companies and suppliers to supermarkets for example, also have been significant. In the case of processing, exports, and local markets, industry and market sector businesses also can provide finance, and the comparatively low monitoring, enforcement, risk, and transaction costs often make them more competitive as sources of finance than financial institutions and other lenders (Key and Runsten, 1999).

Trade, taxes, and investment. Liberalization of foreign direct investment, tax incentives, and reductions in tariffs have been critical elements of the development of the processing, export, and modern retailing sectors, and also of wholesale marketing in many countries. Another key issue influencing the cost of trade has been the level of bureaucratization and improvements associated with fund transfers, and the continuing improvement in electronic commerce. Within countries, the establishment and operation of trade and investment agencies with responsibility for stimulating the development of horticultural exports have been important. Trade offices can work with producers and agribusiness to enhance the profile of country products in export markets, to analyze, negotiate, and promote or market opportunities, and to focus

government attention on streamlining regulatory and bureaucratic procedures and one-stop-shop approaches (e.g. APEDA, 2007; PHDEB, 2007).

Electricity, communication, water and fuel prices, and access are key issues for the development of vegetable production, processing, marketing, and trade. Delivering electricity supplies and telecommunication services is a challenge, especially in remote areas and island communities. Electricity supplies in urban areas are also important as they influence capabilities for household and retail use of refrigeration, which helps extend shelf-life and reduce losses in vegetables. The World Energy Council is an alliance of over 90 countries that promotes sustainable use of energy and provides options for policy in relation to energy needs (World Energy Council, 2007). The council has proposed four energy scenarios to 2050 with the names Leopard, Elephant, Lion, and Giraffe that explore a range of scenarios (World Energy Council, 2007).

Energy use. Refrigerator ownership in tropical Asia is anticipated to rise from less than 1 refrigerator per 5 households in 2000 to about 4 refrigerators per 5 households in 2030 (McNeil et al., 2006). While cool storage represents an opportunity to improve quality and reduce losses, it also entails greater energy use, so investment in improving the energy efficiency of household and commercial refrigeration systems will help reduce electricity consumption. The Asia-Pacific region as a whole is especially vulnerable to global energy cost fluctuations as about 40% of its energy needs are met by imported oil (ESCAP, 2005). The use of renewable resources for electricity generation is increasing and becoming a major focus of donor support. Many countries in the region still use large amounts of wood or manure as fuel; although renewable, supplies of both are likely to decline over time. The Regional Wood Energy Development Program in Asia (RWEDP, 2007) is an FAO-supported program involving 16 Asian countries that monitors wood fuel use in the region and strengthens national and regional capabilities for assessing wood energy supplies, planning wood energy development strategies, and implementing wood energy supply and utilization programs (RWEDP, 2007).

Telecommunication. In the field of telecommunication, use of mobile phones (text messaging) is becoming widespread and access to the Internet is increasing, with the private sector playing a key role. India, for example, is providing village-level access to the Internet for use in

information access, communication, and trade. Affordability is generally good, but in some countries costs are higher than they need to be, and this probably hinders development.

Service delivery. Investment in infrastructure for utility service delivery is a key component of national planning and investment lending. ESCAP (2005) reviewed the features and factors of delivery mechanisms for increased access to energy services in rural areas and concluded that mechanisms need to be flexible enough to support a range of options. Subsidies in electricity and fuel for the rural sector have been adopted in many countries, but the extent of subsidies is declining and costs to consumers increasing. Another trend has been privatization of the electricity and telephone sectors in some countries.

5 Value of the Vegetable Industry

Two aspects are of primary importance in development of this sector: globalization and the involvement of multinationals. Both will provide tremendous opportunities for this sector in tropical Asia, but at the same time pose critical challenges for governments, producers, and local manufacturers in terms of access, finance, logistics, utilities, food safety, and the cost of raw materials.

5.1 Value at farmgate

Estimates of the value of the entire vegetable industry production can be made using farmgate prices (FAOSTAT) for the major vegetable commodities, multiplied by total production. Using this approach, the value of tropical Asia's 2005 production of 124.0 million tonnes was approximately US\$ 29 billion—about 22 times the value of all vegetable exports. Clearly, production for domestic consumption, and domestic marketing, should receive much greater attention. Production from five countries (India, Thailand, the Philippines, Indonesia, and Vietnam) represented 90% of the industry value in 2005 (Table 7).

Table 7. Value (million US\$) of vegetable production in tropical Asia

Year	Tropical Asia*	India	Indonesia	Philippines	Thailand	Vietnam	Other countries
1991	14,102	8,938	1,140	1,037	659	881	1,447
1992	13,823	8,390	1,071	1,259	627	896	1,580
1993	13,215	7,650	1,308	851	737	951	1,718
1994	15,252	8,969	1,459	1,025	834	1,099	1,866
1995	18,182	9,918	2,852	1,135	1,109	1,281	1,887
1996	19,391	10,863	2,547	1,375	1,182	1,398	2,026
1997	19,158	11,318	1,910	1,051	975	1,739	2,165
1998	19,778	12,580	1,061	983	1,031	1,672	2,451
1999	21,708	13,787	2,475	1,122	935	1,600	1,789
2000	19,325	11,842	1,873	836	908	1,662	2,204
2001	20,803	13,974	1,844	716	667	1,682	1,920
2002	20,814	13,351	2,029	798	667	1,818	2,151
2003	24,778	16,302	2,722	851	824	1,907	2,172
2004	26,809	17,938	2,904	1,030	522	1,967	2,448
2005	28,955	19,213	3,079	1,012	595	2,169	2,887
Share in 2005 (%)		66.4	10.6	3.5	2.1	7.5	10.0

Source: FAOSTAT (2007)

*Myanmar was excluded from the calculation since its value estimates seemed too high compared to regional norms.

5.2 Value adding – food processing and provided sectors

Processing of fruits and vegetables in the Asia-Pacific region to reduce postharvest losses and add value has been reviewed by Rolle (2006a). Processing of vegetables in tropical Asia can be divided into traditional and home-based processing, and commercial processing ranging from micro, small and medium enterprises (SME) to fully commercial operations operated by national or international agencies. For commercial operations, continuity of supply of raw materials, as well as market opportunities, influences the mix of products produced.

Home-based processing and SMEs may involve the production of pickles and chutneys, or the preparation of dried or fermented products. Some project initiatives for vegetable industry development at the national or regional level recognize the importance of identifying opportunities for small-scale processing to add value and reduce losses. Battcock and Azam-Ali (1998) have reviewed global interest in fermented fruits and vegetables and provided several recommendations for action to help government and enterprises improve quality and marketability: 1) improving the understanding of fermented products, including documenting traditional knowledge and developing a scientific understanding of the microbial processes; 2) refining the process with attention to process and quality control; 3) disseminating improvements; and 4) creating a supportive environment for production of fermented food products.

Similar principles apply for other types of processing: understand the product, how it is made and what consumers like about it, improve and streamline manufacturing and contain costs, operate in a transparent manner so that traders and customers can be assured of product integrity and safety, and encourage innovation at enterprise and industry level. Other emerging issues include the requirement for specialized certification such as halal or organic certification, and the need for guidelines and frameworks for regulatory compliance.

The extent and size of commercial processing has been influenced by government policy in relation to supporting foreign direct investment (FDI), access and cost of machinery and imported ingredients, and regulation of quality and food safety, with some countries emerging with stronger vegetable processing sectors (e.g. Thailand) as a result. In some countries local growers may face competition when imported products are used as ingredients in the processing sector.

With the growth in tourism, air travel, and shipping, opportunities in the provedore sector are also emerging. In some countries, supplying fresh and processed products to institutional buyers is also significant (e.g. armed forces in India).

5.3 Wholesale and retailing sectors

The wholesale and retail sectors play critical roles in supply distribution and quality maintenance of fresh and processed produce. They benefit from government and private sector investment in infrastructure and

utilities, in market information collection and dissemination, and in the liberalization of foreign direct investment. Other key issues are supply continuity, price, and quality management.

Traditional marketing systems still dominates vegetable marketing in tropical Asia: Farmer > Collector > Local Assembly Market > Wholesale Market > Local Wet Market > Retailers (ranging from shops to street hawkers) > Customers. However, modern retailing (supermarkets, hypermarkets, convenience stores) is increasing rapidly and driving innovation in the wholesale sector (Shepherd, 2005; Regoverning Markets, 2007).

The extent and usefulness of the wholesale sector in marketing, quality management, and profit sharing for the vegetable sector varies across the region, but key issues are: modernization and streamlining of the wholesale sector and improvement of market infrastructure, transport systems, and utilities. The *World Union of Wholesale Markets* (WUWM, 2007), a peak body for wholesale markets, aims to promote the international exchange of information on wholesale and retail markets, with a view to improving their construction, organization, and management. Members are usually wholesale markets, and in 2007, the only members from Asia were in China.

While supermarkets are continuing to grow, traditional marketing dominates retailing in most countries. Key issues are the growing preference of consumers for using supermarkets; the impact of foreign direct investment on the growth of the sector; the move by supermarkets to source products from specialist suppliers that bypass or partly bypass wholesale markets; the growth in use of imported produce when it is of better quality and more competitively priced; the marginalization of traders and farmers who are bypassed by modern retailing; and the need to ensure food supplies for the poorest customers remain adequate.

Shepherd (2005) reviewed the implications of supermarket development for horticultural crop producers and traditional marketing in Asia and noted traditional markets are responding to the competitive threat of supermarkets by improving facilities, being more proactive in cultivating business, identifying new services, improving servicing of non-supermarket retailers and caterers, improving procurement arrangements, and promoting fruit and vegetable consumption to increase demand. He also suggests that in response to the sector changes, governments could either do nothing and allow the changes to settle out, legislate to control

supermarket growth (but this may not be popular with consumers), or work with supermarkets and farmers to improve linkages and assist the traditional market sector and those farmers unable to supply supermarkets in transitional arrangements that minimize adverse impacts and facilitate their competitiveness or transition from the industry. A range of country- and region-specific studies are available (Regoverning Markets, 2007).

5.4 Trade

Of the total vegetable production in tropical Asia in 2005, 3.2 million tonnes of fresh and processed vegetables (2.6% of production; FAOSTAT estimates equivalent fresh weight for processed products) worth US\$ 1.3 billion were exported in 2005. Of this total, 1.7 million tonnes of fresh and processed vegetables worth US\$ 530.4 million were exported from tropical South Asia, and 1.5 million tonnes worth US\$ 762.8 million were exported from Southeast Asia.

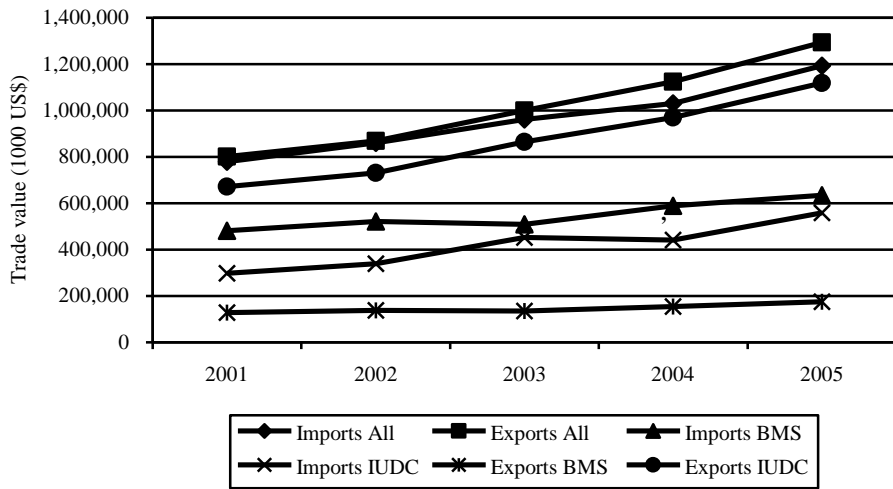
With increased production in some countries, the growth in population and demand, and the development of necessary transport communication and infrastructure, the domestic and export/import trades in vegetables are increasing in the region. Access to and analysis of accurate statistics on domestic and foreign trade enable planners and traders to improve management and delivery of produce and promote industry development to optimize opportunities and returns to farmers.

Exports and imports of vegetables are increasing throughout the region. This is a global trend and reflects improvements in transport, communication, and self-sufficiency in grains in many countries. Trade in both fresh and processed products is increasing. Key issues include market trend information access and analysis; private sector investment, financial transactions¹¹ and cost-containment; customs, excise and regulatory arrangements; sanitary and phytosanitary (SPS) inspection; certification and compliance; and food safety, GAP, and pesticide safety certification. Many countries are investing in the necessary regulatory infrastructure and encouraging private sector involvement in certification frameworks, and also have established agencies to promote export development and provide a one-stop-shop for import /export inquiries.

¹¹ Some countries/traders have reputations for unreliable payment to suppliers in other countries.

In terms of value, total vegetable exports and imports by the countries in tropical Asia have risen steadily from 2001-2005, with the rate of increase of export value slightly ahead of imports. The value of imports from 2001-2005 by the three more developed countries (BMS = Brunei, Singapore, and Malaysia) exceeds that of the developing countries (IUDC), but the gap is narrowing. This data suggests the more developed countries may represent a significant market for fresh and processed vegetables from developing countries in the region (Figure 6).

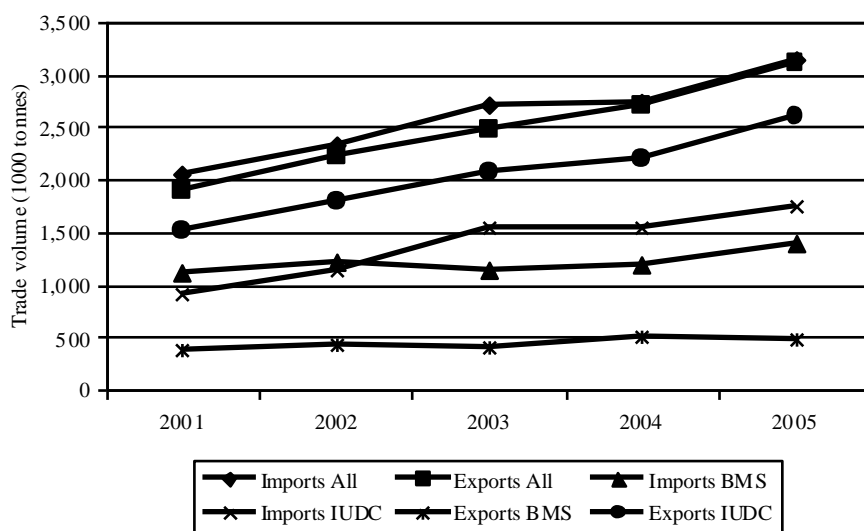
Import volumes show a similar trend, with volumes of exports and imports fairly similar. One significant trend is that the volume of imports by more developed countries in the region is large compared with the volume of imports by the developing countries of the region despite the much lower population of BMS countries. Imports by developing countries have exceeded those of the more developed countries since 2003 and are likely to increase substantially (Figure 7).



Source: FAOSTAT (2007)

Figure 6. Trade value (US\$ 1000) 2001-2005 of vegetables, for all countries in tropical Asia (imports/exports all), compared with trade by more developed (BMS = Brunei, Malaysia and Singapore) and developing (IUDC¹²) countries (= India + UDC) in the region

¹² IUDC = India plus other developing countries: Bangladesh, Bhutan, Cambodia, Indonesia, Laos, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand, Timor Leste, and Vietnam.



Source: FAOSTAT (2007)

Figure 7. Trade volume 2001-2005 of vegetables for all countries in tropical Asia (imports/exports all), compared with trade by more developed (BMS = Brunei, Malaysia and Singapore), and developing (IUDC) countries in the region

6 Institutional Frameworks

6.1 National and regional planning

For most countries in tropical Asia, food security has been an overarching concern. National approaches to this issue and other priorities for agriculture and national development are usually articulated through recommendations from United Nations agencies (country-specific, regional and global) and in National Economic Development Plans. Development of national plans is frequently underpinned by advice to government from national economic planning agencies or think tanks, and access to a range of analysis and advice from the World Trade Organization (WTO), the development banks (World Bank, Asian Development Bank), and international agencies such as the FAO, the United Nations Development Program (UNDP), the United Nations Commission for Trade and Development (UNCTAD), the International Fund for Agricultural Development (IFAD), other UN agencies, and the International Food Policy Research Institute (IFPRI), as well as regional and donor country agencies, universities and independent think tanks, development agencies and nongovernmental organizations.

In developing and implementing national plans, general trends in agribusiness and market development policy are influenced by membership commitments in the World Trade Organization and other bilateral and regional agreements, and the consequent obligations in terms of trading mechanisms, market access, Technical Barriers to Trade (TBT) and the Sanitary and Phytosanitary (SPS) agreement. The plans also reflect the need for food security (ensuring adequate supplies for urban areas) and the need to improve farmer incomes. Other influences include population growth, global concerns about excessive input use, energy shortages, rising fuel prices, land and water shortages, and the impact of natural disasters and climate change. In terms of agricultural productivity and industry development, this has meant emphasis on pro-poor strategies, improving productivity while enhancing sustainability, improving quality and safety through good agricultural practice (GAP), enhancing market access through trade negotiation and SPS compliance, and improving system efficiency through infrastructure improvement, streamlining bureaucracy, and adjusting supply chain management.

Implementation of plans generally focuses on improving production, food security, infrastructure, farmer skills, access to land, finance and

technology, and reducing losses in production and marketing. Attention is also given to policy frameworks and regulatory mechanisms; support for agricultural and trade statistics collection, market analysis and economic planning; and agricultural research, development, and impact assessment. Increasingly, development plans highlight attention to high-value industries, including vegetables; promote strategies to enhance incomes, trade, and value-adding; and promote foreign direct investment.

The *International Portal on Food Safety, Animal and Plant Health* provides a single access portal for authorized official international and national information on food safety and animal and plant health, which can be useful for governments and planning agencies in developing legislation and regulatory frameworks, and in assisting the development of trade between countries (IPFSAPH, 2007). The portal has links to country contact points for CODEX, National Plant Protection Offices (NPPO), and WTO SPS and Technical Barriers to Trade sites, and also has links to relevant national legislation in food and agriculture. Currently, national listings are somewhat patchy and links to additional “unofficial translations” of legislation would improve site breadth and utility.

The Association of Southeast Asian Nations (ASEAN) is an important body for regional dialogue and negotiation on harmonization of SPS and trade issues within Southeast Asia and with member countries’ trading partners. For example, under the ASEAN-Australia Development Cooperation Program, a regional economic facility has been providing support to the ASEAN Secretariat to provide of high quality policy analysis to ASEAN on long-term regional economic issues (REPSF, 2007). For the South Asian region, the South Asian Association for Regional Cooperation (SAARC, 2007) has potential similar to that of ASEAN, but tensions between Pakistan and India hamper its effectiveness (Lawson, 2002).

6.2 Research and development

Support for research and development in agricultural productivity improvement, and more recently in trade, have been priorities throughout tropical Asia. At the national level, agriculture ministries have primary responsibility for overseeing research and development in agriculture with complementary support from the ministries responsible for science and technology, trade and commerce, and health and education.

National research and development. Horticulture research is usually not the highest priority in agriculture research spending in Asia. A study conducted by IFPRI and APAARI in 2008 shows that for a sample of 10 Asian countries, only between 7–13% of government researchers' focus is on vegetables, rather on the lower side as compared to other crops (Beintema and Stads, 2008). Many countries follow development planning frameworks typically articulated in 5- or 6-year plans. Planning documents will outline government priorities for investment in agriculture, and can provide some guide to the relative importance of R&D support for vegetables compared to other rural sectors. Development of new 5-Year Plan discussion papers with associated meetings, and subsequent plan implementation agendas and budgets provide opportunities for national personnel and their external advisers to argue the case for greater attention to vegetables in rural development.

International research and development. The vegetable industries in the region can draw upon research and development carried out by the World Vegetable Center, headquartered in Taiwan with a regional centre in Thailand (AVRDC, 2007), and the FAO Regional Office for Asia and the Pacific (RAP) in Thailand. Other international agencies whose research programs focus on the vegetable sector include the International Food Policy Research Institute (IFPRI), headquartered in the US; the International Water Management Institute, headquartered in Sri Lanka; the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), headquartered in India, for their work on dry-land cropping; and the International Centre for Tropical Agriculture (CIAT) with a regional center in Laos, for their work on integrated management systems for livestock and crops.

Other agencies active in the region include the Food and Fertilizer Technology Center (FFTC) headquartered in Taiwan, the Asian Productivity Organization (APO), headquartered in Japan, and the SEAMO Regional Center for Graduate Study and Research in Agriculture (SEARCA), headquartered in the Philippines. In addition, the potential of biotechnology applications for agricultural productivity and sustainability to benefit the poor in developing countries is the focus of the International Service for the Acquisition of Agribiotech Applications (ISAAA, 2007), with its regional headquarters in the Philippines.

Development agencies. A range of other development agencies are active in funding and implementing development projects for the vegetable sector, including the Australian Agency for International Development

(AusAID); the Australian Centre for International Agricultural Research (ACIAR); the Asian Development Bank (ADB); the World Bank; the United National Commission for Trade and Development (UNCTAD); the United Nations Development Programme (UNDP); US Agency for International Development (USAID); the French International Research Centre for Agriculture Research and Development (CIRAD); the German Technical Agency (GTZ) and other European agencies; the Japan International Co-operation Agency (JICA); and the Japan International Research Center for Agricultural Sciences (JIRCAS). In the marketing sector, the Regoverning Markets (2007) program, funded by the UK Department for International Development (DFID), ICCO, Cordaid, the International Development Research Centre (IDRC), the Canadian International Development Agency (CIDA), and USAID focuses on integration of smallholder farmers into modern food retailing (Regoverning Markets, 2007).

Over and above ordinary development assistance, additional country-specific support has been provided by donor agencies in recent years in response to the 2004 tsunami, which affected Indonesia, Thailand, Sri Lanka, and India, and other earthquakes, floods, and typhoons. In disaster recovery planning and implementation, strategies that foster local vegetable production can be important in providing employment, livelihood support, and food while reducing reliance on outside imports.

Private sector. Private sector companies and groups are also playing a significant role in research and development for the vegetable sector, notably in crop protection chemical and fertilizer companies; seed companies; irrigation system and protected cultivation consultants and suppliers; farm, pack-house, and cool-room machinery manufacturers; processors; and institutional buyers. In some countries, national airlines have provided significant support for the development of quality management, food safety and Good Agricultural Practice (GAP) certification to help develop a vegetable sector able to supply airline food. In transport and marketing, the private sector has focused on economic and marketing analysis, GAP certification, food safety, technology transfer, and infrastructure development.

For all groups, liaison with government on policy and R&D issues is critical. Key private sector associations include the Asia and Pacific Seed Association (APSA, 2007), CropLife Asia (2007a), the International Fertilizer Industry Association (IFA, 2007a) and the national and regional peak bodies for farmers, traders, and exporters.

Global Forum for Agricultural Research. In recognition of the importance of national and international agricultural research institutions in development, the Global Forum for Agricultural Research (GFAR, 2007), headquartered at FAO, is an global alliance of R&D institutions. It provides a forum for strategic planning and discussion in agricultural R&D to alleviate poverty, enhance food security, and promote sustainable development research. Under the auspices of GFAR, the Asia-Pacific Association of Agricultural Research Institutions (APAARI, 2007), headquartered at FAO-RAP in Bangkok, promotes the development of national agricultural research systems within the Asia-Pacific region through collaboration and dialogue, with a focus on human resource development, policy advocacy, and technology transfer.

Professional associations. In the coordination of discipline-based research to support the vegetable sector, and in providing critical fora for the presentation and discussion of R&D, national and international scientific professional associations play a significant role. Key bodies include the International Society for Horticultural Science (ISHS, 2007), the International Society for Plant Pathology (ISPP, 2007), the International Association for the Plant Protection Sciences (IAPPS, 2007), and the International Union of Microbiology Societies (IUMS, 2007).

Agricultural extension. In addition to research and development, agricultural extension has a primary role in enabling dissemination and implementation of innovations in vegetable industry practices, market development, and sustainable practices. For the vegetable sector, key extension priorities include: information and training for farmers; use of improved and reliable seed; optimizing crop management and enhancing sustainable practices; integrated pest management; postharvest handling; community planning and farmer liaison; and marketing and economics. Government sector agencies, industry and farmer associations, media agencies, international development organizations, universities, the private sector and nongovernmental organizations all contribute, with varying degrees of effectiveness. Methods and approaches are constantly evolving, with participatory approaches, community empowerment, and information access and use the key elements to bring about change (Fulton et al., 2003; Rivera et al., 2006; Wikipedia, 2007a).

7 Streamlining Vegetable Production and Supply

Strategies to streamline vegetable production and supply have to be underpinned by planning, investment, and the development and implementation of policy and regulatory frameworks that accommodate globalization and commitments under the World Trade Organization, more sustainable production systems, the impacts of climate change and natural disasters, changing demographics and consumer needs, and burgeoning marketing opportunities.

7.1 Increasing demand

Globally, net production across all agriculture has increased by 2.2% per year, with most growth (3.4% per year), and total production share (67%), in the developing world. Global fruit and vegetable production has increased by 3.8%, while the population has increased by 1.4% per year (1.8% in developing world) (FAOSTAT, 2007) so more fruit and vegetables are available per capita. But, between 2001 and 2010, the world demand for fruit and vegetables is expected to increase at a rate higher than production increases. The FAO estimates demand will increase by 3.6% per year, but production will only increase by 2.8% per year (ISG, 2005). If these trends occur as predicted it will be critical to reduce postharvest losses and improve supply chain efficiencies for vegetables to capitalize on trade opportunities while ensuring supplies are adequate and affordable by the poor.

Asian cuisine is highly developed. Vegetables traditionally have been eaten cooked, as heating can reduce microbiological risks. Freshly peeled raw vegetables (especially fruit vegetables) and freshly harvested leafy greens are also consumed. The diets of tropical Asia are mostly rice-based, with wheat-based diets in some parts of South Asia and maize-based diets in parts of the Philippines. Vegetables, while generally consumed as a side dish, garnish, or ingredient with cereals or protein in a meal, contribute essential nutrients and fiber to the diets of the region. They also contribute flavor, texture, and “spice” to the diverse array of South and Southeast Asian cuisines. With improving incomes and food availability, the demand for vegetables, fruit, fish, and meat are increasing, while per capita availability of cereals has plateaued¹³ (in

¹³ Production for cereals and legumes for animal feed is increasing.

Southeast Asia) or only risen slowly (in South Asia) (Table 8) (FAOSTAT, 2007).

Table 8. Per capita availability (g/day) of selected food groups in tropical South Asia and South East Asia 1990 to 2003

	1990	1995	2000	2003
Cereals - South Asia	442.14	449.37	427.57	437.08
Cereals - SEA	461.94	484.62	488.03	484.54
Vegetables - South Asia	128.87	135.77	157.04	162.17
Vegetables - SEA	100.63	127.01	129.54	134.73
Fruit - South Asia	74.06	87.08	89.72	93.02
Fruit - SEA	134.86	151.05	146.82	165.41
Aquatic - South Asia	11.32	12.81	14.69	14.52
Aquatic - SEA	53.77	62.46	66.88	66.19
Meat - South Asia	14.24	15.71	15.26	16.00
Meat - SEA	37.12	46.20	47.69	55.34

Source: FAOSTAT (2008)

As well as the influences of flavor and texture, the traditional and new ways of using of vegetables and other ingredients in food preparation in tropical Asia are influenced by a number of other issues, including perishability, minimizing fuel use, obtaining adequate energy for physical labor, family influences, religious dietary strictures, and the need to feed unexpected guests. These issues underpin vegetable use in the diet, and need to be considered in developing strategies to promote vegetable cultivation, marketing, and consumption.

This study has confirmed that meeting urban needs (quantity, variety, flavor, intended use), rising consumption levels, and the affordability and seasonality of vegetables are key influences on demand.

Urban need. Population growth, rising incomes, increasing urbanization, the development of export and import trades, food industry innovation, processing, supermarkets, advertising, and consumer education are the key variables contributing to increases in demand for vegetables produced in tropical Asia. More specifically, changing demographics and lifestyles are increasing or reducing demand for specific vegetable types, and vegetables compete with meat, fish, dairy, and convenience/junk food for consumer spending.

Affordability. The proportion of people living with insufficient food in South Asia, Southeast Asia, and Oceania has declined more slowly than poverty levels. In South Asia, the proportion of the population with

inadequate food has declined from 25% in 1990-1992, to 22% in 2000-2002. In Southeast Asia, the decline has been from 18 to 13% (United Nations, 2005). For many in tropical Asia, food affordability may be a key factor that prevents them from consuming an adequate supply of vegetables, but often this is not the price of vegetables per se. Rather it is the convenience, flavor and “advertising pull” of processed starchy, fatty snack foods, which even the very poor will spend money on.

Seasonality. Ali (2000) reported that vegetables as a commodity group across Asia showed seasonal variation in both price and availability, but the availability of fruit in peak supply tended to counterbalance the reduced production and higher prices of vegetables. In many countries, highland areas and imports help fill vegetable supply shortfalls during the hot months when production declines in lowland areas because of unfavorable temperatures and the land being used for the main crop, rice.

7.2 Production growth and sustainability

Vegetable production is growing throughout tropical Asia. More farmers recognize the income opportunities, but governments can do more to facilitate access to technology and land, and the private sector can more profitably provide seed and other inputs. Key challenges include access to and the sustainable use of land; the potential to boost production through improved germplasm, crop management technologies and pest control; the need to adopt and monitor Good Agricultural Practice Certification and meet the requirements of supermarkets and export buyers; and rising interest in organic, low pesticide and protected and hydroponic cultivation. In the longer term, climate change may impact vegetable production practices, but in terms of water-use efficiency and the range of options for different ecosystems, vegetables rate much better than cereal and meat production.

7.3 Inputs, finance, utilities – cost and reliability

Generally, farmers’ and suppliers’ access to inputs is improving, although prices may be excessive, making them unaffordable for poor farmers. Quality standards and regulation of pesticides and fertilizers also are improving, with tighter regulation in producing (China) and marketing countries; this has reduced the risk of toxic or excessive residues.

Overuse and inadequate monitoring or enforcement of residue breaches is still widespread, reflecting inadequacies in personnel, facilities, and farmer capacity, as well as overzealous promotion by sales representatives. Mechanization in the vegetable sector is minor because of small plot-sizes and costs, but the need for more technology will increase, especially for small-scale cultivators, sprayers, and irrigation equipment.

Currently the vegetable sector is a major employer, capitalizing on underutilized family labor to improve farm productivity. But the situation is changing as more off-farm employment is obtained; this will stimulate consolidation of production areas through leasing, increased mechanization, improved transport and storage, and the move of production to areas further from the cities.

Access to finance remains a challenge (as does repayment of loans), but governments are active in devising innovative solutions to supply credit. Unfortunately, farmers are still prey to the deficiencies of climate, transport, markets, and inadequate experience or training in financial management, which can affect production and profits. Utility supplies—electricity, water, and telecommunications—are also improving. Telephone and Internet services are a key element of modern information gathering, marketing, and price reporting, but they need to be affordable and sustainable.

7.4 Value-adding, food processing, and processed sectors – innovation and safety

Investment and modernization of the value-adding, processing, and processed sectors is variable across the region, but huge opportunities exist for product development, quality improvement and marketing to developed countries. Within the region, demand for convenience, out-of-season foods, and ready-to-prepare Asian meals is rising as economies grow.

Management of food safety, product consistency and quality, and the containment of costs are key challenges, along with professional management and the improvement of farmer-processor supply lines and communication. Much scope also exists for innovation in value-adding and environmentally sustainable processing facilities. Care is also needed in use and regulation of additives, to ensure products remain acceptable to markets.

7.5 Marketing – modernization of fresh produce wholesale and retail sector

Supplying urban communities with adequate supplies of suitable produce, recognizing and developing export opportunities, and accommodating and adjusting to imports are key challenges. The emergence of modern marketing, with the high levels of investment by national and multinational private sector partners, is a key driver, with emphasis on variety, timely delivery, cost, quality, safety, and residue risk reductions.

Consumers generally need no encouragement. They will increasingly favor vegetables supplied through supermarkets, small retail businesses, processed and ready-to-eat food, and restaurant outlets. These trends will encourage growth in demand and high turnover of produce.

Challenges include adequacy of quality, reliability and supplies to consumers; encouraging higher consumption and competing with junk food; the cost-price squeezes on, and payment times to, farmers and suppliers; and the emergence of “food-miles” as a factor influencing supermarket and customer food sourcing. Monitoring and reporting of market and trade prices and volumes, and the regulation of marketing are also vital for system efficiency, farmer decision-making, and trader and government planning.

7.6 Trade – market development, GAP compliance and import competition

For all countries growth in trade is affected by three key issues: adopting a market-based approach to developing export industries; adjusting domestic production affected by import competition; and modernizing the industry so that it can meet global sanitary and phytosanitary standards and meet the requirements of good agricultural practice (GAP) certification.

Imports of fresh and processed vegetables are increasing throughout the region while growth in exports has been restricted to three of the five focal countries: Thailand, Vietnam, and India (Table 9). Thailand stands out as the most successful exporter on a per capita basis, with the volume of trade approaching that of India. Total volume of imports by India is very low compared to exports, and volumes of imports by Vietnam and Thailand are low compared to exports (2005 data). For Indonesia and the

Philippines, imports are more than double the volume of exports (2005 data); addressing this is a key challenge.

Table 9. Changes and extent of trade in fresh and processed vegetables by value (US\$ 1000) from five countries in tropical Asia

	2000	2001	2002	2003	2004	2005
Thailand imports	33,914	33,899	42,842	54,261	80,539	89,178
Thailand exports	254,850	260,807	280,767	316,928	388,327	414,615
Indonesia imports	77,727	88,538	90,146	90,251	104,484	126,934
Indonesia exports	59,356	55,039	47,084	49,193	48,476	54,290
Philippines imports	48,622	35,990	31,734	63,443	35,387	89,205
Philippines exports	30,901	27,256	42,676	31,791	42,879	25,180
Vietnam imports	6,952	7,396	26,283	39,748	37,902	45,845
Vietnam exports	27,812	33,324	36,907	45,464	54,817	73,986
India imports	8,934	33,007	27,457	22,835	18,315	25,189
India exports	229,533	254,520	287,192	379,391	397,878	508,454

Source: FAOSTAT (2007)

7.7 Key variables affecting supply and delivery

In the last 20 years, considerable emphasis has been given in international and national research and development to productivity improvement, seed reliability and integrated pest management, sustainability, quality assurance and food safety, good agricultural practice, market information and analysis, peri-urban and intensive production systems, human resource management, the wholesale sector, and modern retailing, with integration of many of these issues within supply chain analysis and improvement and systems approaches.

Key variables that will continue to influence the ways, needs, and profits in producing and delivering vegetables from farm to consumer (the supply chain) include: on-farm diversification with many farmers expanding cropping beyond rice, legumes or maize; the emergence of modern retailing in Asia; food industry innovation, and development of the processing and export sectors; contractual arrangements between farmers and other sectors; improvements in transport infrastructure, storage technology access, communication systems and utility supplies; urbanization; increasing incomes; food-miles as a factor influencing choice; and changing consumption patterns.

8 An Action Agenda – The Way Forward

To accommodate and enhance regional attention to the development and sustainability of the vegetable industry in tropical Asia, a Vegetable Industry Action Agenda focusing attention on five areas is proposed:

Action Area 1: Focus on the implications of market liberalization and access. Map industries to assess status and the impacts and opportunities at local, national, and global levels to introduce improvements and address deficiencies.

Membership in the WTO, the globalization of agriculture, and the expansion of free trade agreements have in general been favorable for the vegetable industry. As the “good guys” of nutrition, the prospects for the fruit and vegetable industries should be bright.

In the future, producing countries in tropical Asia will need to be flexible and innovative in adjusting to competitive threats on both the domestic and export markets to remain competitive by reducing costs while maintaining standards, by proactively identifying both high- and low-end markets for current and future crops, and by cultivating strong “can-do” reputations for honesty, reliability, financial probity, and prompt payment. Market-driven production needs to become a key influence of industry development, and a supply chain approach developed and promoted for all key crops.

Focused attention is needed to acquire and analyze reliable market intelligence to identify threats and opportunities for fresh and processed produce in domestic markets¹⁴ and overseas, with capacity building in:

- data acquisition and use by trade and marketing professionals in the public and private sectors
- interpretation and responding to opportunities for the farming, trading, and R&D sectors
- approaches to the challenges of carbon credits and food-miles affecting consumer buying habits

¹⁴ Also to anticipate and adjust for domestic supply shortfalls.

There is a need to build capacity in policy analysis and development to assist in planning and response to global and domestic issues that affect industry development or viability.

In identifying and accessing markets, compliance with the sanitary and phytosanitary (SPS) requirements of target countries and ensuring local industry is equally protected will add to costs and time for market development. While SPS concerns often can be identified and addressed as part of market development and entry assessment, it is critical that additional resources be provided for this sector of R&D to ensure capacity is adequate for increasing demand for export and import clearances and market access technologies. Attention to the SPS risks to potential export markets can also identify if markets would be closed to local production because of serious phytosanitary risks for which control was inadequate or uneconomic.

A parallel issue is the additional scrutiny and inspection requirements as a consequence of terrorism threats. Long delays in transit while produce is waiting for inspection and clearance—whether for SPS compliance or security—can place additional stress on product quality. Therefore R&D and infrastructure investments will be needed in reliable technologies to keep produce fresh and cool during transport and storage.

Action Area 2: Promote vegetable consumption for health and vitality.

In the supermarket sector of most countries, the fresh produce section is a major source of profitability; it therefore deserves attention from store operators to satisfy customer expectations for quality, safety, and variety. Retailers are often willing to work with industry in mutually beneficial partnerships to promote fruit and vegetable consumption. While the prospects for the vegetable industry in tropical Asia are good, the opportunity exists to make returns to farmers even better by boosting consumer demand and improving and expanding export and domestic markets.

As market access requirements are becoming more stringent, vegetable consumers are also becoming more demanding. Urbanization, rising incomes, travel experiences, and the greater participation of women in the workforce are increasing demand for choice, convenience, ready-to-eat, and take-away food. Demand for some vegetable types is rising while demand for others is falling; more use is being made of frozen and

preserved vegetables and juices. Consumer studies and food technology research will be needed to understand these trends, and to extend options and opportunities in the domestic and export sectors.

Health and nutritional problems are evolving in the region. Dietary inadequacy, vitamin deficiencies, and infant mortality are declining across Asia, but levels of obesity and health problems such as diabetes and cancer are increasing. Helping to reduce the risks of these problems represents a marketing opportunity for the vegetable industry. The health, education, agriculture, and trade sectors of government, industry, and international agencies should work together to:

- educate consumers and encourage healthy eating
- identify varieties and attributes of vegetables that are health-enhancing
- promote increased vegetable consumption and eradicate nutritional deprivation

Action Area 3: Improve industry profitability and competitiveness.

Tropical Asia has a great diversity of vegetable types, many with unrealized or underdeveloped commercial potential, and many countries have well-established reputations for the production and supply of a range of produce. A research, development, and extension agenda should be developed and implemented to improve the profitability and market potential of the vegetable industry through:

- prospecting and discovery, to find, conserve, and develop novel germplasm
- genetic manipulation and conventional breeding and seed technologies to deliver superior varieties with higher yield, better flavor and nutrition traits, pest and disease resistance and growth stress tolerance
- sustainable crop production, protection, and postharvest technologies that maintain quality and reduce losses

Food safety and contaminants are key issues for many export markets and are of increasing concern to consumers. Past problems with contamination of shrimp exports from Asia and more recent problems with avian influenza have been key drivers in encouraging several countries to further enhance their resources and technical capability for

food safety regulation and contaminant control and monitoring across all agricultural products.

The development and implementation of Good Agricultural Practice (GAP) certification, and Hazard Analysis and Critical Control Point (HACCP) assessment for horticulture have been a major focus in some countries, and a key need for others. Certification compliance and monitoring capabilities need to be extended to enable graduation through locally acceptable standards to those required internationally, such as EurepGAP (2007), and Japanese market certifications. An area for attention is the further development of cooperative compliance models and trace-back systems in many countries (focusing first on key exports), and the need to reduce costs associated with certification and compliance monitoring. An emerging issue, which could also influence market opportunities, is the trend of indicating “food-miles” on product labels or other marketing materials for customers that want to minimize food-miles and reduce the carbon-credit costs of food purchases.

Wholesale market facilities and internal transport systems in Asia vary in quality. There is an urgent need to improve facilities and streamline operations in many countries.

To improve infrastructure, logistics, and consumer expectations the FAO has provided comprehensive guidelines to assist countries and cities in implementing necessary changes in a staged approach. Returnable plastic crates are in use by collectors and wholesalers in some countries, but more ecologically acceptable packaging systems are needed for retail marketing and export (especially for Europe). Key areas of attention include enhancement of food safety and hygiene; market infrastructure and logistics; cool-chain handling; recyclable packaging; and a focus on cost-reduction—for example by more efficient consolidation of small consignments and best practice in transport and logistics.

Farmer-with-farmer cooperation, group marketing and produce brand-name labeling all offer opportunities to reduce costs, improve produce consistency and quality, and foster better customer relations. “Buy Local¹⁵” or “Buy Asian” campaigns could strengthen customer demand

¹⁵ “Think globally, act locally” was a philosophy originally espoused by philosopher Rene Dubos, who was an advisor to the United Nations Conference on the Human Environment in 1972, and reflected in the pioneering and influential work of economist E.F. Schumacher. “Buy Local” campaigns are an extension of this

in domestic and export markets, especially if the reputation of the industry as a supplier of sometimes “exotic” but always fresh and safe produce can be enhanced.

Action Area 4: Facilitate industry restructuring

Both internal and external drivers are influencing structural changes in tropical Asia’s vegetable industry. Key influences include import competition and the need for market focus, fluctuations in currency, energy prices affecting profit, increasing stringency of SPS compliance and supermarket quality requirements, increasing urbanization in Asia and in markets, pressure on land and water resources, and changes in land use.

Attention to supply chain mapping will enable policy and research planners and industry to gain a better picture of the dynamics and the strengths and weaknesses of the current industries. Predictive modeling approaches, such as those being developed by Hardeweg and Waibel (2006) could be used to help in industry forecasting and planning across Asia.

Enhanced support for the collection and analysis of reliable industry statistics for production, trade, consumption, and consumer/industry opinions will also assist in modeling and planning.

A detailed analysis of the changes in production systems—options for cropping after rice, the migration of production to areas where land is more readily available or cheaper, the increase in protected cultivation, organics, hydroponics, changes in remote area production, market access, and predictive modeling of the impacts of climate change, will provide a picture of key areas for research, development, and extension attention and socioeconomic planning, and highlight information and R&D gaps.

Accommodating water use, global warming and chemical contamination are also critical areas for attention to improve efficiencies and anticipate and address threats to industry viability. But to deal with these and other challenges comprehensively, a review may be needed of current research, development, and extension structures and funding arrangements.

philosophy to enlist patriotism (whether local or national) in purchasing decisions (Eblen and Eblen, 1994; Goff and Goodrich, 1998; Wikipedia, 2007b).

Approaches such as those adopted for the CGIAR Challenge Programs could be considered, with partnerships extending across government and the private sector, and conducted in collaboration with regional and international agencies.

Action Area 5: Enhance industry professionalism

In developing and maintaining reputations as reliable providers of high quality, safe produce, exporters and suppliers have relied upon more “professional” approaches to farming. As a consequence, some farmers who are less “professional” are becoming marginalized or redundant. Although these trends put those that are unable to compete at a disadvantage, the situation is no different than what would be expected when change and development occurs in any field, be it health care, law—or agriculture. Planning and action by policy makers will be needed to support those who are adversely affected by providing capacity building, alternative employment, and lifestyle transition options for the benefit of individuals and the community. In parallel with this change, farmer populations are aging (yet youth is the highest population sector in much of Asia); labor costs and off-farm incomes are rising. Non-farm incomes have helped buffer transitions, diversification, increasing mechanization and off-farm migration; this income will also be a critical factor in managing the generational change in farming. Key issues will be:

- training and social support for migrant labor
- the provision of retraining opportunities and income safety nets for those that leave the sector
- revision of education curricula to educate farmers and industry personnel about the future
- enhancement of farming as an occupation for young people
- the provision of effective extension services, particularly when taking the participatory approach favored by modern extension practitioners

9 Concluding remarks

In the last few years, the international agricultural research community has recognized the increasing importance of horticulture for development. The way forward will involve more dialogue and investment, and it will require close involvement and partnership with farmers and the private sector. The seed industry, agri-input suppliers, and the trade and marketing sectors have been key drivers of success in the vegetable sector. Farmers are the lifeblood of the industry; without their involvement and cooperation the industry will not be able to fully realize its potential. Farmers are vital partners on the way forward; they provide information and services to other farmers (such as information or access to subsidies, crop production assessments, regulatory matters, and disaster relief) and promote community development. Delivery of these services can reduce the time needed from extension and have long-term benefits by boosting community empowerment.

In optimizing resources for extension, issues include whether agricultural extension and agricultural research and development are the responsibility of different government departments (separation hinders effectiveness), and the extent to which government agencies, the rural and urban marketing sectors, and private industry interact. In general, the better the degree and extent of linkage and liaison between research, development, and extension, the better the results.

The areas and volume of production and the broad trade statistics for the region have been documented, with steady growth in both. While production volume and area in the region have steadily increased, there are concerns that demand may outstrip supply.

Trade is also expanding, with similar growth rates and volumes for imports and exports. The total volume of exports still represents only 2.6% of tropical Asia's production. The value of imports and exports were similar between 2001 and 2005, despite the large difference in quantity; since 2003, the value of exports has begun to grow at a faster rate than imports. This reflects a global trend as developing countries become more significant as a source of supply for the developed world.

Comparisons have been made between the relative size of two-way trade by three more- developed countries in the region (Singapore, Malaysia, and Brunei) and the less-developed countries, with import volume by the

three more developed countries similar to the total trade volume of all other countries combined.

Key farming, processing, and marketing systems and input uses have been described or defined, and key issues identified. Institutional frameworks for policy, research and development, and agricultural extension have been reviewed.

The accompanying CD contains assessments and statistical data for 5 countries: Thailand, Indonesia, India, the Philippines, and Vietnam. The challenges and opportunities for these countries will be used to distill country-specific and regional recommendations as contributions to a *Global Plan of Action for Vegetables*.

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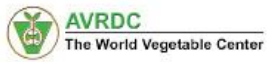
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www.avrdc.org

AVRDC - The World Vegetable Center
Headquarters
PO Box 42
Shanhua, Tainan 74199
Taiwan

T +886 (0) 6 583-7801
F +886 (0) 6 583-0009
E info@worldveg.org