# MALAYSIA

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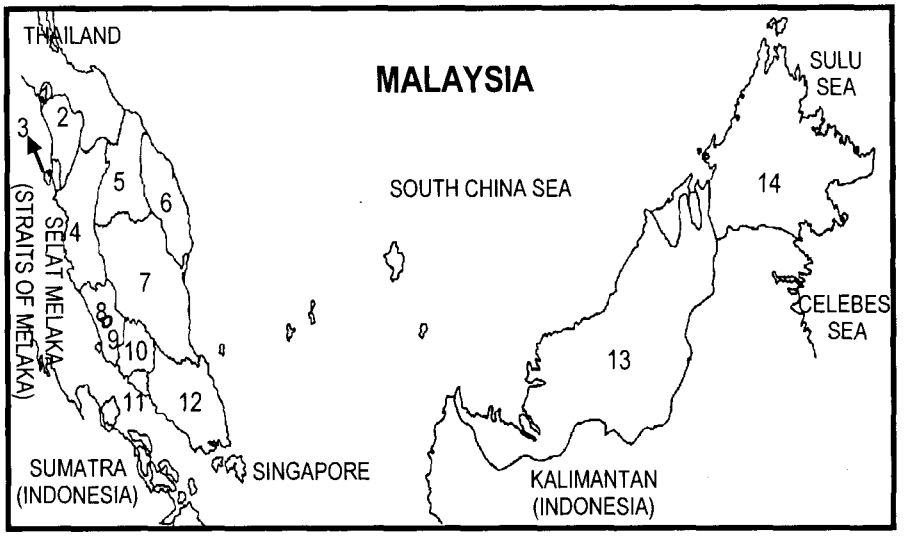
## Introduction

Malaysia is a relatively small country (320,000 km$^2$) with a total population of 20 million in 1995. It is bordered by Thailand in the north, Singapore in the south, and Indonesia in the east and west. The country is surrounded by the South China Sea and the Indian Ocean (Fig. 1). Malaysia consists of three regions: Peninsular Malaysia, Sabah, and Sarawak, each has respectively 6.2, 1.8, and 2.3 million ha of land suitable for agriculture. The topography of Peninsular Malaysia is dominated by a mountain range, called Main Range, which runs through the middle of the peninsula up to an elevation of about 2000 m asl. From this range, many rivers flow towards the flood plains and the coast. The west coast of the peninsula is dominated by alluvial marine deposits while the east coast exposes riverine deposits and sandy beach ridges. In the peninsula, about 8% of land is swampland. Sabah and Sarawak are generally mountainous with almost 70% of Sarawak comprised of very steep areas.




1. Perlis
2. Kedah
3. Pulau Pinang
4. Perak
5. Kelantan
6. Terengganu
7. Pahang
8. Selangor
9. Wilayah Persekutuan Kuala Lumpur
10. Negeri Sembilan
11. Melaka
12. Johor
13. Sarawak
14. Sabah

Fig. 1. Map of Malaysia

More than half of the country's people live in urban areas. The overall population density in the country in 1995 was 62 people/km$^2$, which widely varies from 13 in Sarawak to 4713 in Kuala Lumpur (Department of Statistics 1996). Malaysia is a multiracial country comprised of Malays, Chinese, Indians, and indigenous groups. The indigenous people mainly live in the eastern states of Sarawak and Sabah.

Annual per capita income was around US$5000 in 1995, which was growing at the rate of 8-9% per annum (Department of Statistics 1996). Faster growth of the manufacturing sector has lead to a decline in the contribution of agriculture to the country's gross domestic product (GDP), from 23% in 1980 to about 16% in 1993. This is expected to further decline to 13% by the year 2000. However, earnings from agriculture are expected to increase in absolute terms from MYR14.8 billion in 1980 to MYR20.8 billion in 2000 (Abdul Aziz 1993).

In 1995, palm oil was the major contributor to the agricultural GDP which was growing at an annual rate of 5.8%, followed by rubber (growth 2.5%), and cocoa (growth 1.7%). The area under vegetable cultivation during 1994, excluding potato and sweet potato but including chili, was 25,974 ha (about 0.45% of the total cropped area, and 3.74% of the total cereal area). This produced about 0.399 million t of vegetables worth of about MYR574 million or US$220 million (these figures are only for Peninsular Malaysia, believed to contain more than 80% of total vegetable area). Average vegetable yield is about 15.0 t/ha.

A significant portion of total vegetable availability in the country is imported. Net imports after deducting exports amounted to 0.287 million t in 1995. Annual per capita availability of vegetables, after adding net of imports and exports, is 44 kg, about 60% of the recommended vegetable availability of 73 kg (again these figures are for Peninsular Malaysia only). The major vegetable species grown in the country are long beans, chili, cucumber, Chinese mustard, and lady's finger. These account for more than two-thirds of the total vegetable area.

## Environment

### Topography

In Peninsular Malaysia, a mountainous spine, known as the Main Range or Banjaran Titiwangsa, runs from the Thai border southwards to Negeri Sembilan, effectively separating the eastern and western parts of the peninsula. As a result of the configuration of the country and of the heavy rainfall, many rivers originate in the mountains and fall to the sea on both sides of the peninsular. The longest river on the peninsula is the Sungai Pahang (475 km), followed by the Sungai Perak (400 km).

The most prominent mountain range in Sabah is the Crocker Range. The highest mountain in the range, also highest in Southeast Asia, is Gunung Kinabalu (4101 m). The longest river of Sarawak is the Rajang Sarawak (563 km). The two highest peaks in Sarawak are Gunung Murud (2425 m) and Gunung Mulu (2371 m), the latter of which boasts one of the largest natural caves in the world.

About four-fifths of Malaysia is covered by tropical rain forest. Rice cultivation is practiced throughout the peninsula, but the main and traditional centers are the states of Perlis, Kedah, Selangor, Kelantan, and mainland Pulau Pinang. Most of the larger rubber and oil palm estates are located on the peninsula.

### Climate

Malaysia lies entirely in the equatorial zone characterized by tropical climate, governed by the regime of the north-east and south-west monsoons. The north-east monsoon blows from about mid-November until March, and the south-west monsoon between May and September. The periods of change between the two monsoons are marked by heavy rainfall. The south-west monsoon is drier, particularly for the states on the west coast of the peninsula, sheltered by Sumatra.

Being in the tropics, the average temperature throughout the year is high (26°C). The diurnal temperature range is about 7°C. There is some regional variation in temperature. For example, the Cameron Highlands have a mean temperature of 18°, compared to Kuala Lumpur's 27°C. Mornings are generally fine, and rain in the late afternoons is often accompanied by lightning and thunder. Humidity is high (about 80%) due to the high temperature and a high rate of evaporation. Rainfall is generally heavy, about 2500 mm annually.

## Major Vegetables and Growing Areas

Vegetables are small-holder crops in Malaysia, with an average farm size of less than one hectare. Vegetable production area is concentrated in the states of Johor, Perak, Kelantan, and Pahang. These four states account for about 75% of the total vegetable production in Peninsular Malaysia. Johor alone contributes about 41% of total vegetable area in the country (Table 1).

Table 1. Vegetable area, number of vegetable farmers, and average farm size in Peninsular Malaysia

| State | Area* (ha) | Share in total area (%) | Farmers (number) | Average farm size (ha) |
|---|---|---|---|---|
| Johor | 10618 | 40.9 | 1688 | 1.66 |
| Kedah | 1559 | 6.0 | 835 | 0.86 |
| Kelantan | 3234 | 12.5 | 1610 | 0.29 |
| Melaka | 516 | 2.0 | 650 | 0.72 |
| Negeri Sembilan | 539 | 2.1 | 179 | 0.85 |
| P. Pinang | 972 | 3.7 | 441 | 0.48 |
| Pahang | 2759 | 10.6 | 2568 | 0.65 |
| Peninsular Malaysia | 25974 | 100.0 | 13037 | 0.79 |
| Perak | 3613 | 13.9 | 2433 | 0.74 |
| Perlis | 111 | 0.4 | 97 | NA |
| Selangor & F. Territory | 894 | 3.4 | 1172 | 1.30 |
| Terengganu | 1159 | 4.5 | 1364 | 0.33 |

* Estimated from data for 12 major vegetables.

Source: Area is from official files of Federal Agricultural Marketing Authority (FAMA), time series data on vegetables from 1985 for 1994, while number of farmers and farm size are from FAMA (1992) for 1991.

NA implies data are not available.

Malaysia produces a wide variety of vegetables, of which about 50 species are grown commercially. The five most popular are long beans, chili, cucumber, Chinese mustard, and lady's finger. Although,

onion, shallot, and garlic are major vegetables consumed, these are not currently economical to produce in Malaysia, thus mainly imported. Johor is the major vegetable growing area for many individual vegetable species (Table 2). The Cameron Highlands in the state of Pahang is the oldest and the largest supplier of temperate vegetables in the country.

Table 2. Major vegetable area and cultivation states, 1994

| Vegetable | Area (ha) | Share in total vegetable area (%) | Major growing states (% share in total area of the vegetable) |
|---|---|---|---|
| Cabbage | 976 | 3.8 | Pahang (67), Kelantan (29) |
| Chili | 3930 | 15.1 | Perak (24), Johor (24), Kelantan (15), Pahang (12), Kedah (10) |
| Chinese kale | 523 | 2.0 | Johor (76) |
| Chinese mustard | 2739 | 10.5 | Johor (54) |
| Cucumber | 3723 | 14.3 | Johor (37), Kelantan (26), Perak (12) |
| Eggplant | 1375 | 5.3 | Johor (30), Perak (24), Kelantan (19) |
| French beans | 1673 | 6.4 | Johor (59), Pahang (17) |
| Kangkong | 1655 | 6.4 | Johor (54), Kelantan (9), Perak (9) |
| Lady's finger | 2121 | 8.2 | Johor (40), Perak (16), Kedah (10), Kelantan (10) |
| Long beans | 5171 | 19.9 | Johor (42), Perak (19) |
| Spinach | 1552 | 6.0 | Johor (68) |
| Tomato | 536 | 2.1 | Pahang (79) |

Source: Official file of FAMA, time series data on vegetables from 1985-94.

## Trend Analysis

### Production

In Peninsular Malaysia, the area under vegetables increased sharply from 7735 ha in 1983 to about 25,974 ha in 1994, which resulted in a production increase from 145,000 t to 399,000 t in that period. Yield remained fluctuating between 15 and 18 t/ha. Fruit vegetables recorded the biggest increase in both cultivated area and production.

Total vegetable area and production exhibited quite high linear increases in the early years of the period 1983-94, but increase in area stagnated in the later years shown by its negative quadratic term. Per ha yield of all vegetables, however, did not exhibit a statistically significant trend over the study period (Table 3). During 1983-94, the area under eggplant, chili, cucumber, and Chinese kale increased linearly at very high rates (only linear terms are significant), while spinach and kangkong area increased quadratically. The high linear and quadratic rates can be explained by relatively small areas of these crops to start with.

The yield of most crops has either insignificant trend or increased only in the early years, but then stagnated during the later years of 1983-94. With few exceptions, production followed the area trend in most vegetables (Table 3).

Table 3. Trends in area, production, and yield of major vegetables in Malaysia, 1983-94

| Vegetable | Area | | Production | | Yield | |
|---|---|---|---|---|---|---|
| | T | $T^2$ | T | $T^2$ | T | $T^2$ |
| Cabbage | -0.174 | 0.015 | -0.195 | 0.015 | _ | _ |
| Chili | 0.205 | _ | _ | _ | -0.273 | 0.015 |
| Chinese kale | 0.167 | _ | 0.271 | -0.013 | 0.104 | -0.009 |
| Chinese mustard | _ | _ | _ | _ | _ | _ |
| Cucumber | 0.310 | _ | 0.335 | _ | _ | _ |
| Eggplant | 0.250 | _ | _ | _ | -0.195 | 0.012 |
| French beans | 0.305 | -0.013 | 0.330 | -0.015 | _ | _ |
| Kangkong | _ | 0.013 | _ | _ | 0.065 | -0.010 |
| Lady's finger | 0.862 | -0.049 | 0.954 | -0.060 | 0.092 | -0.011 |
| Long beans | 0.488 | -0.024 | 0.518 | -0.026 | _ | _ |
| Spinach | _ | 0.013 | _ | _ | 0.160 | -0.016 |
| Tomato | _ | _ | _ | _ | _ | _ |
| Total vegetables | 0.220 | -0.006 | 0.262 | _ | _ | _ |

Source: Estimated from the official files of Federal Agricultural Marketing Authority (FAMA), time series data on vegetables from 1983 through 1994.

– implies that the coefficient is not significant at least at the 10% level.

## Prices

The overall nominal vegetable prices at the retail level are increasing at a rate of 2.8% per annum. Most individual vegetable prices are also increasing in nominal terms at the farm, wholesale, and retail levels, and with few exceptions, the increases are statistically significant (Table 4).

Prices are increasing in real terms too, after deflating the nominal prices with an appropriate consumer price index. This is despite a three-fold increase in production, suggesting that production increase failed to match increasing demand. The extent of price increases varies across vegetable species (Table 4).

The general trend is for the prices of fruit vegetables to increase more than the prices of leafy vegetables over time due to the higher consumer preference for fruit vegetables with their longer shelf-life. Another factor which contributes to such a trend is the longer growing period for fruit vegetables, which makes it relatively harder to adjust their acreage to meet the increasing demand, at least in the short term.

In most cases, increases in the farm and wholesale prices are higher than increases at the retail level, suggesting a decrease in marketing margins. This is an interesting situation, and should be studied more carefully in order to understand the factors contributing to this improvement in market efficiency so that the trend can be reinforced.

Table 4. Growth rate (%) in major vegetable prices, 1985-94

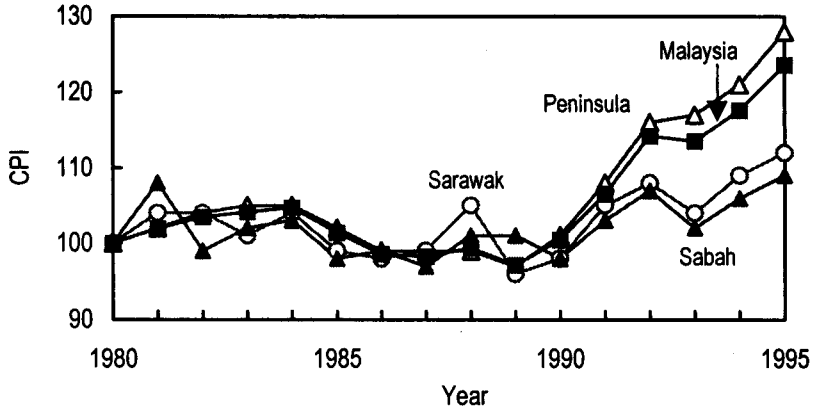
| Vegetable | Nominal | | | Deflated[a] | | |
|---|---|---|---|---|---|---|
| | Farm | Wholesale | Retail | Farm | Wholesale | Retail |
| Cabbage | - | 3.4 | 2.2 | - | - | - |
| Chili | - | 2.6 | 1.8 | - | - | - |
| Chinese mustard | 3.3 | 2.8 | 2.3 | - | - | - |
| Cucumber | 2.8 | 3.2 | 2.7 | - | - | - |
| Eggplant | 10.3 | 7.8 | 6.2 | 7.5 | 5.0 | 3.2 |
| French beans | 10.1 | 9.4 | 7.8 | 7.2 | 6.6 | 4.9 |
| Lady's finger | 7.1 | 7.1 | 6.7 | 4.2 | 4.3 | 3.7 |
| Long beans | 8.1 | 7.9 | 6.1 | 5.2 | 5.1 | 3.2 |
| Spinach | 5.7 | 4.7 | 4.2 | 2.9 | 2.0 | 1.3 |
| Tomato | 5.4 | 4.7 | 3.9 | 2.6 | 1.9 | 1.0 |
| Overall vegetables | NA | NA | 2.8 | NA | NA | 1.0 |

Source: estimated form FAMA, various issues[c] (1980-88, 1995).

[a] To estimate the real prices from the nominal prices, the wholesale prices were deflated with the wholesale consumer price index, retail prices were indexed with the retail consumer price index, and farm prices were deflated with the average of wholesale and retail consumer price indices.

- implies that the coefficient is not significant at least at the 10% level, and NA implies that data are not available.

The overall real vegetable prices at the retail level during 1980-95 drifted upward at a rate of 1.0% per annum. However, the rate of increase during the 1990s was much faster at 3.8%. The rates of increase in retail prices were much higher on the peninsula than in the other two regions of the country (Fig. 2).




Source: Estimated from data reported in FAMA, various issues[c] (1980-88, 1995).

Fig. 2. Trend in real vegetable price at the retail level in different regions of Malaysia.

Despite a higher increase in farm-level prices, however, the profit in vegetable cultivation might not have improved as vegetable farmers faced increasing costs. For instance, since 1990 the cost of insecticide has increased by 20-30%, imported fertilizer by 5-10%, organic fertilizer by 8-10%, and seeds by 20%. Wage rates also increased, by 20%, from MYR14-15 per day in the late 1980s to

MYR17-18 per day in 1993 (Mukhtiar 1994). Farmers have also had to bear an almost 50% increase in transport cost.

## Seasonality

Because most vegetable species are very perishable, vegetable prices are highly seasonal. The extent of seasonal price fluctuation ranges from 25 to 157% in different vegetables at different marketing levels (Table 5). In addition, comparison of monthly and weekly seasonal patterns reveals that prices tend to be more seasonal in the short term, at all levels in the marketing chain.

Leafy vegetable prices tend to fluctuate more than prices for fruit vegetables. Prices of highly perishable vegetables, such as cabbage and mustard, fluctuate more compared to the less perishable ones, such as potato. With few exceptions, seasonality is higher at the farm level than at the wholesale and retail levels, suggesting that marketing agents help to smooth out seasonality by adjusting their profits (Table 5).

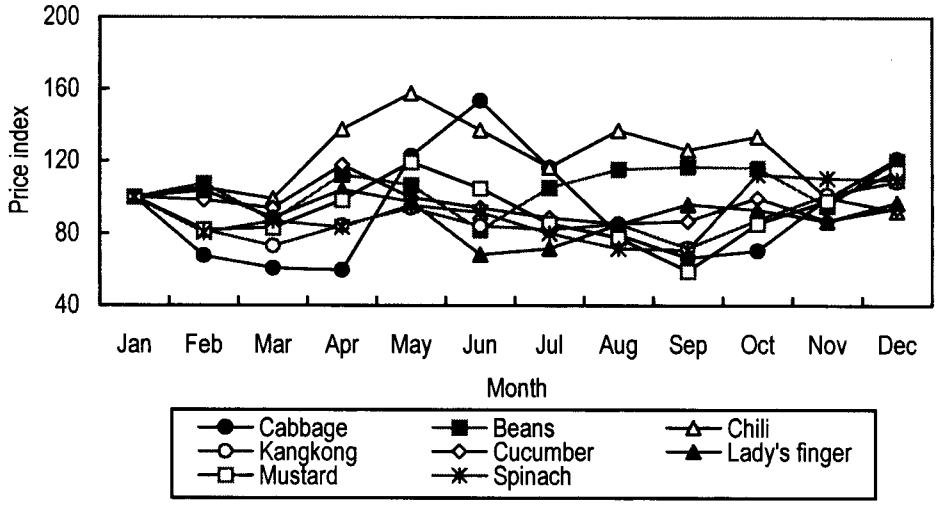
Table 5. Seasonality (%) in vegetable prices in Malaysia (average 1989-93)

| Crop | Max. | Min. | Seasonality | | |
|---|---|---|---|---|---|
| | | | Farm | Wholesale | Retail |
| Cabbage | Jun | Mar | 156.9 | 105.1 | 72.7 |
| Chili | May | Mar | 70.7 | 61.0 | 34.5 |
| Cucumber | Dec | Jul | 37.7 | 69.8 | 44.2 |
| Kangkong | Dec | Mar | 51.2 | 57.3 | 48.0 |
| Lady's finger | Dec | Aug | 52.2 | 39.9 | 25.3 |
| Long beans | Dec | Jul | 47.1 | 29.3 | 30.6 |
| Mustard | May | Sep | 101.9 | 106.2 | 71.0 |
| Onions | Nov | Apr | NA | 81.5 | 35.7 |
| Potatoes | Jun | Feb | NA | 45.5 | 26.9 |
| Spinach | Dec | Jul | 58.7 | 65.3 | 53.7 |

Source: Estimated from monthly data reported in FAMA, various issues[a] (1985-1994).
NA implies data are not available.

A bimodal seasonality pattern can be observed in most vegetable prices (Fig. 3a). Most individual vegetable prices at the retail level are high during April-June and November-January. A similar pattern of seasonality was observed in the prices of all vegetables, as a group (Fig. 3b). An average of all vegetable prices has a monthly seasonality of over 32.5% at the retail level.

a. Individual vegetables




b. Overall vegetables

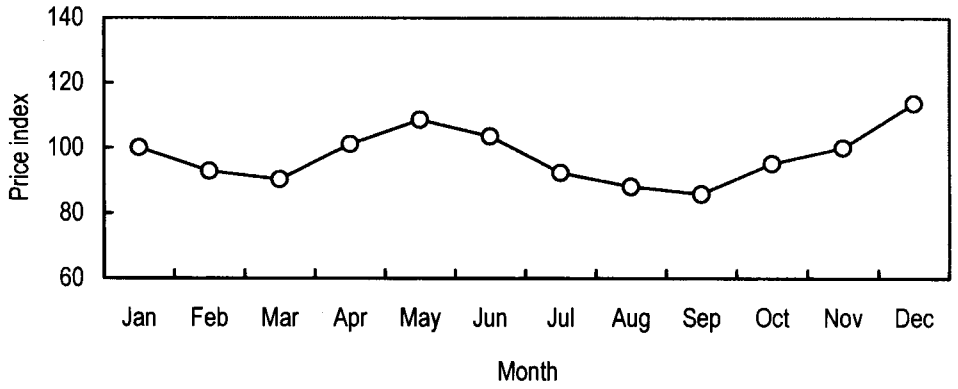



Fig. 3. Seasonality in vegetable prices at the retail level in Malaysia (average of 1989-93).

## Risk in Production

Vegetables, as a group, are more risky to produce than field crops such as rice. The detrended coefficient of variation in individual vegetable production is 3-8 times higher than rice. The highest variation is in the production of cabbage, Chinese mustard, and cucumber (Table 6).

Except in chili, variation in vegetable area is higher than in yield, suggesting that government policies that can stabilize area could have far-reaching impact to stabilize vegetable production in Malaysia. However, instability in yield is also quite high, implying that stable vegetable production technologies can also substantially reduce fluctuation in production.

Fluctuation in vegetable production is a cause as well as a consequence of variation in vegetable prices (Table 6). Again, the variation in vegetable prices is many times more than that in field crops at all market levels. In most cases, vegetable prices have higher variation at the farm and wholesale

levels compared to those at the retail level, again suggesting that marketing agents absorb some of the shocks in market prices by adjusting their profits.

Table 6. Detrended CV (%) in area, production, yield, and prices of major vegetables and rice in Malaysia, 1983-94

| Crop | Area | Production | Yield | Prices | | |
|---|---|---|---|---|---|---|
| | | | | Farm | Wholesale | Retail |
| Chili | 14.7 | 16.8 | 29.7 | 9.3 | 11.7 | 11.1 |
| Chinese mustard | 22.7 | 28.7 | 13.6 | 9.7 | 7.8 | 6.0 |
| Cucumber | 19.5 | 27.4 | 17.9 | 8.0 | 9.8 | 9.1 |
| Eggplant | 22.2 | 18.8 | 18.9 | 16.0 | 11.5 | 8.8 |
| Cabbage | 24.4 | 40.0 | 22.1 | 14.0 | 10.4 | 7.3 |
| Spinach | 25.4 | 18.9 | 15.5 | 8.9 | 11.4 | 7.2 |
| Tomato | 17.2 | 14.7 | 12.1 | 8.8 | 5.8 | 4.4 |
| Overall vegetables | 14.6 | 14.8 | 13.1 | NA | NA | NA |
| Rice | 2.5 | 4.9 | 3.5 | 2.1 | 2.1 | 1.1 |

Source: Estimated from official files of Federal Agricultural Marketing Authority (FAMA), time series data on vegetables from 1983-94 for area, production, and yield of vegetables. The area, production, and yield of rice were taken from IRRI (1995). The vegetable price data were taken from FAMA, various issues[c] (1980-88, 1995), and rice price from Ministry of Agriculture (1995).

NA implies data are not available.

## Measures to Stabilize Prices

Several options were proposed to reduce and smooth out the fluctuations in the domestic price of vegetables (MARDI 1993). These are listed below:

(1) Correction of market imperfection, especially at the wholesale level. For example, an auction system would lead to improved market transparency and increased capacity for transaction.

(2) Improvement of distribution systems to reduce marketing margins. Reduction in marketing costs would lead to lower consumer prices.

(3) Increased production through reserving suitable land for vegetables supported by appropriate infrastructures (e.g., drainage facilities) and technology. This could result in increased domestic supply, reduced production costs, and lower prices to consumers.

(4) Regulation of supply through post-harvest technological advancement, such as storage and scheduling of production. This would result in less seasonality in vegetable prices and availability.

(5) Further liberalization of imports could improve consumers' welfare and stabilize prices.

(6) Establishment of marketing information systems for major production areas. Timely availability of information would reduce intertemporal and spatial price variations.

# Economics and Sustainability of Production

## Suitable Physical Requirements

The increasingly sharp competition for resources, especially land, across all sectors, as well as within agriculture, necessitates the use of marginal lands for agriculture, including vegetable production. Hence, an understanding of the requirements for vegetable production on these soil types is important. For vegetable cultivation, level topography and 50 cm or more of well drained loam to clay loam soil with relatively high fertility and having pH in the range 5.5-7.5 are required (Table 7).

Table 7. Optimum topographical and soil conditions for vegetable cultivation in Peninsular Malaysia

| Soil characteristics | Requirement | |
|---|---|---|
| | Optimal | Intermediate/unsuitable |
| Topography | Level | Undulating |
| Depth of soil (cm) | >50 | <50 |
| Drainage | Well to moderate | Imperfect |
| Soil texture | Loam to clay loam | Others |
| Soil fertility | High to intermediate | Low |
| Soil acidity (pH) | 5.5-7.5 | 7.5-8.2 |

Source: MARDI (1982).

Steep mountains and sloping hills are considered unsuitable for vegetable cultivation, even with terraces to reduce slope. Similarly, peat soils need much investment to correct low or high organic matter content and to bring pH into a reasonable range. They are considered only partially suitable even after these improvements. Bris soils, due to their low water retention capacity, are also only partially suitable, even after developing drainage and irrigation facilities (Table 8).

Table 8. Conditions for vegetable production in different areas

| Type of area/ soil type | Main limitations | Improvements required | Condition before improvement | Condition after improvement |
|---|---|---|---|---|
| Steep mountainous | Steep slopes>30° | Terracing | Not suitable | Not suitable |
| Sloping hills | Slopes between 5-30° | Terracing | Not suitable | Not suitable/ partially suitable |
| Peat | Low and high organic matter | Drainage and manuring, pH correction. etc. | Not suitable | Not suitable/ partially suitable |
| Lowland close to river | Low lying | Drainage, irrigation & manuring | Partially suitable | Suitable |
| Bris | Low lying, sandy soils, low water retention | Irrigation, drainage & high manuring | Not suitable | Partially suitable/ suitable |

Source: MARDI ( 1991).

## Input Use

The Techno-Economic and Social Studies Division of the Malaysian Agricultural Research and Development Institute (MARDI) has published the Production Cost Bulletin since the early 1970s.

The input usage figures reported in these studies were obtained from trials on farmers' fields (Table 9). For the purpose of comparison, input use in rice is also reported here.

Table 9. Quantities of input use (per ha) on selected vegetables and rice in Malaysia

| Crop | Labor (Person-day) | Seed (kg) | Fertilizer (t) | Organic Manure (t) | Pesticide (MYR) | Others** (MYR) |
|---|---|---|---|---|---|---|
| Cabbage | 184 | 0.2 | 2.8 | 5 | 935 | 0 |
| Chinese mustard | 222 | 1.5 | 1.0 | 3 | 300 | 0 |
| Cucumber | 229 | 3.2 | 1.6 | 5 | 292 | 3683 |
| Lady's finger | 277 | 6.0 | 2.7* | 2.5 | 317 | 0 |
| Long beans | 276 | 8.0 | 1.4 | 3 | 375 | 5538 |
| Kangkong | 155 | 26.0 | 0.5 | 3 | 174 | 120 |
| Rice | 37 | 100 | 0.5 | - | 207 | 515 |

* Including 2.5 t of lime.
** Others include farm machinery, water, etc.
- implies data are not available.
Source: MARDI (1994). The rice data were taken from Seriam and Abidin (1995).

Fertilizer use on vegetables is high, i.e., more than 1 t/ha, except for kangkong. Pesticide cost, especially in cabbage, is also exorbitant and higher than rice. All vegetables need more labor than do field crops such as rice.

## Economics of Vegetable Cultivation

Vegetable cultivation is a highly profitable venture. The benefit-cost ratio varies from 179% in chili (kulai type) to 13% in lowland cabbage. With few exceptions, the ratios for most vegetables are comparable or higher than rice (Table 10). Asparagus and chili are considered to be high-value crops, as cost per kg of these vegetables is quite high, and by the same token, cabbage and mustard are considered low-value crops (Table 10).

Table 10. Per ha economics of vegetable cultivation in Malaysia

| Crop | Region/(soil type) | Yield (kg) | Gross return (MYR) | Total cost (MYR) | Net benefit (MYR) | Benefit-cost ratio | Cost/kg (MYR) | Source |
|---|---|---|---|---|---|---|---|---|
| Asparagus | Cameron Highlands, Pahang | 13664 | 68320 | 32308 | 36012 | 1.11 | 2.36 | Yam (1988) |
| Asparagus | Perak, Melaka | 10132 | 40528 | 26435 | 14093 | 0.53 | 2.61 | Yam (1988) |
| Cabbage | Tangkak, Johor | 22565 | 5120 | 3090 | 2030 | 0.66 | 0.14 | Foo (1978) |
| Chili (Kulai) | Jalan Kebun, Selangor, (Peat) | 10300 | 34500 | 12350 | 22150 | 1.79 | 1.20 | Melor (1995) |
| Chili (MC4) | Jalan Kebun, Selangor, (Peat) | 9300 | 27900 | 12350 | 15550 | 1.26 | 1.33 | Melor (1995) |

Contd. Table 10.

| Crop | Region/(soil type) | Yield (kg) | Gross return (MYR) | Total cost (MYR) | Net benefit (MYR) | Benefit-cost ratio | Cost/kg (MYR) | Source |
|---|---|---|---|---|---|---|---|---|
| Long beans | Ipoh, Perak, (Tin tailing) | 12812 | 14990 | 8245 | 6745 | 0.82 | 0.64 | Mahmud (1995) |
| Long beans | Muar, Johor, (Peat) | 8067 | 8874 | 6512 | 2362 | 0.36 | 0.81 | Mahmud (1995) |
| Long beans | Batu Pahat, Johor, (Mineral) | 7506 | 9458 | 7433 | 2025 | 0.27 | 0.99 | Mahmud (1995) |
| Long beans | Rompin, Pahang, (Bris) | 8215 | 8215 | 5227 | 2988 | 0.57 | 0.64 | Mahmud (1995) |
| Mustard | Tangkak, Johor | 48118 | 2223 | 865 | 1358 | 1.57 | 0.02 | Foo (1978) |
| Rice | North West Selangor (Wet seeding) | 4700 | 2331 | 1458 | 873 | 0.60 | 0.31 | Seriam and Abidin (1995) |
| Tomato (FMTT138, MT1, BL699) | Jalan Kebun, Selangor, (Peat) | 36000 | 19440 | 9865 | 9575 | 0.97 | 0.27 | Melor (1995) |

## Factor Share

Estimates of factor share from data reported in different studies conducted under farmers' conditions also suggest that labor share in the total cost is quite substantial, except in mustard. However, pesticide share ranges from 0.9% in asparagus to 12.0% in cabbage (Table 11).

## Income by Cropping Pattern

MARDI has been conducting vegetable farming system research on farmers' plots since 1980 (MARDI 1994). The research estimated returns obtained from seven possible rotations on three different soil types.

On alluvial soils, estimated farm income and returns to labor were highest in a system where two leafy vegetables (cabbage, cauliflower) were rotated with fruit vegetables (long beans, bitter gourd) followed by intercropping of three vegetables (two fruit vegetables with a leafy vegetable). The vegetable farming system of cabbage-cauliflower-bitter gourd was found to increase income by more than 100% compared to a traditional system of cucumber-long beans-bitter gourd. However, introduction of a leafy vegetable in a basically fruit vegetable system was not found to increase monthly income significantly.

A comparison of farm income for several vegetable production systems on peat soils suggested that highest incomes are generated when a tomato-cabbage rotation is followed by a chili-cabbage rotation.

Table 11. Review of factor share (%) in selected vegetables in Malaysia

| Crop | Region/(soil type) | Year | Labor | Fertilizer | Farm manure | Pesticide | Others | Reference |
|---|---|---|---|---|---|---|---|---|
| Asparagus | Cameron Highlands, Pahang | 1987 | 54.6 | 5.8 | 15.0 | 1.2 | 23.4 | Yam (1988) |
| Asparagus | Perak, Melaka | 1987 | 53.5 | 6.0 | 18.5 | 0.9 | 21.1 | Yam (1988) |
| Cabbage | Tangkak, Johor | 1978 | 219.0 | 6.6 | 10.0 | 2.0 | 42.4 | Foo (1978) |
| Chili (MC4, Kulai) | Jalan Kebun, Selangor, (Peat) | 1995 | 143.7 | 7.8 | 3.2 | 5.7 | 29.6 | Melor (1995) |
| Long beans | Ipoh, Perak, (Tin tailing) | 1995 | 151.9 | 7.6 | 10.0 | 1.0 | 19.5 | Mahmud (1995) |
| Long beans | Muar, Johor, (Peat) | 1995 | 122.5 | 4.2 | 10.0 | 0.0 | 53.3 | Mahmud (1995) |
| Long beans | Batu Pahat, Johor, (Mineral) | 1995 | 146.2 | 4.7 | 0.0 | 9.7 | 29.4 | Mahmud (1995) |
| Long beans | Rompin, Pahang, (Bris) | 1995 | 342.8 | 5.9 | 0.0 | 9.0 | 12.3 | Mahmud (1995) |
| Mustard | Tangkak, Johor | 1978 | 27.6 | 5.0 | 0.0 | 6.3 | 61.1 | Foo (1978) |
| Tomato (FMTT138, MT1, BL699) | Jalan Kebun, Selangor, (Peat) | 1995 | 36.0 | 7.1 | 4.1 | 3.5 | 49.3 | Melor (1995) |

Vegetable farming systems on bris soil, especially in Kelantan, involve tobacco and watermelon. These crops are traditionally grown in that order after the north-east monsoon. Highest incomes are obtained when these crops are followed by chili, cabbage, and cucumber, or chili and Chinese mustard in an annual cycle. Both cucumber and Chinese mustard appear to be better than long beans as a fourth crop after tobacco-watermelon-chili.

The Federal Agricultural Marketing Authority (FAMA) also used to publish market potential reports for individual vegetable species in the 1970s under the Green Book program, but these reports were discontinued. More recent studies on farm profitability for vegetable cultivation include the following:

Midmore et al. (1996) found that 25% of farmers in the Cameron Highlands lose money. Per hectare farm income and scale of production are unrelated; nor is farm income related to annual volumes of manure, lime or fertilizer, types of ownership, slope of land (natural or man-made), or to soil physical composition.

Other farm profitability studies include those based on farming system practices. The potential of vegetables to enhance incomes from mono paddy cropping on 0.9 ha was studied by Normiyah and Munir (1994). Among the several enterprise combinations considered for paddy land, the one comprising watermelon planted in the first three months on all the land, followed by 0.75 ha of vegetables in the next three months, was shown to generate the highest return.

Mustaffa (1990) computed farm family incomes from cropping system trials on marginal soils, which include acid sulphate, alluvial, and bris soil. Incomes from vegetables under alluvial and bris soils were also estimated. A tomato–long beans rotation was found to generate the highest income, followed by chili–cabbage intercropping on acid sulphate soil.

### Sustainable Vegetable Production

In the context of vegetable production in Malaysia, the sustainability issue becomes extremely important since a substantial portion of the vegetables consumed are produced on the highlands (Fuad 1993). Starting in 1979, the World Bank funded a program to test various soil conservation practices for highland crops, including vegetables. The impact of the program was assessed by the Asian Vegetable Research and Development Center (AVRDC) in collaboration with MARDI in 1991. The major objective of the evaluation was to determine the extent of adoption of erosion control practices and factors influencing adoption, in particular, cropping system, soil type, slope, size of holding, land ownership, and history of cultivation. The short term costs of erosion control practices were assessed and compared with the long term benefits to farmers and water and energy users (Midmore et al. 1996).

In opening up new areas for vegetable cultivation, farmers use tractors to level the steep terrain. Top-soil is removed and used to fill other areas. In areas where the terrain is steep, terraces are constructed with varying width according to the gradient of the slope. Except for the use of sandbags for soil conservation on some farms, farmers show less concern to slow errosion.

Fuad (1993) examined the prospects for diversification and commercialization of upland agriculture by floriculture, vegetables, and fruits. For a sustainable development of upland agriculture, the following suggestions were made:

(l) allow agricultural activities only in areas having the "least" adverse impact on the environment;

(2) discourage vegetable cultivation on open terrace benches on steep slopes; but encourage use of rain shelters which intensify crop cycles and increase yields;

(3) extend appropriate cropping systems and efficient use of fertilizers and chemicals with integrated management practices; and

(4) review the existing land tenancy policy to provide security of land tenure, which in turn would encourage investment in conservation practices.

## Marketing System

During 1986-90, several studies on vegetable markets were carried out. The project entitled "Marketing Systems of Vegetable in Johor" identified marketing agents and their behavior, market structures and regulations, and commodity flows in the vegetable marketing system in the southern state of Johor (Neguib 1988). Ahmad et al. (1992) identified and evaluated major changes in the Singapore market that were expected to affect vegetable cultivation in Malaysia. The study found that consumers in Singapore emphasize quality over price; suggesting a need for improved packaging, presentation, and quality of Malaysian vegetables. The study provides vital information to marketers and R&D institutions.

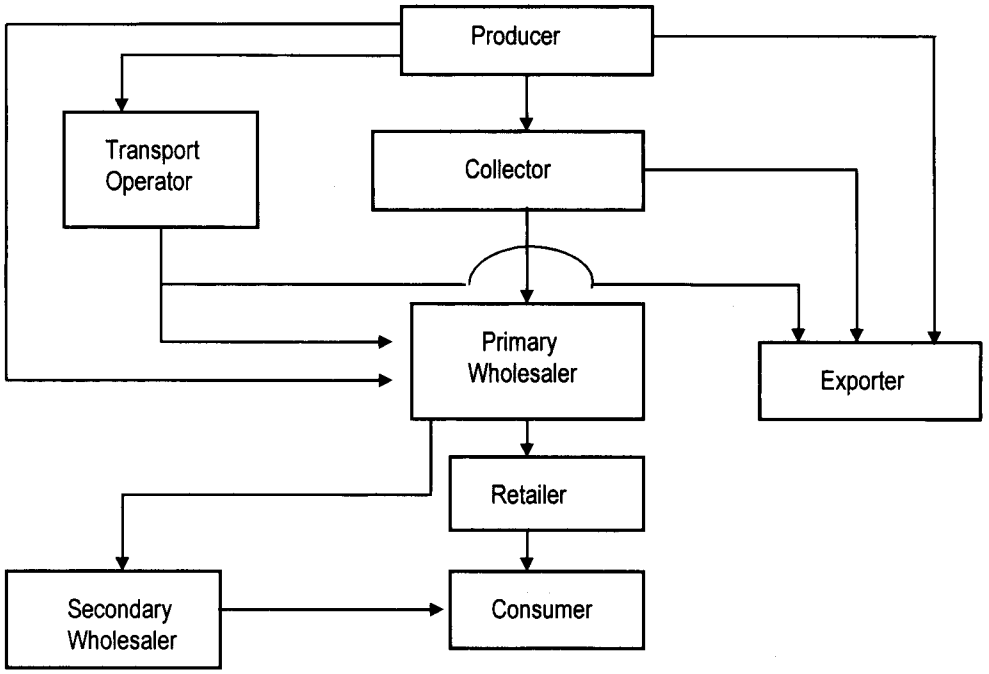
The National Vegetable Workshop, held in 1985, delved into the economics of the vegetable industry in Malaysia. Wong (1985) evaluated the marketing system for vegetables within the context of its constraints and strategies.

Groome and Lee (1990) described the consumption pattern and marketing of vegetables in Miri, Sarawak. An interesting feature in the marketing of vegetables in Miri is the virtual absence of middlemen – the primary producer acts as wholesaler and retailer.

The Federal Agricultural Marketing Authority is also in the forefront in developing an integrated market information systems (MIS) for horticulture. The development of a MIS for perishable products like vegetables would enhance market efficiency. Fauzi and Hasmiah (1992) developed a conceptual framework for computerization of MIS for the horticulture industry in Malaysia, and identified the scope and limitations of such a system.

## Marketing Channels

Vegetables produced in Malaysia for the domestic market pass through traditional market channels involving different marketing agents, such as farm-level collectors, lorry operators, and wholesalers based in the major urban centers. Very few farmers have direct links with wholesalers in the major urban centers, or with consumers, except through farmers' markets. Such markets have been established in almost all consumption centers in the country since 1985. The continued dominance of the traditional marketing channels (Fig. 4) is attributed to a number of factors, including matured business relationships, credit ties, and presence of various guilds and chambers of commerce.




Source: Mukhtiar (1994).

Fig. 4. Vegetable marketing channels in Malaysia

The private sector is pervasive in vegetable marketing in Malaysia. This free enterprise system does not mean, however, that adequate competition exists. Despite many wholesalers being present in every market (Table 12), market power is believed to concentrate in the hands of a few in the major

urban centers. This concentration of power is reinforced and perpetuated by a number of factors, including barriers to entry, such as high capital requirement, strong traditional linkages, inadequate market facilities, and, to a certain extent, lack of timely market information.

Table 12. Number of vegetable marketing agents by state in Peninsular Malaysia, 1991

| State | Farmers | Wholesalers | Retailers* |
|---|---|---|---|
| Johor | 1688 | 178 | 2036 |
| Kedah | 835 | 49 | 218 |
| Kelantan | 1610 | 184 | 1753 |
| Melaka | 650 | 72 | 444 |
| Negeri Sembilan | 179 | 14 | 510 |
| Pahang | 2568 | 157 | 3897 |
| Perak | 2433 | 144 | 3175 |
| Perlis | 97 | 12 | 233 |
| Pinang | 441 | 30 | 398 |
| Selangor & Federal Territory | 1172 | 277 | 3671 |
| Terengganu | 1364 | 71 | 2149 |

* Includes farmers' markets, night markets and retail markets.
Source: FAMA (1992).

Vegetables are marketed largely on a consignment basis whereby the price received by farmers is known only after the produce is sold, a day or two after delivery. The risk therefore lies with producers. While the consignment system has been recognized as a fairly effective system for handling vegetables, it has forced farmers to be price takers after delivery. This contributes to lack of market transparency in term of prices, seasonal preferences, quality standards, timing, and quantities required by consumers.

This is not to deny some positive benefits of the consignment system. Perishability, quality variability, lack of standardization, and incidence of oversupply sometimes necessitate consignment arrangements between farmers and wholesalers. Under the system, wholesalers are, therefore, more prepared to accept vegetables of varying qualities and quantities as their risk is reduced.

With only three well-equipped wholesale markets, handling an estimated 900 t of vegetables daily, Malaysia has limited facilities for bulk disposal of vegetables. Although wholesaling is also carried out at other strategic locations, infrastructure is lacking.

## Marketing Costs and Margins

Marketing margins for leafy vegetables are generally higher than for fruit vegetable. Margins are in the range of 64-81% of the retail price in the case of leafy vegetables and 49-61% for fruit vegetables (Table 13). The higher margins for leafy vegetables are partly due to higher marketing costs, such as transport, and post-harvest losses, incurred by intermediaries, especially retailers. The weight loss for leafy vegetables can be as high as 30-40% compared to 20 % for fruit vegetables.

Table 13. Percentage distribution of consumer price, and marketing margin for important vegetables in Johor, 1990

| Vegetable | Farm | | | Wholesale | | | Retail | | | Marketing |
|---|---|---|---|---|---|---|---|---|---|---|
| | Profit | Costs | Total margin | Profit | Costs | Total margin | Profit | Costs | Total margin | margin[1] |
| Cabbage | 32.7 | 3.4 | 36.1 | 25.4 | 2.4 | 27.8 | 27.0 | 9.1 | 36.1 | 63.9 |
| Chili | 48.0 | 3.2 | 51.2 | 33.3 | 3.9 | 37.2 | 7.5 | 4.1 | 11.6 | 48.8 |
| Chinese mustard | 16.2 | 2.6 | 18.8 | 33.5 | 9.9 | 43.4 | 26.6 | 11.2 | 37.8 | 81.2 |
| Cucumber | 42.1 | 1.8 | 43.9 | 17.8 | 11.2 | 29.0 | 17.8 | 9.3 | 27.1 | 56.1 |
| Eggplant | 48.7 | 1.6 | 50.3 | 22.8 | 4.7 | 27.5 | 14.6 | 7.6 | 22.2 | 49.7 |
| French beans | 44.6 | 3.2 | 47.8 | 15.4 | 9.0 | 24.4 | 16.7 | 11.1 | 27.8 | 52.2 |
| Kangkong | 24.1 | 7.0 | 31.1 | 33.3 | 6.1 | 39.4 | 23.4 | 6.1 | 29.5 | 68.9 |
| Lady's finger | 40.3 | 1.4 | 41.7 | 26.8 | 3.7 | 30.5 | 22.1 | 5.7 | 27.8 | 58.3 |
| Long beans | 34.8 | 4.7 | 39.5 | 14.6 | 8.1 | 22.7 | 26.1 | 11.7 | 37.8 | 60.5 |
| Spinach | 18.4 | 4.1 | 22.5 | 30.2 | 6.5 | 36.7 | 27.1 | 13.7 | 40.8 | 77.5 |
| Tomato | 38.8 | 2.5 | 41.3 | 22.2 | 3.1 | 25.3 | 29.7 | 3.7 | 33.4 | 58.7 |

[1]The marketing margin is the sum of profit and marketing costs of only wholesalers and retailers.
Note: Costs refer to marketing costs.
Source: FAMA (1990).

The retailers' margin is larger than the wholesalers' in spinach, cabbage, long beans, tomato, and French beans. However, the opposite is true for Chinese mustard, kangkong, lady's finger, cucumber, eggplant, and chili (Table 13).

A study on cost and marketing margins (FAMA 1990) showed that marketing cost is a small proportion of the retail price compared to profits earned by wholesalers and retailers. In this study, the retailers' profit varied from 7.5% of the retail price in chili to 30% in tomato, while wholesalers' profit varied from 15% of the retail price in long beans to about one third in Chinese mustard, spinach, kangkong, and chili (Table 13).

Profit of the retailers and wholesalers is perceived as a fixed proportion of the prices they pay, and is normally considered to be exorbitant. However, when the marketing margin (including marketing cost and profit) at a particular market level was regressed on the prices the marketing agents pay, negative relationships were found in all vegetables at both the wholesale and retail levels (Table 14). This suggests that as the prices that marketing agents pay increase, they have to reduce the margin. Because marketing costs are generally fixed, this implies that as prices rise, marketing agents are forced to reduce their profits.

The negative relationships between marketing margin and prices are generally stronger and statistically more significant at the retail level than at the wholesale level (Table 14), suggesting that marketing margins, though high, are more competitive at the retail level. The relationships at the retail level are generally higher than 0.7, implying that a 1% increase in the prices retailers have to pay would force them to reduce marketing margin (mainly their profit) by 0.7%.

Table 14. Relationship between marketing margin and prices, 1989-93[1]

| Vegetable | Market level | |
|---|---|---|
| | Wholesale | Retail |
| Cabbage | -0.39 | -0.71*** |
| Chili | -0.51*** | -0.80*** |
| Cucumber | -0.45 | -0.70*** |
| Kangkong | -0.53 | -0.56*** |
| Lady's finger | -0.25 | -0.85*** |
| Long beans | -0.05 | -1.04*** |
| Mustard | -0.52 | -0.79*** |
| Spinach | -0.13 | -0.75*** |

[1]Dependent variable=natural log of monthly margin; Independent variable=natural log of monthly prices marketing agents pay.
Source: Estimated from monthly data reported in FAMA, various issues[a] (1985-1994).
*** implies the coefficients are significant at the 1% level.

Total marketing margins in eggplant, French beans, long beans, spinach, and tomato dropped significantly during 1985-94. The reduction in the total margins for spinach was due to greater reduction in margin at the wholesale level, while reduction in the total margins for eggplant, French beans, long beans, and tomato, were due to greater reduction in margins at the retail level. The increase in the wholesale margin in chili was offset by a decrease in the retail margin, while the opposite was true for kangkong. There was no change in any margin for Chinese mustard, cucumber, and lady's finger (Table 15).

Table 15. Growth in marketing margins (%/annum) for selected vegetables, 1985-94

| Vegetables | Wholesale | Retail | Total |
|---|---|---|---|
| Cabbage | 5.20** | -2.68** | 0.62 |
| Chili | 3.41*** | -2.39 | 0.32 |
| Chinese Mustard | -0.17 | -0.91 | -0.63 |
| Cucumber | 0.86 | -0.80 | -0.16 |
| Eggplant | -2.93 | -3.53*** | -3.23** |
| French beans | 0.09 | -3.97*** | -2.09* |
| Kangkong[a] | 2.34** | -2.58** | -0.64 |
| Lady's finger | 0.40 | -0.34 | -0.32 |
| Long beans | 1.35 | -3.85*** | -1.50** |
| Spinach | -1.01 | -0.73 | -0.89* |
| Tomato | -1.19 | -1.74 | -1 53* |

[a] Kangkong is estimated for the period 1987-94.
Source: Estimated from data reported in FAMA, various issues[c] (1980-88, 1994).
***, **, * imply the coefficients are significant at the 1%, 5%, and 10% level, respectively.

## International Trade

Malaysia is a net importer of vegetables, and the trade deficit is growing due to rapid increase in the value of imported vegetables and slow increase in the value of exported vegetables (Table 16). Importation of vegetables increased from 381,100 t valued at 108.2 million MYR in 1980 to 551,600 t valued at 560.4 million MYR in 1995. Potatoes, onions, shallot, and garlic accounted for 70% of the import value. While a major portion of these imports are for vegetables which cannot be produced competitively in Malaysia, the high and increasing import figure is of grave concern to the country. An alarming development is the increase in importation of cabbage and tomato, which had traditionally been produced locally. This trend might indicate deterioration in Malaysia's comparative advantage in producing these vegetables.

In terms of exports, the vegetable industry contributed 100.9 million MYR to foreign exchange earnings in 1995, compared to 30.3 million MYR in 1980 (Table 16). More than 20 vegetable species were exported, but cucumber, Chinese mustard, long beans, chili, and spinach were the major exports during 1995.

Table 16. Export, import, and trade deficit in vegetables (quantity in 000 t and value in million MYR), 1980-95

| Year | Export | | Import | | Deficit | |
|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value |
| 1980 | 98.7 | 30.3 | 381.1 | 108.2 | 282.4 | 77.9 |
| 1981 | 123.9 | 41.4 | 437.0 | 142.0 | 313.1 | 100.6 |
| 1982 | 11.1 | 33.8 | 411.2 | 190.1 | 400.1 | 156.3 |
| 1983 | 101.8 | 34.6 | 238.5 | 201.3 | 136.7 | 166.7 |
| 1984 | 2.2 | 1.7 | 126.3 | 206.5 | 124.1 | 204.8 |
| 1985 | 109.1 | 30.6 | 285.1 | 211.0 | 176.0 | 180.4 |
| 1986 | 118.6 | 34.6 | 284.8 | 226.5 | 166.2 | 191.9 |
| 1987 | 143.2 | 41.3 | 279.7 | 216.4 | 136.5 | 175.1 |
| 1988 | 202.0 | 59.9 | 354.6 | 273.8 | 152.6 | 213.9 |
| 1989 | 170.8 | 78.8 | 607.7 | 297.9 | 436.9 | 219.1 |
| 1990 | 179.2 | 76.2 | 612.0 | 305.8 | 432.8 | 229.6 |
| 1991 | 78.8 | 43.0 | 513.4 | 346.3 | 434.6 | 303.3 |
| 1992 | 93.8 | 59.7 | 433.4 | 352.1 | 339.6 | 292.4 |
| 1993 | 203.1 | 108.8 | 520.4 | 412.2 | 317.3 | 303.4 |
| 1994 | 189.7 | 94.8 | 547.9 | 443.0 | 358.2 | 348.2 |
| 1995 | 265.0 | 100.9 | 551.6 | 560.4 | 286.6 | 459.5 |

Source: For 1980-92, Ministry of Agriculture, various issues (1980-1992). For 1993-95, Department of Statistics, various issues (1993-1995).
Note: The imports and exports include potatoes and other tubers.

Malaysian vegetable exports are narrowly focused on the Singapore market, with little success at penetration into other markets, such as Hong Kong and Japan (Table 17). Any undesirable change in Singapore's bilateral trade in vegetables could seriously undermine the Malaysian vegetable industry.

Table 17. Contribution of trading countries (%) in total vegetable import and export

| Country | Export | | | | Import | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | | 1994 | | 1990 | | 1994 | |
| | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value |
| Australia | - | - | - | - | 21.0 | 47.0 | 67.7 | 79.8 |
| Brunei | 1.1 | 4.3 | 2.8 | 21.5 | - | - | - | - |
| China | - | - | - | - | 7.0 | 8.1 | 13.6 | 7.8 |
| Indonesia | - | - | - | - | 38.8 | 13.6 | 7.3 | 5.4 |
| Singapore | 98.5 | 90.3 | 97.1 | 78.2 | - | - | - | - |
| Taiwan | - | - | - | - | 7.2 | 8.0 | 0.9 | 0.4 |
| Thailand | - | - | - | - | 19.5 | 14.3 | 7.5 | 2.3 |
| Others | 0.4 | 5.4 | 0.1 | 0.3 | 6.5 | 9.0 | 3.0 | 4.3 |

Source: Official files of FAMA, time series data on vegetables from 1985 through 1994.

Imports are more diversified than exports, although they are also coming more and more from Australia (Table 17). Australia's share of Malaysia's imports increased steadily, from 47% in 1991 to 80% in 1994, while the shares of Taiwan, Thailand, and Indonesia decreased steadily during this period. More than 20 vegetable species were imported, but major imports were cabbage, carrot, cauliflower, chili, and tomato in 1993.

## Supply and Demand

### Availability

The annual per capita availability of vegetables doubled from 23.6 kg in 1983 to 44.4 kg in 1995. The major jump came during 1988-90 when availability increased from 23 kg to 52 kg. However, since then it has stagnated. The contribution of domestic production to the net availability ranged from 49% in 1985 to 74% in 1988 (Table 18). The contribution of imports in availability is relatively high as compared to other South Asian and Southeast Asian countries.

Vegetables have been assessed as having high potential for the domestic market (Mukhtiar 1992). This is reflected in the increase in vegetable availability over time. The domestic potential could be exploited further considering the relatively low annual per capita availability in Malaysia (about 44 kg in 1995) compared to Taiwan (154 kg) and South Korea (229 kg) (this book).

Table 18. Per capita availability of vegetables in Peninsular Malaysia, 1983-95[a]

| Year | Production[b] (000 t) | Import[b] (000 t) | Export[b] (000 t) | Net availability[c] (000 t) | Population (million) | Per capita availability (kg/annum) | Share of production (%) in availability |
|---|---|---|---|---|---|---|---|
| 1983 | 175.0 | 186.2 | 80.3 | 280.9 | 11.9 | 23.6 | 62.3 |
| 1984 | 169.1 | 242.2 | 84.6 | 326.7 | 12.2 | 26.8 | 51.8 |
| 1985 | 133.2 | 224.0 | 86.7 | 270.5 | 12.5 | 21.6 | 49.3 |
| 1986 | 172.2 | 228.2 | 94.7 | 305.7 | 12.8 | 23.9 | 56.3 |

Contd. Table 18.

| Year | Production[b] (000 t) | Import[b] (000 t) | Export[b] (000 t) | Net availability[c] (000 t) | Population (million) | Per capita availability (kg/annum) | Share of production (%) in availability |
|---|---|---|---|---|---|---|---|
| 1987 | 174.4 | 229.1 | 126.5 | 277.0 | 13.1 | 21.1 | 63.0 |
| 1988 | 227.5 | 268.3 | 189.1 | 306.7 | 13.5 | 22.7 | 74.2 |
| 1989 | 356.5 | 347.6 | 157.6 | 546.5 | 13.8 | 39.6 | 65.2 |
| 1990 | 385.9 | 515.8 | 167.9 | 733.8 | 14.2 | 51.7 | 52.6 |
| 1991 | 386.3 | 431.7 | 74.2 | 743.8 | 14.6 | 50.9 | 51.9 |
| 1992 | 370.3 | 342.0 | 88.8 | 623.5 | 14.9 | 41.8 | 59.4 |
| 1993 | 382.7 | 415.6 | 203.0 | 595.3 | 15.3 | 38.9 | 64.3 |
| 1994 | 399.2 | 531.9 | 183.0 | 748.1 | 15.7 | 47.6 | 53.4 |
| 1995 | 430.0 | 541.6 | 255.0 | 716.6 | 16.1 | 44.5 | 60.0 |

[a] The production figures are for 15 major vegetables in Peninsular Malaysia. Population is also for Peninsular Malaysia. However, this production accounts for up to 80% of the total vegetable production in the country.
[b] The production, imports, and exports exclude potato and sweet potato.
[c] Estimated as production - export + import.

## Consumption

Increase in population and incomes, accompanied by greater health awareness, have contributed to a modest rise in the consumption of vegetables from 38.4 kg in 1982 to 49.4 kg in 1991 (Table 19). Thus, increase in per capita availability might not be as great as shown by the production statistics earlier. It might be due to an improvement in the data collection procedures, instead.

Table 19. Per capita annual consumption (kg) of vegetables in Malaysia during 1982-1991

| Vegetable | 1982 | 1985 | 1988 | 1991 |
|---|---|---|---|---|
| Angled loofah | 0.95 | 0.78 | 0.91 | 1.03 |
| Bitter gourd | 0.90 | 0.89 | 0.85 | 0.54 |
| Cabbage | 2.70 | 3.78 | 4.47 | 4.65 |
| Carrot | 0.41 | 0.48 | 0.64 | 0.73 |
| Cauliflower | 0.31 | 0.29 | 0.34 | 0.35 |
| Chili | 2.50 | 2.10 | 2.48 | 1.82 |
| Chinese cabbage | 0.60 | 0.59 | 0.76 | 0.51 |
| Chinese mustard | 4.06 | 3.79 | 4.88 | 5.97 |
| Cucumber | 3.14 | 3.25 | 3.94 | 3.28 |
| Dry chili | - | 0.46 | 0.51 | 0.45 |
| Eggplant | 1.93 | 1.36 | 1.46 | 1.58 |
| French beans | 0.93 | 0.96 | 1.07 | 1.24 |
| Garlic | 0.71 | 0.96 | 1.61 | 1.03 |
| Ginger | 0.32 | 0.35 | 0.36 | 0.32 |

Contd. Table 19.

| Vegetable | 1982 | 1985 | 1988 | 1991 |
|---|---|---|---|---|
| Kale | 0.30 | 0.34 | 0.86 | 0.77 |
| Kangkong | 1.68 | 2.43 | 2.64 | 2.90 |
| Lady's finger | 1.07 | 1.39 | 1.29 | 1.35 |
| Lettuce | 0.23 | 0.15 | 0.22 | 0.20 |
| Long beans | 3.20 | 3.58 | 3.64 | 4.16 |
| Onion | 4.20 | 5.32 | 5.77 | 4.55 |
| Potato | 2.73 | 2.21 | 2.90 | 2.43 |
| Pumpkin | 0.25 | 2.56 | 0.64 | 0.51 |
| Radish | 0.26 | 0.24 | 0.30 | 0.30 |
| Spinach | 1.75 | 2.37 | 2.67 | 2.45 |
| Tomato | 1.06 | 0.95 | 0.85 | 0.49 |
| White mustard | 0.49 | 0.63 | 0.85 | 0.61 |
| Yam bean | 0.44 | 0.42 | 0.48 | 0.41 |
| Others | 1.29 | 4.57 | 4.89 | 4.73 |
| Total | 38.41 | 47.20 | 52.28 | 49.36 |

Source: FAMA, various issues[b] (1982, 1985, 1988, and 1991).
- implies data are not available.

## Consumption by Income Group

The household consumption survey conducted by FAMA has exposed the vegetable consumption pattern by income groups (Table 20). Short of a deeper analysis, data shown in the table suggest that higher income groups consume more vegetables compared to the lower income groups, although the difference is not significant among the middle income groups in the range of 1001-3000 MYR and very high income groups of more than 3000 MYR. Moreover, the percentage of expenditure on vegetables as a proportion of food expenditure is a declining function of income.

Table 20. Per capita annual consumption (kg) by income group in Malaysia, 1991

| Vegetable | Income | | | | | | |
|---|---|---|---|---|---|---|---|
| | < MYR501 | MYR501 - MYR1000 | MYR1001 - MYR1500 | MYR1501 - MYR2000 | MYR2001 - MYR3000 | MYR3001 - MYR5000 | > MYR5000 |
| Angled loofah | 0.97 | 1.12 | 1.10 | 0.42 | 0.69 | 0.53 | 0.64 |
| Bitter gourd | 0.21 | 0.67 | 0.52 | 0.76 | 0.45 | 0.15 | 0.16 |
| Cabbage | 2.63 | 2.65 | 2.70 | 2.79 | 3.21 | 3.41 | 2.95 |
| Carrots | 0.23 | 0.69 | 1.03 | 1.54 | 1.10 | 2.20 | 1.15 |
| Cauliflower | 0.14 | 0.34 | 0.58 | 0.78 | 1.08 | 0.59 | 0.13 |
| Chili | 2.13 | 2.27 | 2.66 | 2.54 | 2.05 | 1.83 | 2.49 |
| Chinese cabbage | 0.26 | 0.55 | 0.86 | 0.81 | 0.82 | 1.37 | 1.55 |
| Cucumber | 2.75 | 2.46 | 2.13 | 2.08 | 2.02 | 1.79 | 1.26 |

Contd. Table 20.

| Vegetable | Income | | | | | | |
|---|---|---|---|---|---|---|---|
| | < MYR501 | MYR501 - MYR1000 | MYR1001 - MYR1500 | MYR1501 - MYR2000 | MYR2001 - MYR3000 | MYR3001 - MYR5000 | > MYR5000 |
| Eggplant | 1.64 | 1.58 | 1.50 | 1.60 | 1.66 | 1.20 | 1.42 |
| French beans | 0.58 | 1.14 | 1.64 | 2.03 | 2.74 | 3.13 | 1.42 |
| Garlic | 1.05 | 1.08 | 1.24 | 1.22 | 1.14 | 1.56 | 1.73 |
| Ginger | 0.34 | 0.28 | 0.31 | 0.34 | 0.24 | 0.25 | 0.43 |
| Kale | 0.15 | 0.77 | 1.45 | 1.34 | 2.18 | 1.21 | 3.61 |
| Kangkong | 2.21 | 1.98 | 1.73 | 1.46 | 1.58 | 1.97 | 2.27 |
| Lady's finger | 0.98 | 1.33 | 1.70 | 1.65 | 1.10 | 2.42 | 1.09 |
| Lettuce | 0.05 | 0.15 | 0.25 | 0.22 | 0.29 | 0.26 | 0.19 |
| Long beans | 4.72 | 4.93 | 5.13 | 5.33 | 3.69 | 5.23 | 2.23 |
| Pakchoi | 3.35 | 3.95 | 4.31 | 4.18 | 4.48 | 4.76 | 5.00 |
| Pumpkin | 0.38 | 0.54 | 0.64 | 0.66 | 0.63 | 0.60 | 1.05 |
| Radish | 0.11 | 0.30 | 0.35 | 0.31 | 0.21 | 0.17 | 0.00 |
| Shallot | 4.44 | 4.27 | 4.30 | 4.47 | 4.78 | 5.19 | 4.97 |
| Spinach | 1.98 | 3.01 | 3.27 | 3.18 | 3.19 | 3.33 | 1.93 |
| Tomato | 0.35 | 0.81 | 1.50 | 2.28 | 1.80 | 1.43 | 3.10 |
| Yam bean | 0.13 | 0.59 | 0.49 | 0.32 | 0.21 | 0.34 | 0.00 |
| Others | 0.58 | 0.96 | 1.32 | 1.13 | 1.16 | 3.00 | 5.81 |
| Total | 32.36 | 38.42 | 42.71 | 43.44 | 42.50 | 47.92 | 46.58 |

Source: FAMA (1991).

## Consumption by Region

Baring a few exceptions, more vegetables are consumed in urban areas than in rural areas (Table 21). Thus, additional vegetable demand is expected in Malaysia as urbanization proceeds at a faster rate through the 21st century.

Almost all vegetables are consumed more in the urban areas, except angled loofah, cucumber, eggplant, ginger, pumpkin, and kangkong, which are more preferred by rural people. Stronger urban preference for cabbage and pakchoi is evident from the table.

Table 21. Per capita annual consumption (kg) of vegetables by rural and urban groups in Malaysia, 1991

| Commodity | Urban | Rural |
|---|---|---|
| Angled loofah | 0.89 | 1.07 |
| Bitter gourd | 0.55 | 0.46 |
| Cabbage | 5.91 | 2.69 |
| Carrots | 0.99 | 0.42 |
| Cauliflower | 0.59 | 0.19 |
| Chili | 2.77 | 2.23 |
| Chinese cabbage | 0.72 | 0.40 |
| Cucumber | 2.40 | 3.54 |
| Eggplant | 1.38 | 1.73 |
| French beans | 1.48 | 0.91 |
| Garlic | 1.30 | 0.92 |
| Ginger | 0.28 | 0.32 |
| Kale | 1.16 | 0.45 |
| Kangkong | 1.88 | 2.27 |
| Lady's finger | 1.53 | 1.11 |
| Lettuce | 0.25 | 0.13 |
| Long beans | 5.21 | 4.03 |
| Pakchoi | 9.11 | 3.51 |
| Pumpkin | 0.41 | 0.61 |
| Radish | 0.32 | 0.21 |
| Shallot | 4.83 | 4.17 |
| Spinach | 3.36 | 2.34 |
| Tomato | 1.27 | 0.64 |
| Yam bean | 0.45 | 0.37 |
| Others | 1.09 | 0.83 |
| Total | 50.13 | 35.55 |

Source: FAMA (1991).

More glaring differences in vegetable consumption are seen across regions in Malaysia. For example, annual per capita consumption of pakchoi is 14.5 kg in Persekutuan, compared to only 3.6 kg in Kelantan (Table 22).

## Price and Income Elasticities

Only one estimate on demand elasticities is available (Saharan and Ahmad 1994). The demand elasticity for potato reported in the study is fairly inelastic (-0.2). However, data collected in periodic FAMA consumption surveys can be used to estimate a complete set of demand elasticities for vegetables.

Table 22. Per capita annual consumption (kg) of individual vegetables in selected states of Malaysia, 1991

| Vegetable | Johor | Kedah | Sarawak | Persekutuan | Sabah | Kelantan |
|---|---|---|---|---|---|---|
| Angled loofah | 0.92 | 1.11 | 2.24 | 0.16 | 1.35 | 1.31 |
| Bitter gourd | 0.56 | 0.35 | 1.61 | 0.23 | 1.13 | 0.04 |
| Cabbage | 4.61 | 4.18 | 3.01 | 5.52 | 6.33 | 3.74 |
| Carrots | 0.59 | 0.58 | 0.38 | 1.36 | 1.10 | 0.04 |
| Cauliflower | 0.20 | 0.24 | 0.18 | 0.90 | 0.25 | 0.29 |
| Chinese cabbage | 0.34 | 0.28 | 0.54 | 0.94 | 0.92 | 0.01 |
| Cucumber | 2.72 | 4.06 | 3.08 | 2.04 | 5.14 | 3.04 |
| Eggplant | 1.65 | 1.10 | 2.87 | 1.25 | 3.36 | 2.43 |
| French beans | 0.91 | 1.07 | 1.58 | 2.70 | 2.22 | 0.07 |
| Kale | 0.39 | 0.39 | 2.00 | 1.03 | 1.60 | 0.01 |
| Kangkong | 3.30 | 2.64 | 2.84 | 2.80 | 3.55 | 1.65 |
| Lady's finger | 1.33 | 1.78 | 1.50 | 1.91 | 0.32 | 0.27 |
| Lettuce | 0.21 | 0.02 | 0.04 | 0.34 | 0.13 | 0.02 |
| Long beans | 4.82 | 2.59 | 6.38 | 5.82 | 6.08 | 2.50 |
| Pakchoi | 6.23 | 5.74 | 6.04 | 14.52 | 4.60 | 3.62 |
| Pumpkin | 1.08 | 0.65 | 2.00 | 0.15 | 0.50 | 0.04 |
| Radish | 0.13 | 0.65 | 0.33 | 0.04 | 0.01 | 0.11 |
| Spinach | 2.78 | 1.80 | 2.91 | 4.66 | 1.26 | 0.36 |
| Tomato | 0.90 | 1.24 | 0.20 | 1.81 | 1.17 | 0.24 |
| Yam bean | 0.58 | 0.29 | 0.74 | 0.08 | - | - |
| Others | 0.69 | 1.40 | 1.08 | 0.69 | 1.33 | 0.08 |
| Total | 34.94 | 32.16 | 41.55 | 48.95 | 42.35 | 19.87 |

Source: FAMA, various issues[b] (for 1991).
- implies data are not available.

## Policy Issues and Constraints

The National Agricultural Policy (1992-2010) outlines a strategic plan for the vegetable industry to attain a targeted self-sufficiency level of 125% by 2010. Production is expected to increase at 9.3% and 7.1% per annum in the periods 1991-2000 and 2001-2010, respectively, to reach 2.7 million t by the year 2010. The projection predicts that there will be substantial expansion of area under vegetables in the highlands and lowlands. Production will be diversified to include indigenous varieties whose cultivation will be encouraged on a commercial basis.

Demand for quality vegetables is expected to rise as a result of consumers' greater awareness about health and nutrition. Demand for so-called chemical-free vegetables, produced through organic agriculture and minimal use of chemicals, is also expected to increase.

Despite these projections, competition for resources between the agriculture and non-agriculture sectors, as well as within agriculture, might pose a serious challenge to the vegetable industry. The aging of the farm population, and labor shortages, will further aggravate the situation. Rising

production costs might erode any comparative advantage in vegetable production. Competition from neighboring countries has already hurt tomato production and increasing costs have reduced cabbage production. Under such circumstances, a serious government push would be required to keep domestic supply of vegetables increasing. Without such a push, the demand-supply gap will increase, pushing prices higher and/or driving up imports.

Other socioeconomic and institutional constraints include lack of adequate access to land and secure tenure, large fluctuations and uncertainty in prices, inadequate institutional credit facilities for farmers, and ineffective research and extension efforts.

High humidity, prevalent in Malaysia during most of the year, results in greater incidence of pests and diseases. This creates instability in production, and results in excessive use of agrochemicals. Thus, chemical residues on vegetables have become a serious concern of consumers.

Conventional handling techniques and poor infrastructure cause much spoilage of produce. Thus, collection of produce is costly, especially from scattered production areas. Lack of reliable supplies of good quality produce and lack of credit are other major constraints facing the vegetable marketing sector (World Bank 1985).

The vegetable processing industry is extremely small, covering only processing of chili, mushroom, ginger, cabbage, and peas. The major constraints are lack of a consistent supply of quality raw material, and low prices of the finished product (TESD 1989).

## Status and Achievements of Agriculture Research

The Malaysian Agricultural Research and Development Institute is the main organization involved in vegetable research in the country. Universities, the Department of Agriculture, and other institutions conduct research into vegetables. The general strategy for vegetable research involves identification of appropriate technologies capable of increasing yield, and development of efficient management systems in both production and post-harvest handling in order to lower cost.

The Techno-Economic and Social Studies Division (TESD) of MARDI has been involved in the gathering and analysis of data, research planning, industry monitoring, policy analysis, marketing research, and study into resource economics and technology impact. The major thrust of the work is to increase the efficiency of agricultural research by ensuring that the research system continues to be relevant and responsive to the needs of the target clientele groups as well as to national objectives.

Establishment of the Agricultural Statistics and Information System has allowed for the storage, retrieval, and validation of important domestic and international data pertaining to agricultural commodities (including vegetables). The situation and outlook studies (S&O), published annually, cover all commodities and enterprises under MARDI's purview. The S&O for individual commodities are consolidated into a report entitled "Situation and Outlook of the Malaysian Agriculture Sector and Implications on MARDI's Research Priorities." This report forms the basis for the review and planning of MARDI's research programs, formulation of research strategies and programs, and determination of research priorities for each commodity, including vegetables.

Another organization, FAMA, conducts economics research into vegetables, especially on marketing. The daily prices, trading volumes, and other market information, including consumption, recorded by FAMA has increased the scope of vegetable research.

Other institutes conduct research on a wide range of economic issues relating to vegetables. They include agricultural marketing organizations, regional development authorities, central planning agencies, and international development and research organizations. In addition, conferences, seminars, and workshops are held which relate either specifically to vegetables or to the agriculture sector in general. Both macro- and micro-economic perspectives of the vegetable industry are emphasized in these seminars and workshops.

## Achievements of Past Technological Research

The major achievements of technological research and the impact on vegetable production are as follows:

### *Development of Superior Cultivars*

About 2300 accessions of several vegetable types have been collected. High yielding cultivars for lowland and highland cultivation with resistance to common diseases, and having desired quality, have been identified. It is suggested that R&D should concentrate more on high valued and imported vegetables and place less emphasis on leafy species, because leafy vegetables, being perishable, do not face competition from foreign producers.

### *Efficient Production Systems*

A package of technologies for crop husbandry has been developed, including aspects of nutrient requirements and disease and pest control (making use of microbial agents as natural insecticide). The use of reflective mulch in chili cultivation can reduce crop loss due to virus, and increase yield from 6 t/ha to 15-26 t/ha. High-priced vegetable species normally grown in the highlands have been successfully cultivated in the lowlands under rain shelters. The identification of heat tolerant cabbage varieties has promoted production in the lowlands on peat and bris soils, with yield potential exceeding 30 t/ha. There is a need to study adoption constraints in order to help expand the adoption of these yield-enhancing technologies.

### *Pest Management*

Technologies to control diamondback moth, the most serious insect pest affecting the brassicas, have been developed using a combination of biological and chemical methods. This approach has potential to significantly increase marketable yield and profits in cabbage. The number of pesticide applications can be reduced from 9 to 3. The technique is practiced by 70% of farmers in the Cameron Highlands (Syed 1996).

### *Mechanization and Water Management*

Farm implements developed include a seeder, herbicide sprayer, fertilizer injector, and nursery planting machine. Water requirements have been determined and irrigation systems for efficient vegetable production have been designed.

### *Optimum Nutrient Application*

Nutrient uptake by various vegetable species has been determined, and, together with results from fertilizer trials, the information will be used to formulate optimum fertilizer applications for vegetables grown on peat and mineral soils. Diagnostic guides to identify deficiency symptoms for major nutrients and micronutrients in popular vegetable species have also been developed.

### *Post-harvest Technology*

The key to successful marketing of perishable vegetables is good handling and storage. Technologies for primary processing, in-house packing, and storage of cabbage, Chinese mustard, tomato, eggplant, cucumber, long beans, and French beans have been developed.

### *Data Availability*

#### *Area, Production, and Yield*

The statistics on area, production, and yield by individual vegetable variety and region in Peninsular Malaysia are regularly published by the Ministry of Agriculture. However, data for Sabah and Sarawak are not available.

Monthly farm, wholesale, and retail prices of major vegetables, by region, are published regularly by FAMA. However, figures on monthly traded quantities are not available. Therefore, data on prices help to quantify the seasonality in prices, but not in availability.

#### *Trade*

Data on import and export of individual vegetables by destination are published by the Ministry of International Trade and Industry, and compiled by FAMA.

#### *Consumption*

The data on the consumption of individual vegetable species by income group and region are gathered by FAMA every three years through a household consumption survey. However, not all vegetables are included in these surveys. Each survey should quantify all vegetables consumed at different times of the year, along with the prices paid by consumers for each.

## Achievements of Socioeconomic Research

### *Economics of Vegetables*

The input use and economics of vegetables for various soils have been estimated by MARDI. However, these estimates are for the experimental station. Individual studies are available on the economics estimated for farmers' fields, but these studies are not comparable because of differences in time period, place, and methodologies. The economics of vegetables under on-farm conditions need to be estimated by a central organization.

### *Vegetables in the Farming System*

Relative profitability of vegetables under alternative cropping systems, and optimum vegetable-based cropping systems for alternative environments have been identified by MARDI. Information generated has provided a new dimension to efforts in crop diversification. Various vegetable cropping systems have been developed which reduce risk and physical losses, and give high incomes.

### *Marketing Margins*

Marketing margins for important vegetable varieties can be estimated from farm, wholesale, and retail price data. These margins were divided into profits and marketing costs in a FAMA study. However, details of marketing cost, physical losses, and profit are not available. Moreover, to compare efficiency of alternative marketing systems, knowledge of marketing margins for these systems would be required. To know the relative importance of the different market systems, commodity flow in each system would have to be quantified.

### *Demand Forecasts*

Vegetable demand forecasts are mainly based on the expected income and population increases. There is a need to estimate the supply, demand, and income elasticities of individual and total vegetables. This will help to produce more accurate demand projections, and result in better allocation of research resources.

## Summary and Conclusions

This paper provides vital information on the Malaysian vegetable sector, including assessment of trends in production, trade, marketing, consumption, farm management, and policy, and it evaluates the status and achievements of past vegetable research.

The substantial production increase in the late 1980s was mainly due to area expansion, while yield remained unchanged. This caused annual per capita vegetable availability to increase from 23 kg in 1988 to 52 kg in 1990. Since then, total production and per capita availability have remained stagnant or have even declined. The stagnated production in the wake of increasing incomes during the 1990s caused a strong upward pressure on vegetable prices and increased the trade deficit to about 450 million MYR. Despite rising farm prices, domestic supply did not rise, because farm costs, such as labor, fertilizer, insecticide, etc., rose as well.

Higher income groups generally consume more vegetables, suggesting that additional demand will be generated with the fast economic development in the country. More glaring differences exist across regions and between rural and urban populations. Thus, migration to big urban centers, and possible narrowing of regional consumption differences will also create substantial additional demand.

Marketing margins in the vegetable trade are high, mainly accounted for in the high profits of retailers, wholesalers, or both. Our analysis indicates that profits of the marketing agents are not fixed, rather they are negatively correlated with the prices each agent pays. This suggests that these agents do not have as much monopoly power as is perceived. The high profits of marketing agents are probably due to poor infrastructure causing heavy post-harvest losses.

There is bimodal seasonality in vegetable prices, implying a bimodal seasonality in availability. Generally, prices are high during April-June and November-January. Higher seasonality is observed in the prices of more perishable leafy vegetables than in fruit vegetables.

Vegetables are input intensive and require more labor than cereal crops, such as rice. Thus, expansion in vegetable cultivation will generate additional jobs. The benefit-cost ratio is also higher in most vegetables than in field crops. However, high instability in area and yield of most vegetables indicate risk in vegetable cultivation. Thus, stability measures aimed at reducing variation in the area put to vegetables and to reducing variability in yield through stable technologies will go a long way toward expanding vegetable production.

Vegetable cultivation requires many times more cash in hand than does cultivation of other field crops. The major cost items are labor and chemicals. Thus labor- and chemical-saving technologies could help reduce the cost of production.

Other production constraints are high insect pest attack, labor shortage, lack of appropriate mechanical technologies, large fluctuations in prices, inadequate credit, and ineffective research and extension. The marketing constraints include use of conventional post-harvest handling techniques, unreliable supplies, poor infrastructure, and lack of credit.

The government can play a vital role in improving the efficiency of the industry via the following measures: (a) establishment of production and marketing systems; (b) provision of more (and secure) land titles to experienced growers; (c) improvement in growers' access to credit; (d) focusing of R&D on resolving problems of chili production; and (e) training of extension workers to provide specialized services, emphasizing pest and disease control, and correct use of agrochemicals (World Bank 1985).

The Techno-Economic and Social Studies Division of MARDI suggests the following strategies to improve the competitiveness of the vegetable industry:

1) With acute labor shortage and rising labor costs, vegetable production should be capital intensive and operated on a large-scale commercial basis.

2) Exploitation of growth potentials from local and export demand will involve the development of improved post-harvest handling techniques, increasing shelf life, and enhancing product presentation. With improved production and post-harvest practices, Malaysia could compete with producers in Australia, Holland, and other countries.

3) Greater awareness regarding production of chemical-free or minimal-chemical vegetables should be fostered in order to take advantage of expanding demand generated by health-conscious consumers.

4) A standardized system for grading physical attributes and quality should be established, especially for export markets.

## Information Gaps and Future Research Priorities

In Malaysia, future research should focus on:

1) Quantitative assessment of existing and potential constraints to yield and production, and constraints to the adoption of modern technologies.

2) Modeling the operations of the vegetable industry, and assessing the impact of government policies.

3) Estimation of supply, demand, and income elasticities. This will lead to more accurate forecasts of national supply and demand.

4) Economic evaluation of producing "chemical-free" vegetables under various production systems.

5) Assessing the economic potential of indigenous vegetable species.

6) Strengthening the methodologies for the estimation of post-harvest losses with emphasis on developing a complete profile of post-harvest losses for major vegetable species, including identification of causes of these losses.

7) Assessing the private and public cost of alternative vegetable production systems in terms of their capacity to ameliorate environmental problems.

8) Quantitative evaluation of the impact and distribution of the benefits of vegetable research.

9) Monitoring of vegetable consumption by income group and region should be continued. The consumption survey should include all vegetables and the prices consumers pay for each vegetable variety.

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