Explorations #1

The Vegetable Industry in Tropical Asia: *Indonesia*

An Overview of Production and Trade

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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.

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Andaman Sea
Thailand
Gulf of Thailand
Vietnam
Sulu Sea
Philippines
Philippine Sea
South China Sea
Strait of Malacca
Malaysia
Kuala Lumpur
Medan
Simeulue
Natuna Besar
Bandar Seri Begawan
Brunei
Karakelong
Celebes Sea
Sangihe
Morotai
Malaysia
Kayan
Singapore
Nias
Pontianak
Halmahera
Kampar
Padang
Hari
Bangka
Kapuas
Samarinda
Barito
Palu
Molucca Sea
Sula
Obi
Siberut
Jambi
Belitung
Ceram Sea
Ceram
Pagai Selatan
Sumatra
Mus
Sulawesi (Celebes)
Buru
Ambon
Indian Ocean
Nias
Jakarta
Semarang
Java Sea
Ujungpandang
Banda Sea
Kai
Aru
Madura
Flores
Bandarlampung
Bali Sea
Komodo
Flores Sea
Dili
Wetar
Yamdena
Java
INDONESIA
Surabaya
Bali
Sumbawa
Sawu Sea
East Timor
Arafura Sea
Lombok
Sumba
Timor
Christmas Island (Australia)
LESSER SUNDA ISLANDS
Melville Is.
Ashmore Is. (Australia)
Bathurst Is.
Timor Sea
Gulf of Carpentaria
Indian Ocean
Australia

1 Summary

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

1.1 Key statistics for Indonesia

Statistics gathered from FAOSTAT, 2007; MOA, 2006b; Roy Morgan, 2007; Wiesmann, 2006; WHO, 2007.

Land area:	1.8 million km^2
Latitude:	6°N to 11°S
Longitude:	95°W to 141°E
Climate:	Tropical but variable, with cooler meso- and highlands. High rainfall from northern and southern monsoons, except in some eastern areas.
Population:	222.8 million
Global Hunger Index Ranking:	1981-28.2% >1992-18.5% >1997-13.8% > 2003-12.5%
Refrigerator ownership:	35% (Roy Morgan, 2007)
Vitamin A:	Subclinical deficiency common.
Diabetes:	8.4 m (2000); est. 21 m (2030) (WHO, 2007)
Production:	9.4 million t (MOA, 2006b); 7.4 million t (FAOSTAT, for 2005).
Area:	1.1 million ha (MOA, 2006b); 883,619 ha (FAOSTAT, for 2005)

Availability:	1996 -130; 1999 -117; 2005 – 128 g/ca/day
Main crops:	(area) - chili (21.5%), yard-long bean (9.7%), shallots (9.6%), cabbage (6.6%), cucumber (6.1%), mustard greens (5.9%); (volume) - cabbage (16.2%), chili (13.3%), shallot (9.2%), tomato (8.1%), cucumber (6.9%), mustard greens (6.9%) (Σ 6 crops = 60.6% production) (MOA, 2006b, 2007a for 2005).
Exports:	90,490 t (fresh/processed) in 2005 worth US$ 54.29 million (FAOSTAT, 2007). Fresh exports: cabbage and other brassicas, eggplant, mushroom. Processed vegetables: canned mushroom.
Imports:	406,390 t (fresh/processed) in 2005 worth US$ 126.93 million (FAOSTAT, 2007). Fresh temperate vegetables: garlic, broccoli, carrots, leeks. Processed vegetables: dry chilies, tomato paste.

1.2 Industry issues

Assuring production and marketing	• Land availability and use efficiency (urbanization, renting, land consolidation, remote areas) • Climate extremes (protected cultivation), and natural disasters (recovery strategies) • Balancing rice self-sufficiency with high-income cropping • Modernizing the wholesale sector (hygiene, transparency of operation, logistics) • Growth of supermarkets (foreign investment, contract growing, decline of traditional trade)
Expanding trade and value adding	• Supply chain mapping and improvement (sectoral involvement, skills development, technology) • Logistics and inter-island trade (complexity, time, cost) • Investment in processing (large scale and SME, use of local ingredients) • Increasing industry employment (on and off farm)
Benefiting farmers and consumers	• Enhancing farmer incomes (crop diversification, supply chain efficiencies) • Assisting industry transitions (crop migration to new areas, displaced farmer exits, retraining) • Consumer affordability and suitability (access to chili and shallot essential for poor, halal status) • Input use, prices, and quality (access, pesticide residues, safety)
Assuring quality and increasing consumption	• Enhancing Good Agricultural Practice and food safety (cost, regulation, compliance) • WTO/SPS compliance (cost, efficiencies, capacity) • High level of imports (price, variety, safety) • Promoting consumption (trade and nutrition benefits) • Enhancing novelty (indigenous and biopharmaceuticals) and convenience (semi-prepared)

1.3 Recommendations for development

Marketing and economics

- Understand and facilitate modernization of domestic markets.
- Identify and facilitate opportunities for trade and market access.
- Stimulate value-adding and agribusiness development at SME and large industry levels.
- Improve financial management and access to lending across the industry.

Industry development

- Strengthen industry mapping and statistics collection, and foster supply chain and analysis and improvement.
- Facilitate land access and consolidation of farms.
- Enhance intensification of production.
- Assist in the development of new areas (land, technology adaptation, supply chains).
- Improve farmer welfare and promote industry groups and professionalism.
- Revitalize the roles of Dinas Pertanians and Agricultural Technology Assessment Centers (BPTP).

Systems and technology

- Enhance sustainability and productivity.
- Optimize production and distribution and enhance adoption and reliability of Good Agricultural Practice certification.
- Encourage novel crop prospecting and industry innovation.

Collaboration and engagement

- Foster more competitive research and collaboration.
- Improve information on current and planned collaborations and priority outcomes.

2 Introduction

Indonesia is the fourth most populous and the largest Muslim-majority nation in the world (228.1 million people in 2007[1] with growth at 1.1%, 2000-2005). The population is concentrated in Java (59% on 6.8% of land, 77 people/km^2), with much sparser population densities in other regions such as Kalimantan and Papua.

A vast, volcanic archipelago of about 17,500 islands[2], Indonesia straddles the equator (95º N – 141º E x 6º W-11º S). Most islands are mountainous, with some peaks exceeding 3000 m, and there are several active volcanoes. As a consequence, soils are rich and, although tropical, climatic conditions vary, with temperatures lower in elevated areas, providing a range of agroecological environments (Wikipedia, 2007b).

Rainfall comes from northern (November to March) and southern (May to September) monsoons. Rainfall ranges from 1400 to 4000 mm, but is lower (700 mm) and more seasonal in some eastern regions (especially Nusa Tenggara). There are dry spells from April to October. The weather extremes—too much/too little rain, high temperatures—hamper productivity.

From independence in 1945, Indonesia has made steady progress in growth and development. The Global Hunger Index estimates for Indonesia declined from 28.2% in 1982, to 12.5% in 2003 (Wiesmann, 2006), but about 50% remain "near poor," and urgently need feasible options for improving their livelihoods[3].

Indonesia has made a strong economic recovery from the 1997 economic crisis (Wikipedia, 2007a), and is establishing solid macroeconomic foundations, with real government spending back to pre-crisis levels. National recovery and growth have been especially impressive in light of the succession of natural disasters—including the tsunami in 2004, the Nias earthquake in 2005, and the 2006 Yogyakarta earthquake, which was followed by a second earthquake and tsunami in West Java. Bombings in Jakarta and Bali and other security concerns also have plagued the nation, stifling tourism and hampering investment (World Bank, 2007).

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1 Projected to be 284.6 million in 2050 (UNFPA, 2007)

2 With about 6000 islands inhabited.

3 In 2007, 36.2% (= 27.8% of urban, 43.8% of rural) of those receiving income earned less than IDR 500,000 (US$ 65.50) / month (Morgan, 2007).

Economic progress has been assisted by strong donor support, and increasingly, Indonesia is articulating clear agendas for enhancing the focus and effectiveness of external contributions. To encourage stronger growth and advance pro-growth, pro-poor, and pro-jobs strategies, the government is implementing ambitious infrastructure, investment, and financial programs. Oil subsidies have been cut, and savings used to support schooling, healthcare and village infrastructure. Indonesia is continuing to decentralize government services and extend democracy with local elections and devolvement of control over resources to communities (World Bank, 2007).

Regional challenges will affect progress and future planning. With China, Thailand, and Vietnam growing rapidly, it is imperative for Indonesia to: maintain sound macroeconomic policy, and improve investment and policy/regulatory frameworks; adjust to its changing status as a middle-income country, which will require new modalities for development cooperation; and emphasize the effectiveness of development support and collaboration (ADB, 2005). Within this context, the vegetable industry represents a potentially strong contributor to economic development.

2.1 Significance of the vegetable industry in Indonesian agriculture

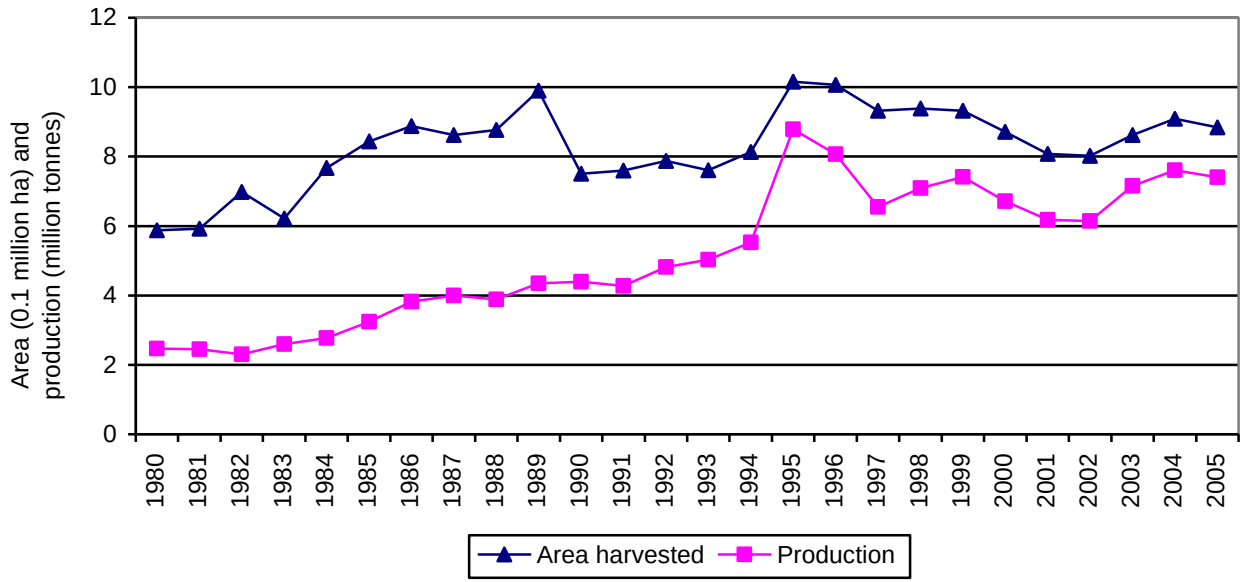
With a land area of 1,919,440 km^2, 16.3% is used as arable and permanent cropland (1998) (MOA, 2006b). Just 15.3% of cropland is irrigated (1999) (Wikipedia, 2007b; EarthTrends, 2007). The climate and history of Indonesia has resulted in lowlands (< 200 m) dominated by rice, maize, cassava, fruit and estate crops, and highlands (> 800m) dominated by vegetables and other cool-climate crops. In recent years, cropping has diversified in the meso-production areas (201-800 m) and the lowlands, with more production of vegetables, and about 30% of the industry in the highlands. In total, 1.1 million ha are used for vegetables and potato (MOA, 2007b).

Production sectors can be further differentiated according to wet-season and dry-season cropping, distance from market, and extent of commercialization (Darmawan and Pasandaran, 2000). Vegetable production is highest in the dry season in March to April (harvested before the wet season of July-August), and lowest in the hottest part of the rainy season, when prices are consequently higher (Darmawan and Pasandaran, 2000).

The majority of Indonesia's 24.9 million agricultural households (2003 est., MOA, 2006b) farms are under 2 ha. In 1993, there were 17.3 million farms under 2 ha and this represented 88% of all farms (Nagayets, 2005); the number

< 2 ha, and sector percentage have increased since then. Farmland is being lost to urban encroachment, and ownership and inheritance issues can complicate access, but renting is relatively cheap. For example, in 2002 surveys of West Java, average farm size was 0.72 ha for non-chili farmers and 0.56 ha for chili farmers, and average monthly per capita household income estimates ranged from IDR 0.25 million for chili farmers to IDR 0.36 million for non-chili farmers, and IDR 0.5 million for urban consumers (Mustafa et al., 2006).

The vegetable industry in Indonesia has been overviewed by Grubben et al. (1994), Darmawan and Pasandaran (2000) and Natawidjaja et al. (2006; 2007). Aside from peaks in 1995-1996, gross production of vegetables in Indonesia grew steadily between 1985 and 1999, with growth averaging about 6.5% per year (
Figure **1**). After 1996, production (volume and area) plateaued, and has oscillated since. From 1995 to 2005, the area harvested fluctuated between 800,000 and 1 million ha, and production fluctuated between 6.0 and 8.8 million tonnes with slightly negative mean annual growth rates for both (whereas the population only grew by about 1.3% per annum (Table 1,
Figure **1**) (FAOSTAT, 2007). In 2005, vegetable production was estimated at 7.4 million tonnes from 0.88 m ha (FAOSTAT, 2007).



Source: FAOSTAT (2007)

Figure 1. Trends in vegetable production and area, 1980-2005

Table 1. Indonesia: Population and area, production, and export - import volume for vegetables

	1995	1997	1999	2001	2003	2005	Growth rate (1995-2005) (%)
Population ('000)	195,649	201,094	206,472	211,893	217,354	222,781	1.31
Area harvested (ha)	1,016,421	931,628	932,014	808,157	861,587	883,619	-1.62
Production (tonnes)	8,790,690	6,546,556	7,407,713	6,178,083	7,164,256	7,395,513	-1.18
	1996	**1997**	**1999**	**2001**	**2003**	**2005**	**Growth rate (1996-2005) (%)**
Exports (tonnes)							
Fresh	80,901	55,163	61,680	70,280	58,434	55,789	-0.52
Processed	32,661	27,978	34,016	36,490	28,312	32,827	2.78
Value (US$ 1000)							
Fresh	16,838	12,133	17,533	19,493	22,671	20,931	7.57
Processed	47,920	29,751	34,835	36,626	28,828	33,905	0.48
Imports (tonnes)							
Fresh	114,900	124,473	230,708	278,262	280,819	376,224	12.85
Processed	14,115	21,763	16,261	23,673	30,781	30,069	9.50
Value (US$ 1000)							
Fresh	80,899	90,692	55,825	71,406	68,684	97,618	1.17
Processed	16,861	22,708	10,534	17,217	21,349	23,310	5.46

Source: Population, area, and production from FAOSTAT (accessed October 2007); export and import from PC-TAS ITC/UNSD (2002; 2007).

Production increases from 1980 to 1994 were largely due to higher yields (better seeds and technology rather than increased plantings), and a focus on multiple harvests or cropping[4], but pesticide use was excessive, fertilizer use imbalanced, and organic matter inputs drastically below levels required to maintain healthy soils (Hilman et al., 1990; Darmawan and Pasandaran, 2000). The elimination of state subsidies reduced the use of fertilizer and pesticides, and boosted interest in IPM and non-chemical alternative technologies (Fuglie, 2001). In the 1990s, the industry provided more employment days/ha (200-300 d/ha) than rice (176 d/ha) (Darmawan and Pasandaran, 2000).

The per hectare production averages for the Indonesia are low by regional and international standards, and there is scope for more use of high yielding (hybrid) cultivars and better management to increase national production without encroaching on grain production areas.

In 2005, total exports of fresh and processed vegetables were 120,132 t (fresh/processed, including potato), worth US$ 84.2 million. Total imports in 2005 were 485,255 t (fresh/processed) worth US$ 174.6 million (MOA, 2006b). The high level of imports in 2003-2005 in part compensated for static domestic production levels.

Indonesian agricultural policy focuses on self-sufficiency and import minimization, with protective measures and government resources focused on the strategic commodities of rice, sugar, maize, and soybeans. However, the small size of farms means this strategy does not help improve incomes or welfare (Molyneaux and Rosner, 2004). Farmers are unable to produce sufficient income from staple crops alone on farms of 0.5 ha. Rice provides on average just 28% of income, non-rice agriculture 33%, and off-farm activities 39% (Molyneaux and Rosner, 2004). The best strategy for improving incomes is to promote high-income options such as horticulture, livestock, fisheries, and estate crops. The high levels of protection for rice, soybeans, sugar, and maize will become increasingly undesirable if, in the absence of sufficient local production, domestic demand for fruit and vegetables is instead met through more imports (Molyneaux and Rosner, 2004).

2.2 Vegetable demand

Indonesian cuisine reflects the archipelago's long history in trade and the movement of people. Vegetables are an important part of Indonesian diets, usually spiced, and served at the main meal along with rice, as ingredients in a

[4] Between 1980 and 1993, about 60% of vegetable production was on Java, where about 60% of the population lives.

soup, with one or two cooked dishes (meat, seafood, tempeh or tofu), and as sambals—spicy condiments made with chili and shallot (Wikipedia, 2007d). The majority Muslim community requires halal foods conforming to Muslim dietary laws.

In eastern Indonesia, particularly Papua, dietary patterns differ and self-sufficiency gardening is traditional. Sweet potato, taro, and sago are the main staples (although rice consumption is also growing), served along with locally grown vegetables and fish or meat, including pork.

Despite its strong traditional food culture, Indonesian consumption patterns are changing with continuing economic growth. Dietary rice and other staple levels are declining, and consumption of fruit, vegetables, and prepared foods is increasing. Rising incomes, urbanization, and greater participation in the workforce encourage the use of ready-prepared ingredients and ready-to-eat meals, which include vegetables. Marketing arrangements are also changing, with rapid growth of the supermarket sector.
Although rice has been the key preoccupation of food policymakers and researchers in Indonesia, horticulture is emerging (along with aquaculture and animal husbandry) as the main option for diversification by farmers. The impetus for change is being driven by consumer demand and export opportunities.

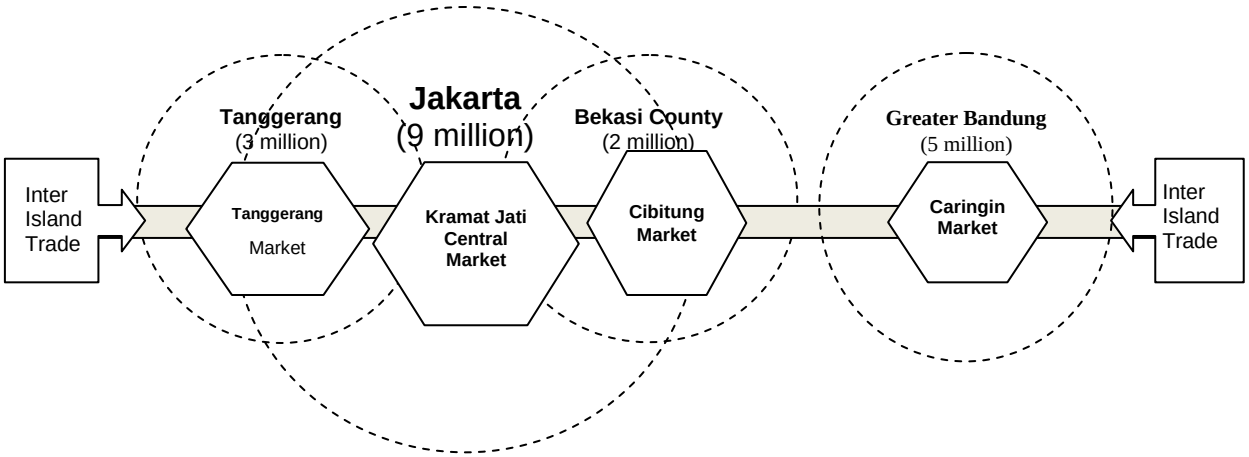
Per capita availability of vegetables has recovered from a low of 117 g/day in 1999 after the economic crisis, to 128 g/day in 2005[5], but per capita availability of vegetables is still low. Incidences of vitamin A, iodine, and iron deficiencies remain high (Lochmann, 2005). At the same time, with increased income, health problems associated with excess consumption have risen. In 2000, 8.4 million Indonesians (4% population) were affected by diabetes, and by 2030, an estimated 21.3 million may be affected (WHO, 2007).

[5] MOA (2006b). The MOA data is broken down into consumption of spinach (probably amaranth), water spinach (kangkong), cabbage, French bean, yard-long bean, tomato, cucumber, cassava leaf (relatively insignificant), eggplant, squash (pumpkin), soup, sour vegetable soup, young jackfruit, unripe papaya, onion (probably shallot), cayenne pepper (probably refers to all chili types) and others, but not chili or shallot, which are the highest produced (their omission probably reflects inclusion under cayenne pepper and onion data). The information in parentheses from G. Grubben (pers. comm., 2007) is to clarify categories (MOA, 2006b). Data for tomato and papaya for 2005 have been corrected by X 1/10. MOA (2006b) include watermelon in fruit consumption. This data may also under-estimate consumption. In 2002 surveys in Java, consumption of vegetables was 210 g/day for chili farmers, 195 g/day for non-chili farmers, and 189 g/day for urban consumers (Mustafa et al., 2006).

To address both under- and over-nutrition problems, enhancing per capita consumption of vegetables should be a key strategy and a critical opportunity for the Indonesian vegetable industry.

3 The vegetable supply chain

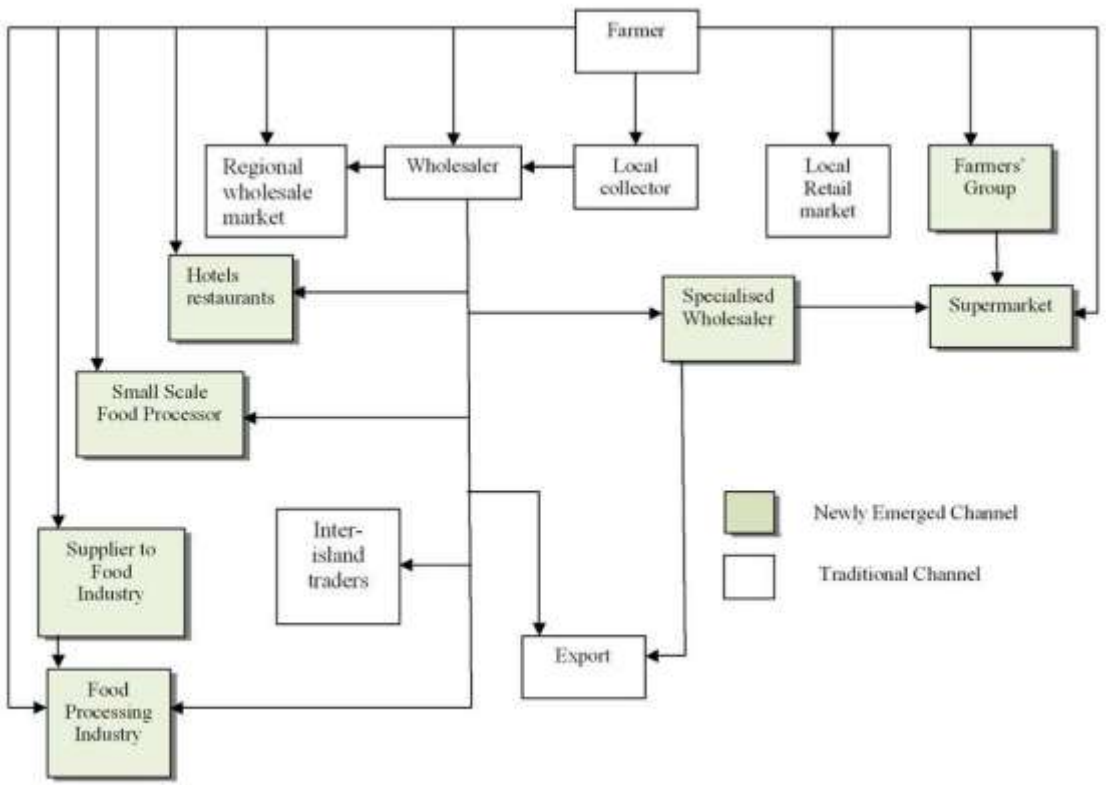
Sectoral involvement in the supply chain is illustrated in fFigure 2 and 3. Figure 2 shows the traditional wholesale market system in Java, where the circles indicate areas supplied by each market**.** Figure 3 shows the traditional wholesale market chain and marketing chains that have emerged with the rise of supermarkets (Natawidjaja et al., 2006; 2007).



Source: After Natawidjaja et al. (2006; 2007)

Note: The circles show overlap in urban areas served by the main markets (= hexagons). Produce from inter-island trade flows into the supply chain with all main markets interconnected by produce flows.

Figure 2. Vegetable supply chains in Indonesia: Traditional wholesale system in West Java, Banten, and DKI Jakarta

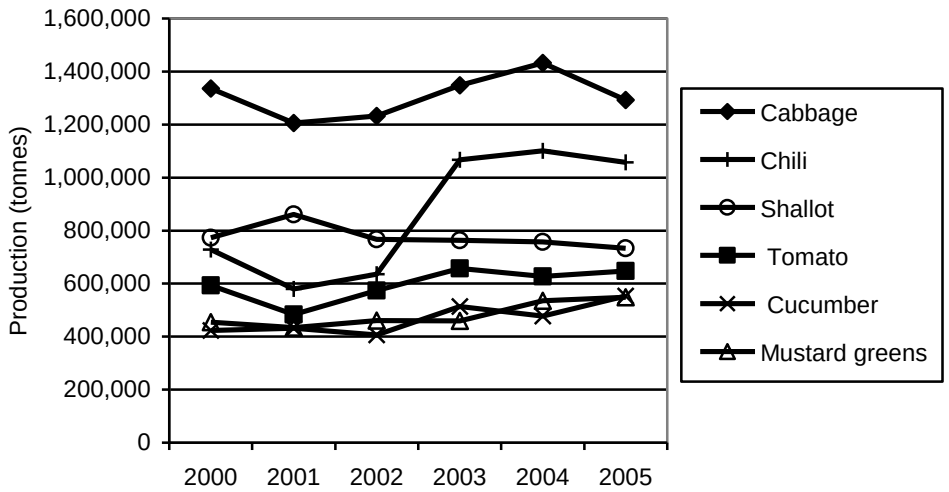


Source: After Natawidjaja et al. (2006; 2007)

Figure 3. Vegetable supply chains in Indonesia: Alternative marketing channels in West Java

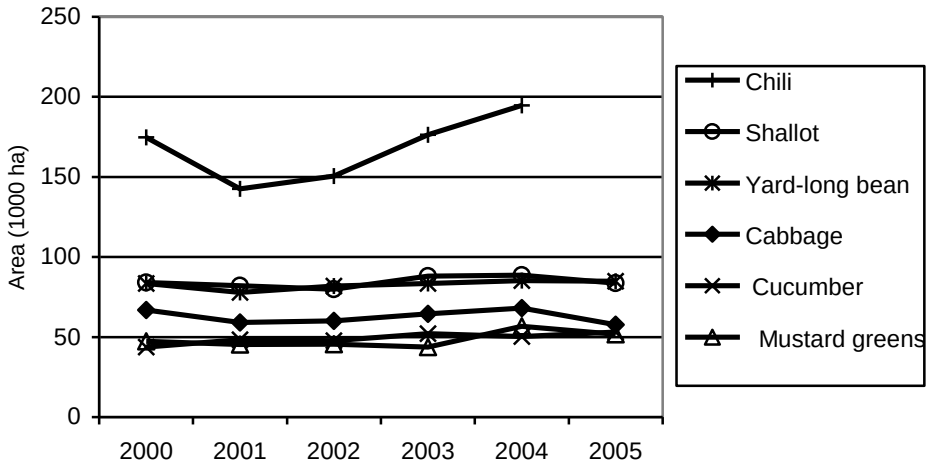
3.1 Production sector

Between 1997 and 2005, production increases for most major vegetable commodities were gradual, but chili showed a sharp increase between 2002 and 2003 (Figure 4 and Figure 5). Main crops were by area: chili (21.5%), yard-long bean (9.7%), shallot (9.6%), cabbage (6.6%), cucumber (6.1%) and mustard greens (5.9%) (Σ 6 crops = 59.3%), and by volume: cabbage (1.29 million t = 16.2%), chili (1.06 million t = 13.3%), shallot (0.73 million t = 9.2%), tomato (0.65 million t = 8.1%), cucumber (0.55 million t = 6.9%) and mustard greens (0.55 million t = 6.9%) (Σ 6 crops = 60.6%) (Figure 4) (MOA, 2006b, 2007a). Between 2000 and 2004, West Java produced 35% of the national vegetable crop, Central Java 13%, North Sumatra 13%, East Java 12%, South Sulawesi 3% and other provinces 24% (Natawidjaja et al., 2006; 2007). Production data for major (reported) vegetable types for 1997-2005 are attached (Appendix 1) (BPS, 2007).



Source: MOA (2006b; 2007a)
Note: Mustard greens data = Chinese cabbage and Bok Choy (Pak Choi)

Figure 4. Production of the main vegetable types (excluding potato) in Indonesia, 2000-2005



Source: MOA (2007a)

Figure 5. Area of the main vegetable types (excluding potato) in Indonesia, 2000-2005

Between 1997 and 2005, production of gingers and other spices also has grown. Indonesia produced 0.34 million tonnes of gingers and other culinary spices[6] from about 19,000 ha in 2005 (BPS, 2007) (Appendix 1) reflecting growth in export markets. Another trend has been an increase in the area under protected cultivation, to take advantage of wet season prices, reduce the need for pesticide use, and improve the supply of safe, high quality produce. The sectors and key trends and issues are further considered in Table 2.

[6] (called medicinal plants in MOA, 2006b)

Table 2. Production sectors and key issues in the Indonesian vegetable industry

Production sector	Trends and issues
Highland production areas	
Intensive, commercialized systems	Production areas are relatively homogeneous districts around Bandung, Malang, and other locations supplying domestic or nearby export markets (Singapore and Malaysia).
Remote and usually less intense systems	Cropping often occurs in combination with perennial crops, fruit trees, and secondary food crops.
Medium altitude production areas	
Peri-urban production	Located close to cities. Production systems are highly intensive, producing large quantities of high-value vegetables with commercial agricultural inputs (F1 and hybrid seeds, fertilizer, pesticides). Some crops are more heat-tolerant varieties of "temperate" vegetables such as potato and cabbage, or more cold-tolerant varieties of tropical crops such as capsicum and leafy greens.
Cropping in areas more distant from markets	Focus is usually on production of less perishable, more easily transported vegetables. Production is occurring in tandem with estate crops (cocoa, coffee, oil palm) in some areas. Supply chains are longer and more challenging.
Rain-fed lowland areas	
Intensive commercial systems	Producing crops such as water spinach from seed to supply urban markets. Many vegetables are grown year-round (in the dry season with irrigation). At least 60,000 ha of shallots, and the majority of the market vegetables: hot chili, yard-long beans, eggplant, cucumber, pak choy (G. Grubben, pers. com., 2007).
Farms cropping vegetables after grain	Less intensive systems producing crops (hot chili, watermelon) on residual fertilizer after cereals, or grown along irrigation dikes with rice.

Darmawan and Pasandaran (2000) summarized the cropping patterns, preferred cultivars, and regional distribution of production of several vegetable types, but the situation is changing, with increasing competition from imports and the changing requirements of markets. The Center for Agricultural Data (MOA, 2006b) regularly publishes provincial production data for shallot, chili and an "other vegetables" category (which combines data for garlic, leek, radish, cabbage, mustard, carrot, kidney bean, tomato, eggplant, French bean, cucumber, pumpkin, water spinach, spinach, yard-long bean, mushroom, cauliflower, and other minor vegetables).

In general the MOA data and the BPS data are fairly similar, and the area and production data from FAOSTAT and MOA are similar for most of the vegetable crops in 1995~2004 except cabbage.

The regular statistical information, which is collected for MOA at district level, could provide a forecast of potential over/under production at national and regional levels, but there are insufficient resources to adequately analyze and quickly disseminate the data (Johnson, 2007).

Annual growth in horticulture in 2005-2009 is predicted to range from 3 to 9%, with 3% growth in chili, 3.6% in cabbage, 4.6% for tomato, and 4.2% for carrot (MOA, 2006b).

3.2 Inputs, finance, and utilities

Inputs and supply chain logistics

Natawidjaja et al. (2006; 2007) noted in their study area of West Java that growers had no complaints about the availability of inputs in the production area. Numerous stores and vendors, and several chemical input and seed suppliers, ensured competitive pricing. Some companies, including East West Seed, Pioneer, and Syngenta, also provided technical assistance to farmers to support use of their inputs. In more remote provinces, input availability may be limiting, expensive, and sporadic (FAO, 2005). The key input sectors include:

Seed

In Java, most chili farmers obtain seed-related information from neighbors or friends (Mustafa et al., 2006). Seed availability estimated for vegetable crops is shown in Table 3 (MOA, 2006b). Probably more than 100 companies[7] in Indonesia produced seed and seedlings for vegetables, with at least two having breeding programs (East West is largest), (Fuglie, 2001). The Indonesian seed industry has been dominated by government agencies, with rice seed distribution centres across Indonesia.

Persero (PT Sang Hyang Seri) is a state-owned enterprise with rice seed production and marketing as its core business. Persero produces vegetable seed locally, and also distributes imported lines (26 commodities x 110 lines), in a joint venture with a Dutch company. It also sources seed from production areas

[7] But, the seed of local companies can sometimes be unreliable (G. Grubben, pers. com., 2007).

in Vietnam. According to Persero, the government aimed to encourage other companies to produce more seed in Indonesia (Johnson, 2007).

Table 3. Availability of seed or planting bulbs (kg) for vegetable crops, 2005

Chili	Shallots (as bulbs)	French beans	Mustard greens	Yard-long bean	Water spinach	Cucumber	Tomatoes	Others	Total
23,913	1,065,296	158,347	2,364	341,661	482,274	25,666	21,364	206,531	2,327,416

Source: MOA (2006b)

Agricultural chemicals

Fuglie (2001) suggested vegetable crops were the largest users of pesticides, accounting for 30% of total sales. This trend was confirmed in surveys of chili crops in West Java in 2002, where the adequacy of crop protection is a major factor affecting production and profitability of chili crops (Mustafa et al., 2006). Pesticide use is also high for shallots. More than 100,000 ha of shallots are sprayed with fungicide/pesticide cocktails at least three times per week over two month cropping periods. Cabbage, potato, cauliflower, and tomato are also sprayed frequently, but late blight resistant hybrids of potato require fewer sprays (G. Grubben, pers. com., 2007; Mustafa et al., 2006).

The phase-out of pesticide procurement and distribution programs, and the end of subsidies (up to 85%), in 1989 led to greater involvement by the private sector in distribution and training (Fuglie, 2001), and increased interest in IPM, biopesticides, and farmer-led training supported by FAO (Community IPM, 2007). Sastrosiswojo et al. (2001) considered that for the Indonesian situation, IPM for cabbage (targeting Diamondback Moth) was superior to conventional approaches because of reduced chemical use (reductions of 79% at Lembang and 64% at Pangalengan) and increased saleable yield (increases of 57% at Lembang and 19% at Pangalengan), but did not consider the labor implications of the approach. In West Java, a multinational chemical company, Syngenta, is working with vegetable farmer groups to promote lower chemical use (Natawidjaja et al., 2006; 2007).

Fertilizers

Fertilizer is produced by six plants in Indonesia (five for urea, one for superphosphate and ammonium sulphate, with some raw materials imported). From 1998 to 2002, 6.5 million t of urea were produced per year (FAO, 2005). Regulation of production, distribution, and use of fertilizers has been modified periodically with the aim of ensuring an adequate supply of affordable fertilizer to farmers, but this does not always work in practice (FAO, 2005).

To encourage optimal fertilizer use, local research and extension bulletins detail specific fertilizer recommendations for the main crops (G. Grubben, pers. com., 2007). FAO (2005) suggested that approximate per hectare needs for vegetable crops in Indonesia should be around 100-150 kg nitrogen, 100-150 kg phosphorus and 100-200 kg/ha potassium. Lime (1 tonne/ha) may be needed on acid soils.

Vegetable crops account for about 5% of total fertilizer use (FAO et al., 2002). In the 1990s, fertilizer use (for rice) far exceeded rates needed for optimum productivity (Roche, 1994). Since then, fertilizer rates have declined, but have

become less balanced, leading to reductions in productivity and the need for staple imports (FAO, 2005). As in most countries, key issues are: avoiding overfertilization, attention to micronutrient deficiencies, and access to credit (DFID, 1997).

Farm machinery

Vegetable cropping is fairly labor-intensive, but the increasing mechanization of rice production has freed up family labor, giving more time for vegetable production (Fuglie, 2001). In West Java in 2002, among surveyed chili farms, there were 1.3 sprayers/farm, 14% used a power tiller, and 20% had a water pump (Mustafa et al., 2006).

Irrigation and watering systems

Indonesia has ample freshwater supplies in much of the country (up to 25 times the world average per capita availability of 600 m^3) (Freshwater, 2004), but dry season access can limit productivity. A large portion (> 2.1 million ha = 30%) of the water distribution is through small-scale irrigation systems that supply < 500 hectares each. Water policy reform focuses on three issues: the sustainability of water quality and quantity; food security and sustainable irrigation; and overcoming institutional constraints (Freshwater, 2004).

A key element of reform is Water Law No. 7 (2004), which targets the chronic problems of pollution, water shortages, and natural disasters, with river basin management a key strategy for addressing the problems in a systematic manner. A significant challenge is engaging 400 local governments in essential service supply, as they lack know-how and funding, and must deal with high levels of pollution and mismanagement (Al' Afghani, 2006; ADB, 2007).

In vegetable production, too much rain can damage crops, and protected cultivation is still relatively minor (especially for bell [sweet] pepper), but increasing for wet season production. To improve water use and accessibility in dry areas or seasons, cheap, easy-to-install drip irrigation systems need to be promoted (G. Grubben, pers. com., 2007). For the vegetable sector, catchment conservation (e.g. phase out of steep lands (> 45º) used for vegetable cropping), water quality, and affordability of access and watering systems, are the key issues.

Labor

Labor needs in vegetable production are generally higher than for rice. For example, while hybrid chili cultivation offers superior yield and quality (and gives higher returns), it requires more labor (345 days/ha) than OPs (330 days/ha) or local cultivars (265 days/ha). And, while it would have the potential

to reduce losses, add value, and provide additional employment, almost no processing activity occurs at farm level. Most processing is small-scale (sun drying), and practiced by traders, with most larger commercial food processors using cheaper imported chili powder (Mustafa et al., 2006).

Labor absorption by the horticulture sector is expected rise from 3.4 million in 2005 to 4.9 million in 2009, and represent about 11% of employment in agriculture (MOA, 2006a). Between 2005 and 2009, labor productivity across agriculture is expected to increase from IDR 4.8 million to IDR 5.0 million/capita/year[8] (1.4% per annum), and the percentage of rural poor to decline from 18.9% in 2005 to 15.0% in 2009 (MOA, 2006a).

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

The Indonesian government is moving to introduce Good Agricultural Practice Certification for the vegetable sector in response to national, regional, and European market demands. A range of options is being trialed (Hortin, 2006; Asandhi et al., 2006; Ledger et al., 2006; Natawidjaja et al., 2007). Three levels of certification are being trialed in the vegetables sector: Good Pesticide Practice, Good Agricultural Practice (GAP), and EurepGAP (now, GLOBALGAP), to enable a phased approach to improving farmer compliance capabilities. The first two levels allow for government certification while EurepGAP certification is undertaken by private agencies. In the fruit sector, an ASEAN-GAP certification (which is designed as a more feasible option than EurepGAP) is also being trialed (Ledger et al., 2006), and this may be an option for the vegetable sector for export markets in the region.

Postharvest technology

There are three major supply chain types with different needs: local distribution of less durable (hot chili, tomatoes, cucumber) and perishable (leafy vegetables, eggplant) domestically grown vegetables; long-distance, inter-island distribution and export of domestically grown more durable lines (cabbage, potato, shallot, pumpkin, gourd); and receipt and distribution of imported vegetables (high-value perishable and low-cost durable) (G. Grubben, pers. com., 2007). For perishable local lines, quick sales minimize loss and the need for technologies.

Development of postharvest technologies for the vegetable sector is fairly basic and patchy, and where technology is available, chain players use the facilities primarily for handling and storage of fruit, particularly imported fruit, and high-value vegetables such as imported broccoli and leafy greens.

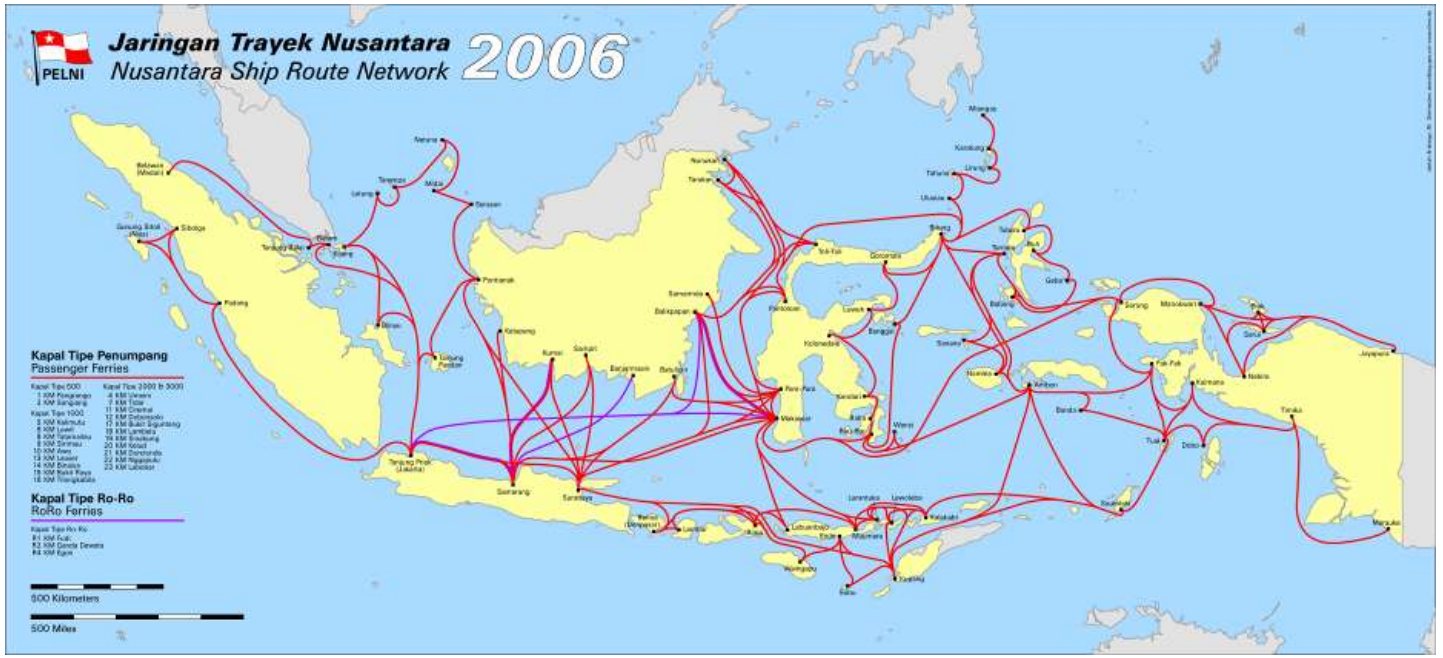
[8] This estimate is low. Morgan (2006) indicated that in surveys conducted in 2005-2006, 43.8% of rural workers were in the lowest strata of income classifications (E2) and earned < IDR 6.0 million a year.

Packhouses at farm level are fairly basic. There are few incentives for farmers to apply technologies, because wholesalers and suppliers prefer to undertake grading and quality management to ensure standards and capture price premiums. Innovation is occurring at different levels: wholesaler/importer/supplier (cold rooms); distribution (refrigerated trucks, improved plastic crates); grading (cooling, ready-to-sell packaging at wholesale/supplier level); point-of-sale, including refrigerated displays; and home storage, with refrigeration in 35% of households (Roy Morgan, 2007).

Logistics

Shipping access (

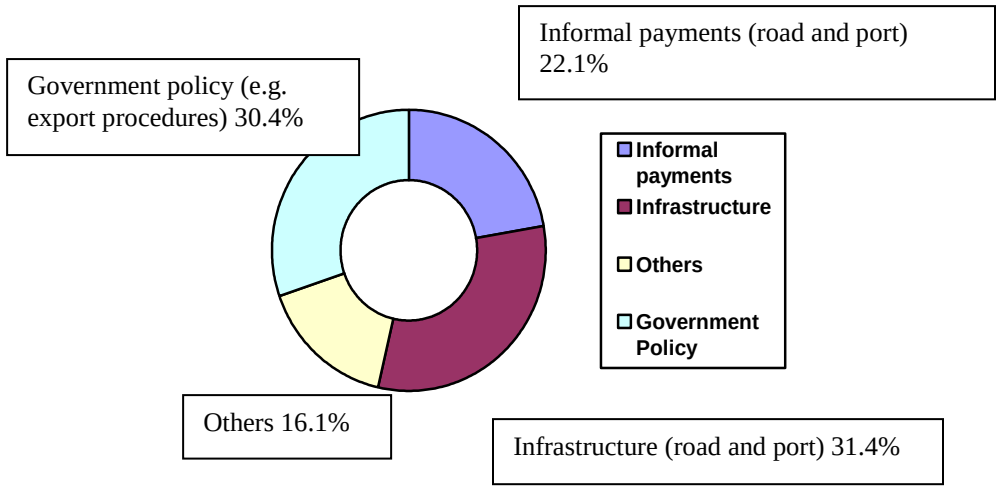
Figure **6**) is a major constraint, and air-freight is expensive. The inadequacy of port facilities is a key impediment to produce and food distribution systems, especially for eastern Indonesia during bad weather periods. Retailers need to hold large inventories, and there are problems with market access and product delivery (Rangkuti, 2004; Natawidjaja et al., 2006; 2007).



Source: Wikipedia (2007e) (Maximilian Dörrbecker [Chumwa])

Figure 6. Shipping routes in Indonesia

For exports by sea, infrastructure and government policy are the significant contributors to costs (Patunru et al., 2007) (
Figure **7**).



Source: Patunru et al. (2007)

Figure 7. Sources of inefficiency in Output Logistics Costs (FOB)

Poor road systems and other aspects of logistics are also a major problem, as are the charges that need to be paid to use them (Natawidjaja et al., 2006; 2007). Indonesia has some toll roads connecting major centers, more than 200,000 km of highways, and more than 150,000 km of unpaved roads (2002 est., Wikipedia, 2007f).

Financial and utility services

Fuel and electricity

Energy demand is growing steadily, but Indonesia has good energy reserves (oil, gas, coal) and has the potential to develop renewable sources (Wattimena and Soerjono, 2004). A priority is to develop a national energy plan to optimize energy supplies at national, provincial, and municipal levels (Wattimena and Soerjono, 2004). For farmers, access and affordability of electricity and fuel are critical for modernization.

Rural electrification is a government priority. Electrification has reached 67% of the population, and market competition has been introduced, but an estimated 48% (UNESCAP, 2005) lack access to electricity. One option for rural areas is private-public partnerships with NGOs, to increase access to small-scale hydroelectric systems (UNESCAP, 2005).

A recent commercial report is available on the demand and supply of electricity in Indonesia (IBISWorld, 2007).

Financial services

Access to finance at affordable interest rates is a key constraint for many farmers and the rural poor. In Java in 2002, only 21% of chili farmers could access a loan facility. Credit access was mainly informal (family, traders), with 92% of surveyed farmers on average borrowing IDR 0.656 million for 7 months at 11% per annum interest to obtain inputs (Natawidjaja et al., 2006; 2007).

Value-adding: Food processing and provedore sectors

Food-processing industries are significant drivers of the national economy but emphasis has been mainly in the processing of non-vegetable commodities. The industry is concentrated in Java, Sumatra, Bali and Sulawesi. Many small- to medium-sized enterprises (SMEs) are located in rural areas, and use simple technologies to produce for local domestic marketing. They provide significant opportunities for employment and empowerment of women, especially at the small and micro-industry level, with benefits flowing from participatory approaches to home economics training (Eckman, 1994). An important feature of the Indonesian food industry is its ability to service the growing market for halal foods.

Smallholder assistance initiatives managed by nongovernmental organizations (NGOs) are frequently more sustainable if they involve, or are linked to, value-adding and marketing components (Wheatley et al., 2006; VECO Indonesia, 2007).

The commercial processing industry was affected by the 1997 monetary crisis, but is now recovering and expanding export as well as domestic markets. The undervalued currency made investment more attractive in the last few years, but also made imported equipment and ingredients more expensive. The ministries of Agriculture and Trade & Industry have responsibilities for the sector. Challenges include the modernization of production and the implementation of more stringent HACCP and quality control systems as required for global trade.

Marketing: Fresh produce wholesale and retailing sectors

Wholesale

The wholesale sector in Indonesia is similar to that of many developing countries. Brokers/collectors and wholesalers purchase direct from farmers, and wholesaler/importers source from overseas. Produce often then passes through the traditional wholesale market and "many hands," to the point-of-sale (Figure 2). The facilities are considered by many retailers and wholesalers to be unhygienic, inefficient, and costly. The sector is changing, however, with consolidation among wholesalers and a decline in collectors, and the emergence of modern retailers and their preferred suppliers, which often bypass the traditional wholesale market (Figure 3) (Natawidjaja et al., 2006; 2007).

The central wholesale markets are a major bottleneck in fresh produce trading in Indonesia, but still carry the bulk of produce (e.g. 68% of produce from West Java) (Figure 2). Kramat Jati, a government-owned market in Jakarta, occupies 14.7 ha, and has 3653 stalls (2433 selling vegetables), with 70% of sales going to Jakarta (pop. 7.2 million), much via 151 smaller wholesale markets. About 1500 tonnes/day of vegetables move through the market, but the market is considered small by international standards. Caringen, a privately owned market in Bandung, has 4000 vendors and serves a city of 4 million (Natawidjaja et al., 2006; 2007).

The traditional wholesalers are adapting quickly to new retailing developments, for example by selling to supermarket suppliers (9% of sales) and the food industry (5%), and by maintaining their role as capital lenders to farmers (Natawidjaja et al., 2006; 2007).

Retail

Modern retailing[9] is fast becoming the major focus of fresh produce retailing in Indonesia and is replacing traditional "wet" markets. If supermarket penetration extends more widely beyond Java and reaches to the district level, its share could grow to 60% before 2016 (Natawidjaja et al., 2006; 2007). The sector's growth and expansion has been encouraged by consumer demand, and by removal of foreign direct investment (FDI) restrictions in 1998 (Natawidjaja et al., 2006; 2007). Major chains include Alfa, with 35 supermarkets under the name of Alfa Supermarket and Alfa Toko Gudang Rabat and 8 wholesale grocers (Alfa, 2005); Carrefour, with 30 hypermarkets (Carrefour, 2007); Hero, with 99 Hero supermarkets, 12 Giant hypermarkets, 101 Guardian pharmacies,

[9] "Modern retailing" is used to refer to supermarkets, hypermarkets, and mini-market outlets.

and 54 Starmart minimarkets (Hero, 2007; Wright Reports, 2007); Matahari Supermarkets, the number 2 retailer, with more than 50 conventional supermarkets and compact hypermarkets under the brand name Hypermart (Business Monitor International, 2006; Matahari, 2007); and Makro (Wikipedia, 2007c).

Nationally, only 7% farmers (but 11-15% in West Java) link directly to new market channels. The rest (93%) market to the traditional sectors through collectors (40%), and by direct selling at traditional wholesale markets (7%) and to wholesalers (46%). But of the produce from farmers going to traditional wholesalers, 9% also passes on to the supermarket chains (Natawidjaja et al., 2006; 2007), so it is possible that in total some of the production from 10-15% of farmers may end up in supermarkets.

Trade development

By comparison with total production, export and imports are small, representing 1.3% and 5.6% of production by volume respectively in 2005[10] (based on production from MOA and trade from BPS (2007). In general, the PC-TAS ITC/UNSD (2002; 2007) data is lower than the FAOSTAT (2007) data for imports and export volumes and value (Table 4).

10 Based on total production of 9,101,986 tonnes, including 1,009,619 of potatoes (MOA, 2006b p. 102).

Table 4. Import and export volumes (tonnes) and value (000' US$) for fresh and processed vegetables (excluding potatoes)

	2000	2001	2002	2003	2004	2005
(PC-TAS ITC/UNSD)						
Export volume fresh	60,235	70,280	74,374	58,434	49,237	55,789
Export volume processed	40,506	36,490	29,840	28,312	31,976	32,827
Exports Volume Total	**100,741**	**106,770**	**104,214**	**86,746**	**81,213**	**88,616**
Export value fresh	17,525	19,493	22,594	22,671	17,092	20,931
Export value processed	42,527	36,626	26,156	28,828	33,556	33,905
Export Value Total	**60,052**	**56,119**	**48,750**	**51,499**	**50,648**	**54,836**
Import volume fresh	249,734	278,262	286,249	280,819	322,741	376,224
Import volume processed	23,091	23,673	26,946	30,781	32,310	30,069
Import Volume Total	**272,825**	**301,935**	**313,195**	**311,600**	**355,051**	**406,293**
Import value fresh	62,237	71,406	69,908	68,684	77,610	97,618
Import value processed	15,828	17,217	20,209	21,349	23,508	23,310
Import Value Total	**78,065**	**88,623**	**90,117**	**90,033**	**101,118**	**120,928**
(FAOSTAT)						
Export volume fresh	59,970	70,260	68,280	66,350	49,320	58,410
Export volume processed	39,950	36,500	25,510	24,350	29,270	32,080
Exports Volume Total	**99,920**	**106,760**	**93,790**	**90,700**	**78,590**	**90,490**
Export value fresh	17,570	19,602	22,625	22,703	17,132	20,961
Export value processed	41,786	35,437	24,459	26,491	31,344	33,329
Export Value Total	**59,356**	**55,039**	**47,084**	**49,193**	**48,476**	**54,290**
Import volume fresh	249,080	278,230	284,490	280,490	329,040	376,340
Import volume processed	21,890	22,120	26,880	29,590	31,940	30,050
Import Total	**270,970**	**300,350**	**311,370**	**310,080**	**360,980**	**406,390**
Import value fresh	62,421	71,670	70,510	69,908	79,665	101,506
Import value processed	15,305	16,868	19,636	20,343	24,819	25,428
Import Value Total	**77,727**	**88,538**	**90,146**	**90,251**	**104,484**	**126,934**

Source: PC-TAS ITC/UNCD (2002; 2007); FAOSTAT (2007)

Exports
Export volumes and value from two data sets are fairly similar (Table 4). Data tends to be higher from 2000 to 2002 than from 2003-2005, with volume and value fluctuating, but trending downwards.

Imports
Import statistics from the two data sets are similar (Table 4). Imports rose substantially in volume and value between 2000 and 2005 and especially from 2003 to 2005 (Table 4). Imports come particularly from Thailand and China—garlic, broccoli, carrots, leeks, celery, chestnuts, and bean sprouts, to meet supermarket and consumer preferences for quality and price (Natawidjaja et al., 2006; 2007).

Global retailers (e.g Carrefour) make use of their own regional sourcing hubs to obtain supplies of the vegetables they import, but they, and the national chains, also use large importer/wholesalers to source supply. The importer/wholesaler distribution is essentially "traditional" in its mode of operation and the major retailers all consider that sourcing through imports is much easier than sourcing locally (Natawidjaja et al., 2006; 2007).

3.3 Institutional framework and operational environment

Policy and regulatory agencies

Key framework policy issues for agriculture (and the vegetable sector) encompass Indonesia's commitments as a member of the World Trade Organization (WTO, 2007), the Asia Pacific Economic Cooperation forum (APEC, 2007), the Organization of the Islamic Conference (OIC, 2007), and the Cairns Group (2007). Indonesia is signatory to various international and regional agreements, such as those on water and land management, but so far only the free trade agreements are with ASEAN (Association of Southeast Asian Nations); ASEAN + China; and an Economic Partnership Agreement with Japan, signed August 20, 2007 (ANTARA, 2007a, 2007b). Other agreements are under negotiation (ASEAN + 3) or consideration (Australia[11]) (Haswidi, 2007). Impacts are felt in the vegetable sector in terms of attention to GAP certification, sanitary and phytosanitary (SPS) issues, and WTO/export access and import competition.

[11] Preliminary studies indicate that Indonesia's exports of agricultural products would be very competitive (ANTARA, 2007a, 2007b).

The government's *Medium-Term Development Plan* (RPJM) 2004 to 2009[12] has three main themes: peace and safety, justice and democracy, and national prosperity. The role being played by agriculture in the implementation of this plan reflects both the impact of current and past policies, and the ongoing opening up of the economy (Bank Indonesia, 2002).

Under earlier plans, Indonesia made considerable progress in poverty reduction through growth policies that shared the benefits of economic development; agricultural policy, focusing on improving smallholder crop and livestock productivity; and government interventions in commodity pricing, input supply, and trade (Fuglie, 2001). Self-sufficiency and stability in producer and consumer prices for rice have been key social and political imperatives; however, trade and pricing of soybean and corn were liberalized, subsidies on pesticides were removed in the 1980s, and fertilizer subsidies were removed in 1998 (Molyneaux and Rosner, 2004).

The focus on "protection and promotion" can no longer help improve incomes or welfare because farms are too small to earn sufficient income raising staple crops alone. An Indonesian/USAID Food Policy Program proposed a policy rethink—continue to support staples, and imported fruit and vegetables will boom, or promote more local production of fruit and vegetables and seek staples elsewhere (Molyneaux and Rosner, 2004). In progressing toward this objective, closer engagement with the private sector and agribusiness will be critical (Nainggolan, 2001).

The RPJM 2004-2009 aims for annual average growth rate of 3.5%, and increased incomes and well-being of farmers. Key elements of the strategy are increasing food resiliency, developing agribusiness, and developing fisheries resources. Judging by production statistics (
Figure **1**; Table 1), the vegetable sector is helping only marginally to meet the growth targets.

With the growth in demand and improvement in domestic supply chains, the vegetable sector could do considerably more for the economy. Table 5 lists constraints to agri-industry that are identified in the RPJM 2004-2009 plan (Bank Indonesia, 2002), and indicates how policy, R&D, and investment support for the vegetable sector could help address them. Key issues are: facilitating the retail sector development to reduce losses and improve quality management; enhancing demand for domestic produce by improving supply chains and building competitive advantage over imports; and stimulating agribusiness and

[12] The timing of this vegetable sector review was mid-way through the plan.

processing—to add value, reduce losses, and provide SME sector employment in production areas.

Table 5. Agri-industry constraints identified by the Indonesian *Medium-Term Development Plan* (RPJM), 2004 to 2009, and suggested ways in which the vegetable and modern marketing sectors could help address them (in italics).

- Relatively high poverty and low welfare of farmers
- *Vegetable production can improve income and nutrition.*

- Weak institutional aspects and bargaining position of farmers
- *Supplies of vegetables to supermarkets are currently inadequate. Grower access to markets could be improved through supplier mediated linkages, to enhance supply and farmer benefits.*

- Inadequate incentives to invest in production increases, associated with need for land reform and access to capital
- *Vegetable marketing could be promoted more for cropping after rice, or on rented land in short-term crops, to boost incomes.*

- Low level of technology transfer for the processing of products, resulting in low productivity
- *Promotion of innovation in SME processing could provide uses for lower grade vegetables and reduce losses.*

- High dependence on rice consumption as major food crop
- *This may decline as per-capita availability of rice is declining, and fruit and vegetable consumption is rising. The policy of support for rice needs to be reviewed, with a view to stimulating the vegetable sector for income enhancement.*

- Lack of basic infrastructure and poor access to markets and services
- *Facilitating private sector investment (suppliers and supermarkets) will help improve supply chains and market access for vegetables.*

Source: Bank Indonesia (2002)

Research and development

Stads et al. (2007) provide a recent overview of agricultural research and development in Indonesia. Current vegetable industry research and extension strategies are articulated in the *Indonesian Agricultural Development Plan* for 2005-2009 (Rencana Pembangunan Pertanian) (MOA, 2006a), with objectives of boosting professionalism of farmers and state, provincial and district government personnel; enhancing production sustainability; strengthening food security and safety; improving competitiveness and adding value; stimulating rural economies; and developing farmer-focused management systems for development (MOA, 2006a). Farmer and vegetable industry-led initiatives can contribute to these objectives, with trade and value-adding as particular opportunities.

The Ministry of Agriculture (MOA) has overarching responsibility for agriculture in the economy and for fostering people-focused and decentralized development to enhance competitiveness and sustainability. As part of the decentralization of government, district Dinas Pertanian (farming advisory) staff have been assigned to local government, along with day-to-day responsibilities for extension, regulation, quality management, and statistical reporting. Directorates and agencies under MOA have redefined roles (
Table **6**), with the Directorate of Horticulture Production Development, the Directorate General of Agricultural Product Processing and Marketing Development, and the Agency for Agricultural Research and Development playing key roles in research, and the linked Agricultural Technology Assessment Centres (Balai Pengkajian Teknologi Pertanian – BPTP) and the Dinas Pertanians supporting technology assessment and extension (World Bank, 2007; MOA, 2007b).

For vegetable research, the Indonesian Vegetable Research Institute[13] (IVEGRI, 2007a) in Lembang has a key role, with complementary R&D by the Center for Agricultural Postharvest Research and Development, and the Center for Agriculture Socioeconomic and Policy Studies. Policy and standard formulation and implementation are the responsibilities of the Directorates General of Horticulture Production Development and Agricultural Product Processing and Marketing Development (MOA, 2007b).

[13] The functions of IVEGRI: vegetable research and technical services for genetics, breeding and germplasm use; crop ecology and protection; and systems and agribusiness. Priority crops are potato, hot pepper, shallot, tomato, beans, cabbage, yard-long bean, and mushroom; prospective commodities are eggplant and cucumber and some "future prospect" focus on indigenous vegetables.

According to these institutions, priority areas for attention include improvement of land and water use and enhancing industry sustainability; building market awareness and supplying what the market requires, while avoiding gluts and capitalizing on supply shortfalls in export and domestic markets; improving production efficiency (breeding, seed quality, production technology) and reducing costs and competitiveness; optimizing quality and ensuring product safety; expanding information access and community planning; and working with local government agencies to identify and address infrastructure and logistic challenges (IVEGRI, 2007b; MOA, 2007b).

Table 6. Indonesian Ministry of Agriculture agencies with responsibilities in the vegetable sector

Ministry of Agriculture

Agency for Agricultural Research and Development undertakes research and development in the agricultural sector. http://www.litbang.deptan.go.id/ ; http://iaard.go.id/about/index
- Center for Horticulture Research and Development undertakes horticulture strategic and high technology research and development with the Indonesian Vegetables Research Institute, Bandung, responsible for vegetable research
- Center for Agroclimate Soil Reseach and Development undertakes soil and agroclimate strategic and high technology research and development
- Center for Agricultural Social and Economic Reseach and Development undertakes agricultural social and economic strategic and high technology research and development.

Directorate General of Horticulture Production Development formulates and implements policies and technical standardisation in horticulture production management. http://www.hortikultura.go.id/
- Directorate of Seed formulates policies and technical standards, and provides guidance in the horticultural seed sector.
- Directorate of Vegetables, Multifarious and Ornamental crops formulates policies and technical standards, and provides guidance in the vegetable, medicinal and ornamental crop sectors.
- Directorate of Horticulture Business Development formulates policies and technical standards, and provides guidance in horticulture business development.

Directorate General of Agricultural Product Processing and Marketing Development formulates and implements policies and technical standardisation in agricultural and processing management. http://agribisnis.deptan.go.id/

Center for Agricultural Data and Information prepares for the promotion and development of agricultural information systems.

Center for Standardization and Accreditation oversees development, co-operation and promotion of agricultural produce standardization.

Agency for Agricultural Human Resource Development oversees development and utilization of agricultural human resources including extension and agricultural entrepreneurship.

Agency for Food Security and Community Empowerment undertakes research and development and co-ordinates stabilization of food resilience. Within this agency The Center for the Development of Food Consumption focuses on policy and research on diversification of food consumption.

Agency for Agricultural Quarantine oversees quarantine within the agricultural sector.

Responsibilities for technology evaluation and extension respectively lie with the Agricultural Technology Evaluation Agencies (Balai Pengkajian Teknologi Pertanian – BPTP) and the provincial level Dinas Pertanians. Links to BPTP: BPTP Sumut, BPTP Jambi, BPTP Sumbar, BPTP Bengkulu, BPTP Lampung, BPTP Jawa Barat, BPTP Jakarta, BPTP Yogyakarta, BPTP Jawa Tengah, BPTP Jawa Timur, BPTP Kalbar, BPTP Kalsel, BPTP NTB, BPTP NTT, BPTP Sulteng, BPTP Maluku, BPTP Papua

Source: MOA (2007b)

Priority crops for support by MOA within the sector are: shallot (*bawang merah*), chili (hot pepper or *cabai merah*), potato (*kentang*), tomato (*tomat*), beans (*buncis*), cabbage (*kubis*), mushroom (*jamur*), yard-long bean (*kacang panjang*), eggplant (*terong*), and cucumber (*mentimun*), but there is also focus on "medicinal and biopharmaceutical" crops, including the gingers, and more minor crops with economic potential as part of the diversification strategy.

Using "varieties released" by the MOA as an index of relative resources and effort in government agency R&D, the outcomes for fruits, field crops, and vegetable varieties released in the period 2002 to 2005 are: 46 > 36 > 11 respectively (MOA, 2006b). The low result for vegetables is indicative of the higher involvement in the private sector in vegetable variety development and release.

Other ministries that play a role in agricultural research are listed in Table 7. Of these, the following institutions could contribute significantly to the development of the vegetable sector: the National Agency for Export Development www.nafed.go.id within the Ministry of Trade (export promotion); the Directorate General of Customs and Excise within the Ministry of Finance (import/export clearance and statistics); the Environmental Impact Management Agency (steep land phase out and environmental sustainability); the Department of Cooperatives and Small-Medium Enterprises; the Department of National Education (Universities); the Department of Health for community health and nutrition (MOH, 2004, 2005); and the Indonesian Institute of Sciences (PROSEA series on Plant Resources of Southeast Asia, including a volume on vegetables, and E-Prosea, an on-line version of the PROSEA series (PROSEA, 2007)).

Table 7. Government institutions of Indonesia which have policy and development responsibilities for the vegetable sector

National Institutions:
- Departemen Pertanian (DEPTAN) [Department of Agriculture] (See also Table **6**)
- Departemen Koperasi, Pengusaha Kecil & Menengah (DEPKOP) [Department of Cooperatives and Small-Medium Enterprises]
- Departemen Pendidikan Nasional [Department of National Education]
  - Direktorat Jenderal Pendidikan Dasar dan Menengah
    - Direktorat Pendidikan Menengah Umum
  - Direktorat Jenderal Pendidikan Tinggi
- Departemen Keuangan [Department of Finance]
  - Direktorat Jenderal Bea dan Cukai [Directorate General of Customs and Excise]
- Departemen Luar Negeri (DEPLU) [Department of Foreign Affairs]
- Departemen Kesehatan (DEPKES) [Department of Health]
  - http://www.depkes.go.id/en/index_en.htm
- Departemen Perindustrian dan Perdagangan (DEPPERINDAG) [Department of Industry and Trade]
  - Direktorat Jenderal Industri Kimia, Agro dan Hasil Hutan (IKAH) [Directorate General of Chemical, Agriculture and Forestry Industries]
  - Direktorat Jenderal Perdagangan Luar Negeri (DPLN) [Directorate General of Foreign Trade]
  - Badan Pengembangan Ekspor Nasional (BPEN) [National Agency for Export Development]
- Departemen Transmigrasi dan Pemukiman Perambah Hutan (DEPTRANS) [Department of Transmigration and Forest Squatter Resettlement]
- Badan Perencanaan Pembangunan Nasional (BAPPENAS) [State Ministry for Development Planning / National Development Planning Agency]
- Badan Pengendalian Dampak Lingkungan (BAPEDAL) [State Ministry for Environment / Environmental Impact Management Agency]
- Badan Pengkajian dan Penerapan Tehnologi (BPPT) [State Ministry for Research and Technology / Agency for the Assessment and Application of Technology]
- Biro Pusat Statistik (BPS) [Central Bureau of Statistics]
- Lembaga Ilmu Pengetahuan Indonesia (LIPI) [Indonesian Institute of Sciences]
- Bank Indonesia

Regional Institutions:
- Government of Bali
- Government of East Kalimantan
- Government of North Sumatera

Municipal Institutions:
- DKI Jakarta Municipal Government

Source: Anzinger (2007)

In addition to the efforts of national agencies and the private sector in agriculture R&D for the vegetable industry, several international and regional agencies contribute substantially to industry development and policy analysis through local and regional bases, including the World Vegetable Center, the

ASEAN Secretariat, the Australian Agency for International Development (AusAID), the Australian Centre for International Agricultural Research (ACIAR), the South East Asian Regional Center for Tropical Biology (BIOTROP, 2007), the Food and Agriculture Organisation (FAO), the Asian Development Bank (ADB), the World Bank, the United National Commission for Trade and Development (UNCTAD), USAID, UNDP, the International Food Policy Research Institute (IFPRI), 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). Support from donor agencies was increased substantially after the 2004 Aceh tsunami (RAND, 2007).

Support also comes from industry bodies, such as the Asia and Pacific Seed Association (APSA) and CropLife Asia, and numerous nongovernmental organizations, including the Indonesian Nutrition Network (INN) www.gizi.net/eng/about.shtml, an independent network that aims to disseminate accurate and timely information about nutrition to national and global interest groups. INN maintains links with the ministries of Health, Agriculture, and Statistics.

Extension and training

In Indonesia, the long emphasis on rice and legume self-sufficiency has left a legacy of government personnel with skill sets that differ from what is optimal for developing high-return enterprises capable of supplying vegetables to the new retail sector and export markets, or able to successfully compete with imports.

Vegetable farmers in West Java found government extension services to be inadequate, and many farmer groups relied on technical advice from suppliers (such as Bimanderi) or cooperative links to chemical companies (such as ASPIRASI[14]) (Natawidjaja et al., 2006; 2007). A challenge for MOA is to address this.

Part of the solution may be the supply chain approach to industry research and development. In recent years, the Indonesian Agency for Agricultural Research and Development Research Institutes (IAARD, 2007), and the Directorate General of Horticultural Production have been encouraging this approach to

[14] ASPIRASI (Asosiasi Petani Mitra Syngenta) is one of several farmer groups that Syngenta formed as small joint ventures at farmer level in Java (with low pesticide use practices) (Natawidjaja et al., 2006).

industry improvement and innovation in produce marketing, and some promising progress has been made (Dimyati, 2005; Basuki et al., 2006). A key strength of the approach is the focus on working across the chain to build communication and trust and to strengthen innovation, training, and information flows—the key issues for improving links between extension and farmers.

The farmer field school approach fostered by FAO and other participatory approaches to integrated pest management have been a strong focus in Indonesian agriculture, particularly rice (Morgan et al., 2004). With the need to provide additional government resources for high-value industries, including vegetables, and growing demand by potential export markets for SPS risk compliance (residue risk reduction, pest risk analysis) and Good Agricultural Practice (GAP) certification, enhancing extension service capacity and skills has become a critical priority. Key needs for the vegetable sector include improving the technical and management skills of extension personnel and farmers for production and postharvest handling (Natawidjaja et al., 2006; 2007).

While the devolution of responsibilities for extension to district level allowed greater local autonomy, in practice the extent and effectiveness of approaches at the district level have been variable. A new Extension Law (Law No. 6/2006) has reinforced the policy and advisory roles of the national government and explicitly recognizes the need for multi-provider approaches. As the law is implemented, scope should increase for the national government to foster private sector involvement in the provision of extension, and additional resources may be earmarked for training and skills development in the public sector (Natawidjaja et al., 2007).

4 Achievements and Lessons Learned: Case Studies

The challenges for the Indonesian vegetable industry and some of the lessons learned can be highlighted by examples from selected industry sectors: chili, tomato, and the retail sector.

4.1 Chili

> ***Lesson 1:*** Hybrid varieties enhance productivity, reduce the risk of supply shortages, and enhance smallholder incomes.

The chili industry is the most important segment of Indonesia's vegetable sector, with est. 463,000 families involved in production, and similar numbers in processing and marketing (Mustafa et al., 2006). Indonesians consume 80% of chilies fresh, and the rest in dried and processed forms (Mustafa et al., 2006). Production is year-round, primarily to meet domestic demand. In most areas, yields are low because the crop is extensively planted after rice in the dry season, and in mixed cropping with few inputs and poor seed (G. Grubben, pers. com., 2007).

Chili (mostly low-value dried chili) is also imported for the processing industry and to maintain domestic supply when there are production shortfalls. Compared to domestic production, imports and export volumes are insignificant (Table 8). Java and North Sumatra are the main production areas, with yields highest in West Java (12.5 t/ha, c.f. average of 5.7 t/ha (2005)) (MOA, 2006b). Between 2000 and 2005, production has shown two trends: lower production in 2001-2002 compared to 2000, corresponding to similar changes in area, and a substantial increase in production between 2002 and 2003 through increased area harvested and yield per hectare (Table 8).

Production has been variable, with peaks of production over 1 million tonnes occurring in individual years in the period between 1994 to 1996, in 1999 (Mustafa et al., 2006), and from 2003 to 2004, but dropping to as low as 0.58 million tonnes in 2001 (Table 8). Despite West Java farmers ranking "price uncertainty" and "lack of market information" as the major constraints in marketing, they ranked "profitability" as the primary attraction for hybrid chili production (Mustafa et al., 2006).

Table 8. Production and trade statistics for Indonesian chili 2000-2005, with comparisons of FAO and MOA statistics, where available

	2000	2001	2002	2003	2004	2005
Production (tonnes) per MOA	727,747	580,464	635,089	1,066,722	1,100,514	1,058,023
Production (tonnes) per FAOSTAT	727,747	580,464	635,089	1,066,722	1,100,514	871,080
Area (ha) MOA=FAOSTAT	174,708	142,556	150,598	176,264	194,588	173,817*
Yield (tonnes/ha) (FAOSTAT)	4.17	4.07	4.22	6.05	5.66	5.01
Imports (tonnes) (FAO[15]) (after Mustafa *et al.* 2006)	22,959	26,241	29,289	26,418	29,751	26,619
Exports (tonnes) (FAO) (after Mustafa *et al.* 2006)	2,511	4,190	3,257	2,890	854	87

* This area data was from FAOSTAT (2007), while it was 187,236 ha from MOA (2006b)

Source: FAOSTAT (2007); MOA (2006b) for 2001-2005; MOA (2007a) for 2000; Mustafa et al. (2006).

Some like it hot

In West Java, compared to non-chili farmers, chili farmers tend to be younger (40 vs. 45)[16], to have larger families (4.54 vs. 3.24 persons), smaller (0.56 vs. 0.72 ha) and more fragmented (1.53 vs. 1.35 blocks) farms, and own less land (0.36 vs. 0.5 ha). They also have fewer farm animals (0.1 vs. 2.0 standard

[15] Data for fresh and dried combined. Mustafa et al. (2006) converted volume of dried chili to fresh equivalent by multiplying dried weights by 4.

[16] Chili farmers grow on average, 0.38 ha of chili, (28%) 0.61 ha other vegetables (44%) and 0.17 ha cereals (12%); while non-chili farmers grow 0.69 ha (55%) of other vegetables and 0.33 ha cereals (26%) (Mustafa et al., 2006).

animal units (Mustafa et al., 2006)), smaller cultivated areas (0.49 vs. 0.71 ha), and crop more intensively (282% vs. 177%). However, their off-farm incomes are not significantly different from non-chili farmers (IDR 2.72 vs. 3.17 million/year). Despite their asset disadvantages compared to non-chili farmers, the indebtedness of chili farmers is lower (IDR 1.57 million vs. 1.75 million/year), and ownership of brick homes higher (89 vs. 63%) (Mustafa et al., 2006).

These data suggest chili production is chosen by more disadvantaged, younger farmers with more dependents to enhance their incomes. West Java chili farmers on average earned IDR 39.21 million/ha for hot chili production, compared to the averages of just IDR 2.06 million/ha for rice, and IDR 26.84 million/ha for tomato production (Mustafa et al., 2006).

Critical success factors in determining income and productivity among chili farmers include choice of hybrids over open pollinated (OP) or local cultivars. Three-quarters of the chili blocks surveyed in Java were planted to hybrids, but about one-third of these were second-year progeny of hybrid seed. Hybrid and OP varieties were favored because of shorter cropping times and opportunities for off-season production, and hybrids and were frequently interplanted with one other crop (29%, mainly tomato or shallot), or two other crops (4.8%, tomato and onion). Varieties from two companies (Hung Nong and East West) predominated among hybrid plantings (
Table **9**) (Mustafa et al., 2006).

Table 9. Chili type and source by region (2002)

Type	Company/variety	Percentage of blocks			
		West Java	Central Java	East Java	Overall (%)
Hybrid		**38**	**52**	**10**	**75**
	Hung Nong	80	20	-	43
	East West	-	100	-	41
	Chai Tai	100	-	-	2
	Super	-	-	100	8
	Others	50	21	29	6
Open Pollinated (improved)		**11**	**67**	**22**	**5**
Local		**20**	**79**	**1**	**17**
Bell (Sweet) Pepper (hybrids)		**100**	**-**	**-**	**3**

Source: Mustafa et al. (2006)

Preferred cultivation practices (2002) included use of raised beds (91%), irrigation [17] (79%, with 67% as flood irrigation, and 21% rain-fed), plastic

[17] Hybrids received 82, OPs 67, and local lines 58 irrigations (Mustafa et al., 2006).

mulching (42%, but 64% for hybrids), use of organic (76%) and inorganic fertilizers (100%) and the application of mixtures of pesticides (70%).

In marketing chili, farmers depend on traders and neighbors as sources of price information, and this also influenced selection of red chili varieties. However, disease resistance was main factor influencing choice of green chili variety. Crops on average were harvested nine times, and in 2002 sold to local traders/commission agents (72%), the district wholesale market (17%) or sub-district local markets (7%), and farmer associations (4%) (Mustafa et al., 2006). It is likely that the marketing channels have changed since 2002, with some trade moving to supermarket suppliers, at least for some farmers.

Chili yields varied from 17.9 t/ha for irrigated hybrids (vs 9.4 non-irrigated), to 11.2 t/ha for irrigated local cultivars (vs 3.0 for non-irrigated), but were lower with intercropping. Overall, net returns from hybrid production was IDR 45.62 million/ha compared to IDR 20.9 million/ha for OPs, and IDR 16.82 million/ha for local varieties (Mustafa et al., 2006).

Clearly, production of hybrid chilies is the most profitable, but even local variety chili production is much more profitable than rice (IDR 2.06 million/ha). Resource use efficiency in chili vs rice production is also higher for both labor (generating income of IDR 150,000/day vs IDR 36,000 /day) and fertilizer (generating income of IDR 188,000/kg vs IDR 24,000/kg). Chili production provided more employment for women (63%) compared to rice (39%). Hybrid chili production is labor and input intensive; because of the associated costs, most resource-poor farmers grew local cultivars when they lacked access to finance or information for hybrid cultivation.

To enhance income opportunities for resource-poor farmers, hybrid chili production appears to be an attractive option provided markets are available. To enable greater industry entry by the most resource-poor farmers, several issues could be addressed: growing under contract, supplemented by training and financial support for inputs, would enhance market opportunities and reduce financial risks. Gradually linking contract growing to incentives for grading for quality at farm-level would provide additional income (but suppliers would prefer to capture this advantage).

A key to cost containment and pesticide residue reduction is to enhance support for developing integrated disease and pest management strategies through use of resistant cultivars, non-chemical or low-risk treatments and cultural practices (ACIAR, 2007).

Promoting market development and stimulating investment in processing at micro and small and medium levels would provide value-adding opportunities for farmers and traders, but the enterprises would need to be competitive with those based on imported products, and they would need to actively promote sales of their products. Certification of products as low in pesticide and mycotoxin residues would be one option (this would require greater scrutiny of imported produce and wet markets), as would region or cultivar "branding." The growth of supermarkets, and increasing consumption of processed products by consumers, may also provide new opportunities based on niche market products.

As production increases, strategies may need to be implemented in partnership with the retail sector to increase demand and strengthen price segmentation strategies, to ensure that a range of grades and qualities are available, assure supplies for poor customers, and promote purchases among middle- and high-income customers (for example through "ready to eat" sambals). Mustafa et al. (2006) suggested there was scope to have some consumers pay more for produce, without reducing demand. Other options for increasing sales include fair-trade exports and the local expatriate market.

4.2 Supermarkets and their customers

Sector trends

> ***Lesson 2:*** Supermarkets and consumer preferences are strong drivers of change that will help modernize the production sector.

In 2004, 70% of total food expenditure occurred in traditional markets, 7.6% in minimarkets and 22% between supermarkets and hypermarkets, despite the fact that there were about 300,000 traditional stores and only about 520 supermarkets/minimarkets[18]. Selected sales statistics for the major retail chains are shown in Table 10. Within the expansion, fruit and vegetable (FFV) purchases have lagged behind other commodities, with supermarkets providing an estimated 15-20% of FFV sales in 2006 (some chains only moved into vegetables in 2000), but trending higher, and having profound influences on the Indonesia vegetable industry (Natawidjaja et al., 2006; 2007).

[18] Competition between outlets is fierce in the Indonesia retail sector. As an indication that hypermarkets may force closure of some supermarkets, Matahari is continuing to close unprofitable supermarkets during 2007 due to competition from hypermarkets. Matahari closed 35 supermarkets between 2002 and 2007, leaving only 35 still operational (Business Monitor International, 2006; Matahari, 2007). The establishment of min-markets is seen as a strategy by local chain operators to compete more effectively against foreign competitors, with minimarkets penetrating more deeply into neighborhoods (Natawidjaja et al., 2006; 2007).

Table 10. Major retail chains in Indonesia sales and reach

Chain	2005 Sales (US$ million)	2005 Sales (2001 = 100)	Format shares of total sales	Groceries share of sales (%)	Finance nationality	Market reach
Matahari	764	94	60% dept. store, 21% hypers, 12% supers	28	National	Asian regional (now in China)
Alfa Retailindo	697	165	49% conv. store; 22% cash/carry; 29% supers	90	Iational	national
Carrefour	644	255	100% hypers	70	French	global
SHV Makro	566	135	100% cash/carry[19] (authors: but 20% retail)	80	Dutch	global
Ramayana	537	128	77% dept.store, 23% supers	24	national	national
Dairy Farm/Giant	455	165	47% hypers, 42% supers	74	HK Chinese	Asian regional
Indomaret	420	197	100% conv stores	95	national	national
Delhaize/ Lion Super Indo	144	160	100% supers	90	Belgian	global

Source: After Natawidjaja et al. (2006; 2007)

Natawidjaja et al. (2006) quoted a view of the Chairman of the Indonesian Food and Beverage Association that 60% of Indonesia's population was already targetable by supermarkets, with 40 million (20%) existing customers as upper and middle income[20] and 40% emerging customers (lower middle class and working poor). He considered the remaining population (mainly rural poor) would remain with traditional wet markets for some time. Within the customer community, upper and middle income customers regularly buy their produce from supermarkets while lower middle income customers only bought discounted produce "on special." But recognizing this preference, supermarkets will sell a range of grades, with "B" grades targeted to poorer customers.

[19] Only 20% retail (Natawidjaja et al., 2006; 2007).

[20] Roy Morgan (2006) gives breakdown of income levels of upper, middle, lower middle, working poor, and unemployed poor consumers.

The rapid growth of the supermarket sector is not only the result of the removal of restrictions on foreign direct investment. It is also the result of consumer shopping preferences. Consumer behaviors influencing shopping habits in Indonesia include: price consciousness (less brand/store loyality), frequent shopping/small purchases, buying local rather than imported, and consuming more fresh food items. In general customers are less "nutrition-conscious" in purchase decisions, and show an increasing preference for shopping at supermarkets/modern outlets rather than wet markets due to comfort, product range, (perceived) quality guarantees, competitive pricing, service, and ease of access (Rangkuti, 2004).

Consumer trends in vegetable purchasing and consumption

In 1999, the average Indonesian consumer spent US$ 0.49 on fresh fruit and vegetables (FFV) for every US$ 1.00 spent on rice, but by 2004, it was US$ 0.74 on FFV for every US$ 1.00 spent on rice (= US$ 0.99 on FFV in urban, and US$ 0.59 on FFV in rural, for every US$ 1.00 on rice) (Natawidjaja et al., 2006; 2007).

Indonesian vegetable per capita availability statistics are divided into 17 categories, with per capita availability levels (2004), ranging from 8-14 g/day respectively for tamarind, water spinach (kangkong), spinach (possibly amaranth), "vegetable soup," yard-long beans, and cassava leaf, to around 3-5 g/day for cabbage, tomatoes, French beans, cucumber, eggplant, squash, young jackfruit, green papaya, onion, cayenne pepper, and others (Molyneaux and Rosner, 2004). Between 1996 and 1999 (during the economic crisis), there was a 9.8% drop in per capita vegetable availability (from 130 to 117 g/day), with a gradual recovery since then to 128 g/day in 2005 (MOA, 2006b). In spite of the 1997 economic crisis, total per capita food availability grew between 1996 and 2002, both for the poor and for the total population. All of the growth was in ready-to-eat and high-quality foods, including fruit and vegetables, at an average growth rate of 2% per year (1996-2002), accelerating to 11% per year from 1999 (Molyneaux and Rosner, 2004).

In the same period, starch availability declined, indicating a change in dietary preference away from starch and toward fruit and vegetables and other high-quality foods. Expenditure on vegetables rose 30%, and vegetable "calories" rose 17% between 1999 and 2002 (

Table 11). Data from Aceh, Maluku, and Papua was omitted, as these areas were not surveyed in 2002.

Table 11. Monthly per capita deflated expenditures and calories for vegetables and selected other foods

	Vegetables	Fruit	Sugar & Drink Mixes	Spices	Processed foods	Prepared foods & drinks
Deflated Expenditures (IDR)						
1996	3,470	2,060	2,083	984	924	6,097
1999	3,119	1,372	1,869	765	773	5,816
2002	4,047	2,554	2,344	1,049	1,129	6,932
% Change						
'96-'99	-10	-33	-10	-22	-16	-5
'99-'02	30	86	25	37	46	19
'96-'02	17	24	13	7	22	14
Calories Consumed						
1996	36	40	113	16	35	173
1999	32	32	102	16	29	174
2002	37	41	120	18	42	198
% Change						
'96-'99	-11	-20	-9	-1	-16	0
'99-'02	16	26	17	18	42	14
'96-'02	3	1	6	17	19	14

Source: after Molyneaux and Rosner (2004)

Product sourcing

Supermarkets stock both imported and local produce, for example at Giant in Bandung, the seven top vegetables were (i) imported carrots, (ii) local shallots, (iii) local potatoes, (iv) local carrots, (v), tomatoes, (vi) imported onions, and (vii) local garlic. Supermarkets also were featuring low pesticide and organic produce for niche customers (Natawidjaja et al., 2006; 2007). The preference for imports in Indonesia is higher than in many comparable countries, partly because local farmers are hampered by supply chain problems. Modern retailers are still sourcing fresh vegetable lines that are too perishable to import from "new generation" specialized suppliers who have invested in infrastructure, transport, and grower-support strategies, and from grower/packer/shippers linked to out-grower schemes. Produce may go via a central distribution centre (more durable lines) or direct to stores (leafy vegetables) (Natawidjaja et al., 2006; 2007).

Industry impacts

The growth in the supermarket sector and the gradual stagnation of wholesale markets is affecting supply chain links. Small-scale brokers (collectors) are being overtaken by the new-generation suppliers[21]; farmers are moving to fruit and vegetable production over rice, graduating through easy-to-produce lower-value commodities like field tomatoes to higher-value more demanding crops like asparagus; and the land rental market is booming, enabling upcoming farmers to expand (Natawidjaja et al., 2006; 2007).

The emergence of supermarkets and suppliers is having profound effects on farmers. In the most advanced production areas such as parts of West Java, 11-15% of horticulture crop farmers are accessing supermarket supply chains, which pay more than traditional wholesale market chains. Use of irrigation, greenhouses, and other technical innovations is occuring (Natawidjaja et al., 2006; 2007).

But other farmers who are unwilling or unable to join the supermarket supply chain because of inadequate capacity or financial commitments to traditional wholesalers are being marginalized, and in some cases leaving the industry and renting to more efficient producers (Natawidjaja et al., 2006; 2007).

The future

The market share for hypermarkets and supermarkets in Indonesia will continue to grow, expand more in provinces, and follow consumer demand. Traditional store operators will be increasingly marginalized. Saturation of the supermarket/hypermarket sector in some regions may affect industry viability/security for farmers. While lower prices due to increased retail competitiveness may benefit customers and boost total sales, farmers and suppliers may face tighter price squeezes.

Supermarkets will increasingly source fresh and processed products through imports where price and quality/delivery requirements can be met. Strategies are needed urgently to offset this—to promote streamlined domestic production and

[21] For example, Matahari uses 75 suppliers for Jakarta area, 6 are main suppliers for onion, potato, tomato, shallots, 25 for other products, and the remainder (44) for leafy vegetables. Bimandiri (Tukan and Roshetko, 2006) is an example of the type of 'new wholesaler' (supplier) used. The new wholesalers also sell to the food industry, fast food chains and airlines. (e.g. Saung Mirwan (Coyle, 2006) supplies to McDonalds, which pays in advance.) (Natawidjaja et al., 2006; 2007).

supply of produce to the supermarkets, targeting both replacement of imports and the international supermarket chain global distribution centers.

What can be done?

The suppliers (e.g Bimanderi) and key producer/suppliers (e.g. Saung Mirwan) to supermarkets are already implementing strategies to maintain viability. They work with farmer groups to grow more efficiently the range of produce supermarkets require, offer novel lines that will give them a marketing edge by encouraging crop diversification, and source and trial lines in cooperation with growers. Production of more durable products is moving away from Java to other islands, or is being replaced by imports. They are investing in infrastructure to enhance quality management and logistics and reduce costs (grading sheds, cool rooms, trucks). They are grading produce and capitalizing on market opportunities for higher prices and value-adding. They are moving production of more durable produce to lower cost production areas (e.g. Sulawesi) and marketing locally, into Java, and into Singapore. The supplier sector could benefit from strategies that speed up payments from supermarkets (often two weeks). Suppliers have to borrow to pay their farmers as some farmers cannot afford to wait for two weeks for payments; they are accustomed to being paid immediately, or within three days by wholesalers, or are indebted to collectors or wholesalers and need help to change.

Farmers who have entered the vegetable sector in West Java are expanding their productivity and incomes. They are working under contract in groups or with suppliers to ensure access to markets. They, and those who would like to grow vegetables but lack access to credit, would also benefit from improved access to finance at more favorable terms. They also need more technical advice and ongoing support in R&D to sustainably improve productivity.

Policy and infrastructure improvement strategies are also needed to modernize the whole sale sector and help farmers survive the transition of the marketing sector.

5 Conclusions

5.1 Policy and human resource issues

Indonesia has adopted generally sound macroeconomic policies and recognizes the need to revitalize agriculture and stimulate agri-industry. The current medium-term plan recognizes the critical importance of infusing production, marketing, and research and development with new skills. The government is moving to boost investment in infrastructure, and to enhance "info-structure"' (information systems) in partnership with private sector interests. Key policy challenges include rice self-sufficiency, balancing diversification and income generation; land use, urban encroachment, inheritance laws, and reversing farm-size reduction; opening up less-developed areas while managing deforestation and land-care; industry sustainability and modernization, including human resource development, technology, and improving supply chains, infrastructure, logistics, and inter-island trade; and agribusiness, with value-adding, trade statistics, market analysis and information flow for planning innovation and investment, national development, and adjustment to globalization.

5.2 Industry issues

Land availability, the high population density of Java, and the complexities of transportation within the Indonesian archipelago are major constraints to Indonesia's agricultural growth. The government recognizes Indonesia can sustainably boost agricultural productivity, but remains committed to meeting farmer welfare and consumer expectations (quantity, variety, halal), and ensuring food supplies are safe, affordable, and nutritionally adequate at national, regional, and household levels.

Although per capita availability of staples is declining, the National Planning Agency (BAPPENAS) has set a target of 90-95% rice secured from domestic production (MOA, 2006a); this creates some pressure on land use and farm diversification. So, while demand for vegetables is increasing along with opportunities for biopharmaceutical crops (e.g. gingers), and farmers are discovering these options provide better incomes, supply chain difficulties and lower prices encourage the marketing sector to import some lines rather than use domestic production. Whether farmers focus on staples or diversify, the challenges remain: farm sizes are inadequate, the vegetable processing and export sectors are underdeveloped, and productive land is being lost to urbanization.

To capitalize on opportunities, high-yielding, short-season varieties of perishable commodities (as the market sector still sources perishables locally) and innovation in dry season water access are needed to take advantage of "between rice" land. To improve competitiveness of more durable commodities, costs need to be contained and supply chains streamlined, especially for trade to and from Eastern Indonesia.

5.3 Issues for focus

A favorable investment environment and consumer demand are driving modernization of the retail sector in both densely populated and less-developed areas of the country. Imports of fresh and processed vegetables are increasing to help meet market expectations. Consumer demand for processed and ready-to-eat foods is also growing, and this is providing new opportunities for SME and large-scale investment in food processing, as well as for importers.

Changes in the retail sector are also affecting wholesaling. More efficient supply chains are emerging. Wholesaler-importers are consolidating. The government and the private sector recognize the need for modernization and new investment in the "traditional" wholesale markets of major cities.

Demand growth and the emergence of contract growing arrangements enable more farmers who can't earn adequate income from staple crops alone to grow vegetables, and to expand, diversify, and modernize their production systems. At the same time, some farmers are unable to take advantage of the changes and are becoming marginalized, or leasing their farms while they seek employment elsewhere.

Domestic market changes, and the emergence of export opportunities to Malaysia, Singapore, and the Middle East, are also stimulating investment in vegetable production and marketing in Sumatra and less developed areas (Kalimantan, Sulawesi). Production of more "transportable" vegetables (cabbage, potato, shallot, pumpkin, gourd) is migrating to more distant areas where land is more affordable, with cultivation in some areas occurring in tandem or in competition with increased production of cocoa, coffee, oil palm, and other estate crops.

The changes at all levels—in the vegetable industry, and government—highlights the need for investment in market information systems, research, development, extension, "info-structure," training, and human resource development. The new Extension Law provides an opportunity for closer coordination of efforts and resource boosting for farmer- and trader-centered

approaches to industry development in partnership with the private sector. Within this context, the government, planning and development agencies, and training and education systems must frame and implement policy and regulatory systems, and improve infrastructure and logistics to facilitate industry growth and transformation.

6 Recommendations for R&D

Identify and facilitate opportunities for trade and market access
Market and consumer trend analysis in local, or current and prospective international markets, together with dissemination of price, biosecurity requirements, and market needs to the industry will help expand trade and improve compliance with customer requirements. The industry and the ministries of Agriculture, Health, and Trade Promotion could also work together with retailers and exporters to vigorously promote vegetables and medicinals for health and nutrition, to increase consumption and enhance demand.

Stimulate value adding and agribusiness development
The processing and value-adding sectors of the vegetable industry are underdeveloped (and overly reliant on cheaply imported ingredients). Innovative strategies are needed for improving their suitability and affordability and boosting the use of local ingredients. Enhancing financial incentives, training, capacity building and industry assistance with a focus on satisfying customer requirements will stimulate the sector and increase investment and employment.

Improve financial management and access to lending across the industry
Promoting basic account keeping and financial management at farm and industry levels will strengthen capacity for managing finances and improving profit and benefit distribution to farmers, and enhance the industry's reputation with markets. Strategies to speed up payments in the market chain[22] and to provide loans to small holders and the poor are also needed.

Strengthen industry mapping and statistics collection, and foster supply chain approaches
Detailed supply chain analysis, linked to strategies for stakeholder engagement and capacity building, will enhance industry planning and technological innovation, and pave the way for consolidating attention to cost control, food safety, and quality improvement.

Facilitate land access and consolidation
Small farm size, unsustainable land use (slopes above 45º) and inadequate exit strategies for marginalized farmers hamper poverty alleviation and

22 Traditional wholesalers pay in 2-3 days while supermarkets pay in 2-3 weeks; to be competitive, the "modern" wholesaler has to pay farmers in 3 days, and carry the cost until the supermarket pays them.

modernization of the industry. Attention to these issues will enable farmers, farmer groups, and traders to find easier ways to gain economies of scale by expanding their production base. The private sector is helping the production base to move from sloping elevated regions to the lowlands by developing cultivars suited to higher temperatures (e.g. hybrid tomatoes that have good fruit set at high temperature and a lowland French bean "Perkasa" from East West Seed (G. Grubben, pers. com., 2007).

Assist in the development of new production areas

Some industry leaders (e.g. Saung Mirwan (Coyle, 2006)) are already investing in less developed regions to enhance production and marketing to local, metropolitan, and export markets. Investment incentives and R&D support is needed to accelerate the migration of industry to these areas, and to strengthen national coordination of production and marketing to avoid gluts, shortfalls, and export competition). In moving to new areas, international community concerns about deforestation, habitat destruction, and smoke pollution should also be accommodated.

Enhance sustainability and productivity

Increase development and uptake of higher yielding cultivars suited to customer requirements. Develop cropping systems and watering and nutrition recommendations within systems frameworks to improve productivity and conserve resource use.

Optimize production and distribution

Improve crop production and protection systems and develop supply chain innovations to enhance safety and reduce losses and input costs. Strengthen attention to development of feasible but reliable approaches to Good Agricultural Practice (GAP) and food safety.

Encourage novel crop prospecting and industry innovation

The vegetable industry faces competition from imported vegetables, fruit, junk food, and other lifestyle choices. Industry innovation can improve system efficiencies and enhance produce salability (organics, safe vegetables) and utility (minimally processed). New and indigenous crop prospecting and development can capitalize on consumer passions in Indonesia, and among export markets, for novelty and health benefits. Opportunities include development of indigenous vegetables such as bitter gourd, and the ginger family for the bio-pharmaceutical market.

Revitalize the roles of Dinas Perkebunans and Agricultural Technology Assessment Centres (BPTP)

Planning, skills development, capacity building for the future, bigger operational budgets, and strategies for improving links to the private sector are needed. Review, reform and restructure technical and tertiary training and information dissemination pathways, and involve extension personnel in supply chain studies and consumer nutrition education. Capitalize on opportunities afforded by the new Extension Law.

Foster more competitive research and collaboration

Research and development agencies, universities, the private sector, and NGOs need to be encouraged to take more strategic and innovative approaches to research, development, and extension. The gaps between basic and applied research, and between development and uptake, need to be bridged or eliminated. Encouraging a more competitive funding system and strengthening industry and private sector partnerships will sharpen attention from agencies and scientists, highlight strategies for uptake, determine economic feasibility, and increase chances for success.

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8 Appendixes

Appendix 1. Volume of vegetable and spice production (tonnes) 1997-2005

Year	Cabbages	Chili[23]	Shallots	Tomatoes	Cucumber	Mustard Green[24]
1997	1,338,504		294,423	460,542	489,595	441,856
1998	1,459,232		287,506	547,260	506,889	462,384
1999	1,447,910		323,855	562,406	431,950	469,996
2000	1,336,410		772,818	593,392	423,386	454,815
2001	1,238,079	580,464	861,150	483,991	431,921	434,043
2002	1,232,843	636,089	766,572	573,517	406,141	461,069
2003	1,348,433	1,066,722	762,795	657,459	514,210	459,253
2004	1,432,814	1,100,514	757,399	626,872	477,716	534,964
2005	1,292,984	1,058,023	732,609	647,020	552,891	548,453

Year	Leeks***	Yard-long Beans	Carrots	Watermelon	Eggplant	French Beans
1997	294,426	368,352	227,321		279,625	295,312
1998	287,506	447,596	332,846		311,765	311,994
1999	323,855	386,188	286,536		300,323	282,198
2000	311,319	313,526	326,693	179,860	270,748	302,684
2001	283,285	317,408	300,648	240,299	244,371	228,840
2002	315,132	310,295	282,248	266,904	272,700	230,020
2003	345,720	432,365	355,802	455,466	301,030	247,782
2004	475,571	454,999	423,722	410,195	312,354	267,619
2005	501,437	466,387	440,002	366,702	333,328	283,649

Year	Water Spinach	Pumpkin/ Chayote	Ginger	Spinach*	Turmeric	Melon**
1997	188,594	41,007	81,178	73,790	26,954	
1998	201,147	84,873	92,968	98,410	23,247	
1999	211,597	121,233	120,851	81,433	15,363	
2000	215,303	158,654	115,092	65,723	24,813	27,081
2001	193,825	137,673	128,437	64,360	27,195	37,140
2002	205,351	172,125	118,496	71,011	23,993	59,106
2003	208,450	103,451	125,386	109,423	30,707	70,560
2004	212,870	179,845	104,789	107,737	40,467	47,664
2005	229,997	180,029	125,827	123,785	82,107	58,440

Year	Chinese Radish	Galangal	Greater Galangal[25]	Garlic	Wild Ginger[28]
1997	49,547	23,295	18,853	102,283	16,552
1998	12,651	24,701	21,283	83,664	11,559
1999	13,967	16,916	5,809	62,222	4,616
2000	7,745	27,512	9,490	59,008	5,674
2001	6,880	26,154	11,112	49,573	6,089
2002	7,779	27,934	12,848	46,393	7,174
2003	26,313	24,588	19,527	38,957	11,762
2004	30,625	24,299	22,609	28,851	16,667

[23] Note that online data for area and volume of chili are the reverse of the data in the published version. Here, the data reflects published version.

[24] Chinese cabbage + Pak Choi.

[25] Greater Galangal = *Alpinia galangal*; Wild Ginger = *Zingiber zerumbet* (L.) Sm. (MMPND, 2007).

2005	54,226	36,294	35,478	20,733	22,582

Source: BPS (2007)

* Probably amaranth; ** Probably bitter gourd; *** (May include Welsh Onion data) (G Grubben pers. com., 2007)

Appendix 2. Laws relevant to the vegetable industry

Relevant laws as located are listed with URLs below. Those without URLs were not located and their status is uncertain:

General laws

Indonesia - Guide to Law on Line: http://www.loc.gov/law/guide/indonesia.html and FAO: http://faolex.fao.org/faolex/index.htm

Duties, Functions and Authorities of the Ministry of Agriculture are in accordance with Presidential Decree No. 102 year 2001: http://www.deptan.go.id/english/organisasi/deptan_e.htm

Food Law (No 7, 1996). http://faolex.fao.org/docs/pdf/ins9666.pdf

Plant Variety Rights, Genetically Modified Organisms

Plant and Animal Quarantine 1992. http://faolex.fao.org/faolex/index.htm

Extension Law (No 6/2006), Co-Operatives Law (No 25/1992), http://faolex.fao.org/docs/pdf/ins3953.pdf

Regional Administration (No 22, 1999) http://faolex.fao.org/docs/pdf/ins42653.pdf

Agricultural Laws in Indonesia – Seed contamination http://www.grain.org/front_files/Flier2seedcontamination2007.pdf

Specific laws/orders

(quoted verbatim from http://www.grain.org/front_files/Flier2seedcontamination2007.pdf)

The Ministry of Agriculture's Agency for Agricultural Research and Development is the nodal agency for biosafety in Indonesia. The Biosafety and Food Safety Committee and the Biosafety and Food Safety Technical Team are both to be restructured. The several government rules and regulations relevant to biosafety are:

- *Government Regulation on Biosafety for Genetically Engineered Products (2005)*

- *Food Safety Decree (1999)*
- *Provisions on Biosafety of Genetically Engineered Agricultural Biotechnology (1997)*
- *Law on Food (1996)*

The following drafts are in the pipeline:

- *DRAFT Safety of Living Organisms of Biotechnological Products Produced through Genetic Engineering (2001)*
- *DRAFT Safety of Living Organisms and Foods of Biotechnological Products Produced through Genetic Engineering (2001)*
- *Laboratory Guidelines for Genetic Engineering Research (1993)*

Genetic engineering (non-biological) technologies are patentable under the Patent Law. The Law on Systems for Plant Cultivation states that the overall principle of Indonesian agriculture is to be beneficial, environmentally friendly and sustainable. However, despite all these rules and regulations, the interests of small farmers are not guaranteed. Meanwhile, research on transgenic varieties of food and other crops including corn, rice, tomato and sugar cane continues. There is, however, no order for the segregation or isolation of plants and produce of genetically engineered crops, something that is required if the government is to cash in on organic exports. Concern for biosafety may simply be reduced to labelling.