SRI LANKA

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Introduction

Sri Lanka is an island located between 6° and 10° north of the equator, at the southern tip of the Indian sub-continent. The country has a land area of 6.56 million ha, and a population of 17.6 million (Department of Census and Statistics 1994b). Most people live in rural areas, as the urban population accounts for just 22%. The country's population growth rate is 1.2%, and its per capita income US$652. According to the 1981 census, Sri Lanka has the highest overall literacy in South Asia at 87%. The literacy rate among females is especially impressive at 83%. Agriculture plays a major role in the country's economy. Approximately 21% of the gross domestic product and 23% of the total export earnings are derived from agriculture. It also accounts for 44% of all employment (Central Bank of Sri Lanka 1994). The crop subsector has a large number of small farmers on 1.8 million small holdings. Nearly half of the holdings are less than 0.5 ha (Department of Census and Statistics 1985).

Rice is the dominant crop grown on approximately 732 thousand ha. Other important crops are corn (32,000 ha), mungbean (22,000 ha), cowpea (20,000 ha), groundnut (10,000 ha), and potato (7,000 ha). During 1993, vegetables, including chili and onion but excluding potato and those not reported in the statistics, are grown on 117 thousand ha, producing an output of 656 thousand t worth LKR 7.5 billion (US$156 million). Both tropical and temperate vegetables are grown throughout the year under varying climatic conditions. In addition to the conventional vegetables, tubers such as potato and local yams, pulses such as lentils mungbean, and cowpea, as well as many varieties of green leaves are consumed as vegetables.

In 1993, average per capita food availability in the country was about 800 g/day, of which cereals constituted 45%, vegetables 13%, fresh fruits 1%, livestock products 12%, roots and tubers 6%, oil and fat 12%, and others 10%. Rice is the staple food, accounting for 34% of total consumption (Department of Census and Statistics 1994a). In 1993, average annual per capita availability of vegetables was about 40 kg or 110 g/day, about half the 73 kg/year or 200 g/day recommended by AVRDC.

General Information

Climate

The temperature variation through the year is low with the mean ranging between 21.1 and 31.7°C. The rainfall pattern in Sri Lanka is bimodal with two periods of monsoonal precipitation resulting in two distinct cultivation seasons. The major cultivation season, called Maha, is in October-February. The precipitation during this season comes from the northeast monsoon of October-December. The harvesting period of crops cultivated in Maha is at the end of January, usually a dry period. The second crop season is called Yala and extends from May to July. The rains in this season come from the southwest monsoon during mid-April to June. The remaining months of the year are dry, and almost no cultivation occurs during this period.

Zones and Regions

With in the two main rainy seasons, rainfall distribution across the country is determined by topography. The whole island benefits from the northeast monsoon. The southwest monsoon is intercepted by the central mountains resulting in 2000-5000 ml of rain per year in the highlands and southwest part of the island. This is the "wet" zone of the country covering 1.53 million ha. The "intermediate" zone covering 4.17 million ha receives 2000-2250 ml of rainfall per year, and is hotter than the "wet" zone. The dry zone receives only 900-1000 ml of rain, with the highest temperatures ranging between 28 and 30°C. It covers 0.8 million ha (Table 1).

Table 1. Environmental parameters of major physiographic regions

Zone/region	Elevation (m)	Temperature (°C)	Mean rainfall (mm)
Wet zone			
Up-country	1000-2400	10-15	2500-5000
Mid country	500-1000	15-20	2000-3000
Low-country	0-500	20-25	2000-3000
Intermediate zone			
Up-country	1000-1500	15-22	1500-2250
Mid country	350-500	24-26	1500-2250
Low-country	0-350	25-29	2000-2200
Dry zone			
Low-country	0-300	28-30	900-1000

Source: Perera (1989).

Depending upon the elevation and temperature, these zones can be classified into three distinct physiographic regions. These are lowland, middle, and up-country peneplain. The range of elevation in each region depends upon the rainfall pattern (Table 2).

The soils of Sri Lanka have been surveyed and mapped. Nine soil orders are found in the country. Based on the soil, elevation, and rainfall data, 22 agroecological regions have been identified (Fig. 1). As the combination of soil, rainfall, elevation, and irrigation facilities vary across the regions, it is possible to grow a wide range of vegetables in the country.

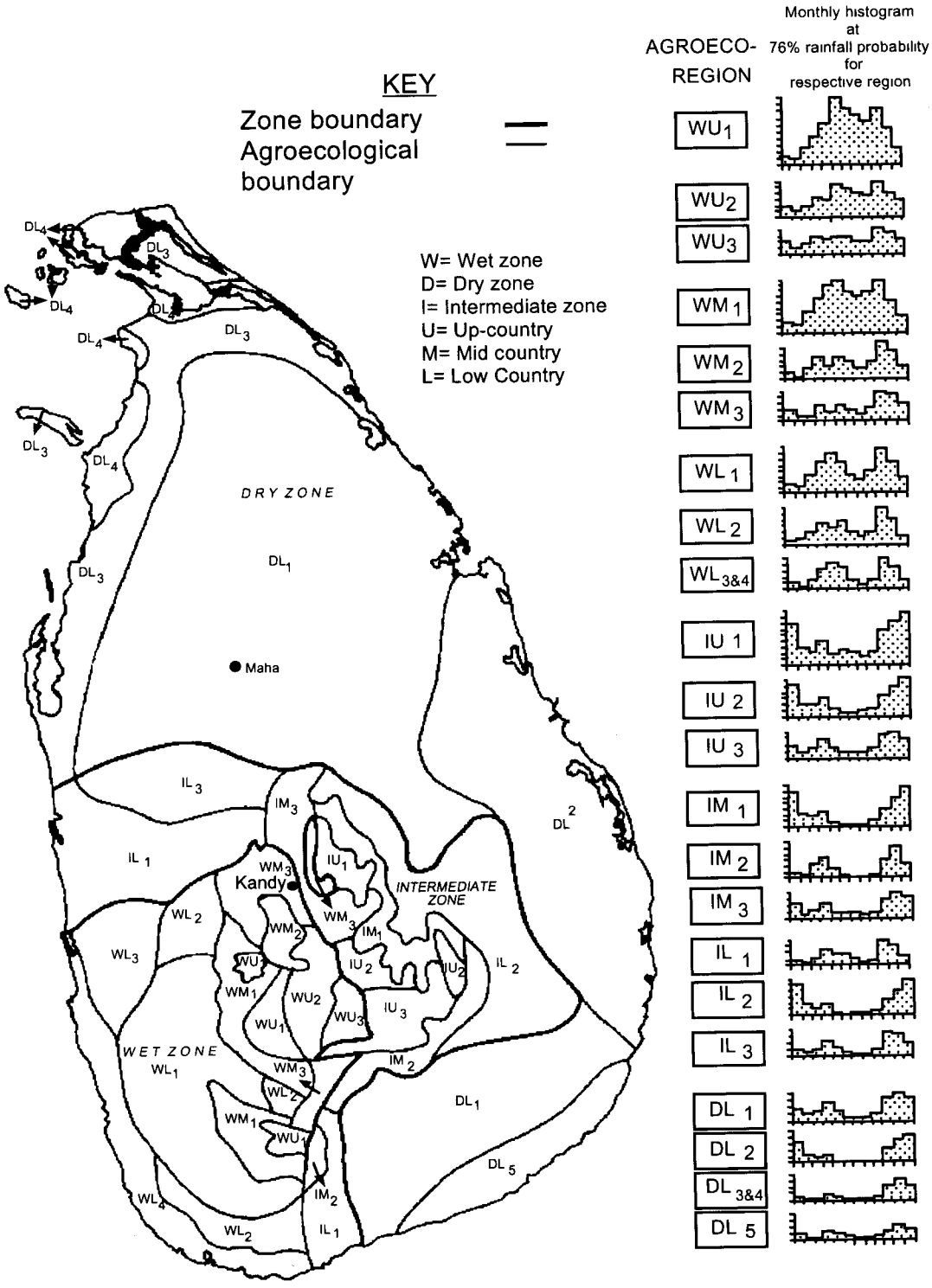

Fig. 1. Agroecological map of Sri Lanka.

Zonal Distribution of Vegetables

Leek, carrot, and radish are dominate vegetables in the wet zone; beans and tomato are dominant crops in the intermediate zone; while ash pumpkin and red pumpkin are dry zone crops. Beetroot, knol-khol, and cabbage are grown about equally in the wet and intermediate zones, while bitter gourd, cucumber, eggplant, lady's finger, and snake gourd are equally distributed across all regions (Table 2).

Table 2. Regional distribution (% of the total) of vegetables, 1993

Vegetable	Wet zone	Dry zone	Intermediate zone
Ash pumpkin	19.0	65.0	16.0
Beans	34.9	4.1	60.9
Beetroot	48.9	9.5	41.7
Bitter gourd	32.9	39.9	27.2
Cabbage	49.8	4.9	45.2
Carrot	69.6	2.2	28.2
Cucumber	19.5	35.2	45.3
Eggplant	28.2	43.6	28.2
Knol-khol	43.9	1.2	54.9
Lady's finger	36.0	40.0	24.0
Leek	69.7	0.7	29.6
Radish	53.1	7.9	39.0
Red pumpkin	11.4	53.1	35.4
Snake gourd	24.9	40.7	34.3
Tomato	16.8	30.1	53.0

Source: Estimated from official file of Department of Census and Statistics data.

Vegetable Classification

Vegetables in Sri Lanka are classified in different ways. One grouping, based on vegetable type, has four major categories, namely, leafy vegetables, fruit vegetables, roots and tubers, and seeds (Table 3).

Another form of classification is by origin of the varieties. The more traditional and indigenous types are grouped as tropical types, or, as they are popularly known, "low-country" vegetables, because they are commonly cultivated in lowland and midland peneplains. Those introduced from other countries are called exotic vegetables, or temperate vegetables, or, popularly, as "up-country" vegetables. They are usually cultivated in the cooler climates of the up-country peneplain. This classification is shown in Table 3.

Table 3. Classification as low-country and up-country vegetables

Botanical Name	Common Name	Peak production months	Major growing districts	Eating type
Low-country Vegetables				
Abelmoschus esculentus	Lady's finger	Jan.-March, July-Sept.	Matale, Anuradhapura, Kurunegala, Hambantota	Fruit
Allium cepa	Big onion	Jun.-July	Matale, Kalawewa	R&T
Allium cepa	Red onion	Jun.-July	Jaffna, Puttalam	R&T
Alternanthera sessilis	Mukunuwenna (Alternanthera)	Year round	All wet zone districts	Leafy
Amaranthus tricolor	Amaranth	Year round	All wet zone districts	Leafy
Artocarpus altilis	Bread fruit	Aug.-Sept.,Jan.-Feb.	Matale, Anuradhapura, Kurunegala, Hambantota	Fruit
Artocarpus heterophyllus	Jack fruit	Year round	All wet and intermediate zone district	Fruit
Basella alba	Spinach	Year round	All wet zone districts	Leafy
Beta vulgaris	Beetroot	Feb.-March, Aug.	Matale, Kurunegala, Hambantota	R&T
Capsicum spp.	Chili	Jun.-July	Anuradhapura, Kalawewa, Kurunegala	Fruit
Centella asiatica	Gotukola (Asiatic penny wort)	Year round	All wet zone districts	Leafy
Coleus rotundifolius	Innala (Hausa potato)	Jan.-March	All districts	R&T
Cucumis sativus	Cucumber	Jan.-July	All districts	Fruit
Cucurbita maxima	Pumpkin	Jan.-Aug.	Matale, Anuradhapura, Kurunegala, Hambantota	Fruit
Dioscorea alata	Wellala (Yam)	Jan.-April, July-Sept.	Galle, Kalutara	R&T
Ipomoea aquatica	Kangkong	Year round	All wet zone districts	Leafy
Ipomoea batatas	Sweet potato	Jan.-Feb., Aug.-Sept.	All districts	R&T
Lagenaria seceraria	Bottle gourd	Jan.-July	All wet and intermediate zone district	Fruit
asia spinosa	Kohilala (Spinyelephantsear)	Year round	All wet zone districts	R&T
Luffa acutangula	Luffa	Jan.,July-Sept.	Matale, Anuradhapura, Kurunegala, Hambantota	Fruit
Lycopersicon esculentum	Tomato	Aug.-Sept.	Matale	Fruit
Manihot utilissima	Manioc (Cassava)	Year round	All districts	R&T
Momordica charantia	Bitter gourd	Jan., July-Sept., Dec.	Matale	Fruit
Moringa oleifera	Drumstick tree	May-June, Oct.-Nov.	All wet zone districts	Leafy
Musa sapientum	Ash plantain	Jan.-May, Sept.-Oct.	Matale, Kurunegala,	Fruit
Phaseolus vulgaris	Beans	July-Oct.	Kandy, Badula, Nuwar Eliya	Fruit

Contd. Table 3.

Botanical Name	Common Name	Peak production months	Major growing districts	Eating type
Psophocarpus tetragonolobus	Winged bean	Jan.-Feb., Dec.	Matale, Kurunegala, Hambantota	Fruit
Raphanus sativus	Radish	Jan.-Nov.	Matale, Kurunegala, Hambantota	R&T
Sesbania grandiflora	Kathurumurunga (Sesbania)	Year round	All wet zone districts	Leafy
Solanum melongena	Eggplant	Jan.-Feb., May-Dec.	Kurunegala, Hambantota	Fruit
Trichosanthes anguina	Snake gourd	Jan., July-Sept., Dec.	Matale, Anuradhapura, Kurunegala, Hambantota	Fruit
Vigna radiata	Mungbean	Feb.-April, July-Aug.	Hambantota, Kurunegala, Monaragala	Seed
Vigna unguiculata	Cowpea	Feb.-April, July-Aug.	Kurunegala, Puttalam, Anuradhapura	Fruit
Up-country Vegetables				
Allium porrum	Leek	Jan.-Feb., Apr.-June, Sept.-Dec.	Nuwara Eliya, Badulla Nuwara Eliya, Badulla	Leafy
Beta vulgaris	Beetroot	Feb.-May, Aug.-Sept.	Nuwara Eliya, Badulla	R&T
Brassica oleracea	Cabbage	Jan., Apr.-Dec.	Nuwara Eliya, Badulla	Leafy
Brassica oleracea	Cauliflower	Jan., April, Dec.	Nuwara Eliya, Badulla	Fruit
Capsicum annuum	Sweet/hot pepper	May-Sept.	Nuwara Eliya, Badulla	Fruit
Dancus carota	Carrot	Feb.-Nov.	Nuwara Eliya, Badulla	R&T
Lactuca sativa	Lettuce	Jan., Apr.-Dec.	Nuwara Eliya, Badulla	Leafy
Phaseolus vulgaris	Beans	Jan.-April	Nuwara Eliya, Badulla	Seed
Raphanus sativus	Radish	Jan.-Nov.	Nuwara Eliya, Badulla	R&T
Solanum tuberosum	Potato	Sept.-Nov.	Nuwara Eliya, Badulla	R&T

Source: Personal communication with vegetable scientists in the country.
*R&T implies root and tuber type of vegetables.

Cultivation Time

Most vegetables are grown about equally in both Maha and Yala, except for some up-country vegetables, such as onion, which are mainly grown in the Yala season, and tropical vegetables, such as chili, which are mainly grown in the Maha. Total production of vegetables in Maha is slightly higher than that in Yala (Table 4). No significant difference in the yield of most vegetables grown in Maha and Yala was observed.

Important Vegetables

Chili, onion, ash plantain, eggplant, lady's finger, beans, red pumpkin, and tomato are major vegetables (Table 4). Although chili contributes more than one third to the total vegetable area, its contribution in production is small. On the other hand, cabbage is grown on only 2.3% of the area while its contribution to production are 6.8%.

Table 4. Vegetable area (ha) and production (t) by season, 1992

Vegetable	Maha			Yala			Total			Contribution in total*	
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production
Ash plantain	7185	51256	7.1	5164	32618	6.3	12349	83874	6.8	10.6	12.6
Ash pumpkin	394	3665	9.3	325	3016	9.3	719	6681	9.3	0.6	1.0
Beans	3619	19987	5.5	3118	15494	5.0	6737	35481	5.3	5.8	5.3
Beetroot	624	6949	11.1	778	8007	10.3	1402	14956	10.7	1.2	2.2
Bitter gourd	1772	9202	5.2	2017	12935	6.4	3789	22137	5.8	3.2	3.3
Cabbage	1398	23581	16.9	1312	21768	16.6	2710	45349	16.7	2.3	6.8
Carrot	1015	13718	13.5	829	11720	14.1	1844	25438	13.8	1.6	3.8
Chili	22426	9200	0.4	18140	19800	1.1	40566	29000	0.7	34.8	4.8
Cucumber	1129	11317	10.0	969	6185	6.4	2098	17502	8.3	1.8	2.6
Eggplant	5126	35338	7.3	3897	25193	6.5	9023	60531	6.9	7.7	9.4
Knol-khol	645	5731	8.9	752	6452	8.6	1397	12183	8.7	1.2	1.8
Lady's finger	3719	18814	5.1	3690	19085	5.2	7409	37899	5.1	6.4	5.7
Leek	339	5040	14.9	457	7467	16.3	796	12507	15.7	0.7	1.9
Onion	4916	50827	10.4	5634	63550	11.3	10500	114377	10.9	9.0	17.2
Radish	1051	9257	8.8	1047	9655	9.2	2098	18912	9.0	1.8	2.8
Red pumpkin	3647	38308	11.5	2202	23122	10.5	5849	65430	11.2	5.0	9.8
Snake gourd	1337	11628	8.7	1452	11403	7.9	2789	23031	8.3	2.4	3.5
Tomato	2284	16625	7.3	2281	18080	7.9	4565	34705	7.6	3.9	5.2
All vegetables	62576	340443	5.6	54064	315550	5.8	116640	655993	5.7	100.0	100.0

Source: Data provided by the official file data of Department of Census and Statistics.

*A vegetable task force set by the Ministry of Agriculture found that ash plantain is cultivated on only 3400 ha, rather than on 12,349 ha, and its production is 52,000 t rather than 83,900 t. To the extent that the later estimates are correct, the contribution of ash plantain is overestimated, and contributions of other vegetables are underestimated. Moreover, to the extent that task force figures are correct, total vegetable production will also be overestimated. However, we keep the data provided by the Department of Census and Statistics as no other reliable time series data are available.

Vegetable Production Systems

Vegetables are cultivated under various farming systems throughout the year in different regions of the country. Broadly they can be grouped as follows:

Low-country Peneplain

Vegetable production in the lowland peneplain is characterized by large areas and poor technology adoption. The application of fertilizers and use of improved cultivars are not widespread. The exception, however, is the northern-most part of the country where vegetable cultivation is relatively advanced. The bulk of the lowland vegetable production comes during the Maha season with little or no supplementary irrigation.

Rainfed cultivation is popular in the dry and intermediate zones on well-drained soils. Many food crops, such as maize and millet, as well as cowpea, soybean, and mungbean, are intercropped with vegetables such as tomato, cucumber, eggplant, luffa, bitter gourd, capsicum, lady's finger, and pumpkin.

Up-country Peneplain

In the cool highlands, where land is scarce and the climate is favorable throughout the year, monocropping, multiple cropping, and relay cropping are practiced in vegetable production. The cropping intensity and the level of technology adoption is high, often with overuse of inputs. Vegetable growers are competent and marketing of inputs and the produce is well organized.

Highland vegetable cultivation is commercialized. Average plot size is small and cultivation is undertaken continuously with intensive labor, organic and chemical fertilizers, and high levels of agrochemicals. The output is dispatched to the wholesale markets in Colombo and Kandy.

Mid-country Peneplain

The midlands have varying altitude, temperature, and rainfall, and the nature of vegetable production varies accordingly. In higher altitude and wet areas, more intensive production, somewhat similar to the highland systems, can be observed, especially in home gardens. In the drier parts of the midlands, extensive cultivation of vegetables is carried out in a fashion more similar to the lowland system. The crops cultivated are a mixture of both up-country and low-country vegetables.

Home Gardens

Another important site of vegetable production is the home garden. Most home gardens, in both rural and urban areas, have at least a few popular vegetables, especially in areas where both monsoons prevail. Definite statistics on production and consumption from such units are not available.

Home gardens also have permanent vegetable trees, such as jackfruit and breadfruit in the wet and intermediate zones and drumstick in the dry zone. Ash plantain and kathurumurunga are also common in wet and intermediate zone home gardens. Many leafy vegetables grow wild in backyards. Gotukola and mukunuwenna grow under shade and among the planted trees or natural grass. Kangkong is common in water stagnant patches of homesteads in the wet lowlands and also on many marshy lands. Amaranth grows wild even on wastelands.

Rice-based Vegetable Systems

In the dry zone, vegetables are grown during the Yala season in paddy fields only if supplementary irrigation is available. The popular crops are chili, capsicum, tomato, and onion. In the mid- and up-country regions during the Yala season, terraced paddy fields located around 1500 m asl are cultivated with potato, beans, tomato, and cabbage. Vegetables cannot be cultivated in paddy fields during the Maha season due to stagnant water.

Peri-urban System

The peri-urban production system is a specialized form of market gardening near major cities (especially Colombo) which consists of usually very intensive cultivation of leafy vegetables to supply the needs of the urban and semiurban populations. Both organic and inorganic fertilizers are used in large quantities. As green leaves are an important component of the Sri Lankan rice- and curry-based diet, there is a ready demand for these vegetables. The most popular leafy vegetables are gotukola, amaranth, spinach, mukunuwenna, and kangkong.

Trend Analysis

Production

The trends in area, production, and yield of vegetables during the period 1981-1993 are given in Table 5. Both quadratic and linear functions have been tested to obtain the best-fit. The area, production, and yield of total vegetables have stagnated during the last couple of years in the reference period, as the quadratic term is negative and significant.

Table 5. Trends in area, production, and yield of major vegetables, 1981-93

Crop	Area		Production		Yield	
	T	T^2	T	T^2	T	T^2
Ash plantain	-	-	0.2896	-0.0232	0.2320	-0.0165
Ash pumpkin	-	-0.0052	-	-0.0045	0.1572	-0.0108
Beans	0.0082	-	0.2369	-0.0144	0.2011	-0.0124
Beetroot	0.0084	-	0.1968	-0.0120	0.2170	-0.0142
Bitter gourd	0.0181	-	0.0314	-	-	-
Cabbage	-0.0030	-	-0.0060	-	-0.0030	-
Carrot	-	0.0054	0.1500	-	0.0788	-
Chili	-	-	0.1739	-0.0103	0.1165	-0.0085
Cucumber	-0.0042	-	0.1062	-0.0085	-	-
Eggplant	-0.0144	-	0.2545	-0.0178	0.2976	-0.0200
Knol-khol	0.0100	-	0.0413	-	0.0313	-
Lady's finger	-0.0010	-	0.2539	-0.0163	0.2555	-0.0163
Leek	-0.0100	-	0.0264	-	0.0368	-
Onion (big)	0.1952	-	-0.2289	0.0218	-0.4239	0.0153
Potato	0.2191	-0.0177	0.2869	-0.0245	-	-0.0019
Radish	-0.0226	-	-0.0081	-	0.0145	-
Red pumpkin	-0.0256	-	0.3369	-0.0245	0.3403	-0.0228
Snake gourd	-0.0193	-	0.1350	-0.0093	0.1641	-0.0101
Tomato	0.0004	-	0.0437	-	0.0433	-
Total (excl. potato)	0.0117	-0.0007	0.1681	-0.0116	0.1564	-0.0109

Source: Estimated from the official file data of the Department of Census and Statistics.
- implies that the coefficient is not significant at least at the 5% level.

With few exceptions, area under most vegetables is either stagnant, or decreasing linearly or quadratically. Quadratic decrease in area was observed in ash pumpkin, while the opposite was observed for carrots.

Most vegetables show rising production trends in the earlier years because of similar rising yield trends, however, as yield trends turn negative so do the production trends. In cabbage, both yield and production showed linear declining trends, while leek, carrot, knol-khol, and tomato showed linear positive trends throughout the period. The yield of radish increased and its production declined at linear rates (Table 5).

Prices

There was an upward pressure on the real (or deflated) retail prices of all vegetable during 1985-95. These prices increased at an average rate of 1.8% during this period (Table 6). The real wholesale prices, on the other hand, first increased more than the retail prices, but then declined, and the index became almost equal to that for retail in 1994. During 1995, there was a downward swing in wholesale prices. Therefore, overall real prices at the wholesale level remained almost stagnant during the period (Figure 2).

Individual vegetable prices at the retail level generally increased more than the consumer price index (CPI), resulting in an increase in the real vegetable prices at this level. On the other hand, the real wholesale prices of only knol-khol, snake gourd, and tomato showed increase, while the prices for cucumber, drumstick, long beans, and pumpkins showed significant decline (Table 6). Rising retail prices are curbing demand, and stagnant or declining wholesale prices are discouraging production.

Table 6. Growth rates (%) in the nominal and deflated prices of selected vegetables in Colombo market, 1985-95

	Nominal		Deflated	
Vegetable	Wholesale	Retail	Wholesale	Retail
Ash plantain	13.5	14.7	ns	2.6
Bandakka	11.0	11.8	ns	ns
Beetroot	12.6	14.1	ns	2.1
Bitter gourd	12.5	13.5	ns	1.5
Butter beans	11.9	13.0	ns	1.0
Cabbage	14.4	13.1	ns	1.0
Capsicum	12.3	13.9	ns	1.8
Carrot	10.8	12.3	ns	0.2
Cucumber	10.3	11.9	-1.8	ns
Drumstick	7.6	10.0	-4.5	-2.0
Green beans	12.5	13.0	ns	0.9
Green chili	12.4	13.2	ns	1.2
Knol-khol	13.5	14.9	1.4	2.8
Leek	11.5	12.7	ns	0.6
Long beans	8.7	12.9	-3.3	0.9
Luffa	12.2	13.1	ns	1.0
Mungbean	11.5	13.6	ns	1.5
Pumpkin	7.8	10.4	-4.2	ns
Radish	12.0	13.5	ns	1.5
Snake gourd	13.7	14.7	1.6	2.6
Tomato	14.3	14.9	2.3	2.8
Overall[a]	12.2	13.6	ns	1.8
Consumer price index (CPI)	-	11.7	-	-

[a] This is a Layspare price index of individual vegetable prices.

Source: Estimated from the data of Agrarian Research and Training Institute, various issues[b] (from 1985 through 1995).

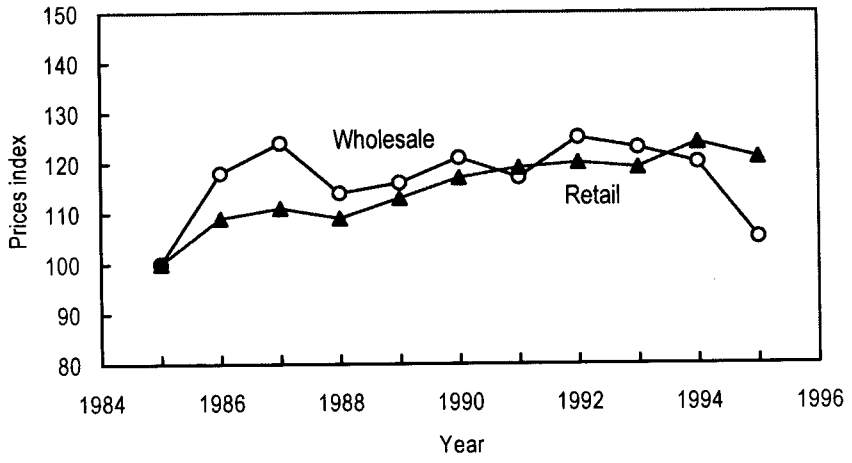

Fig. 2. Trend in deflated vegetable price index in Colombo market in Sri Lanka, 1985-95

Seasonality

Seasonal indices of wholesale and retail vegetable prices are plotted in Figure 3. All vegetables show strong bimodel price seasonality. The wholesale and retail prices move in similar fashion. Prices are normally low in January-April and August-October, and high in November-December and May-July.

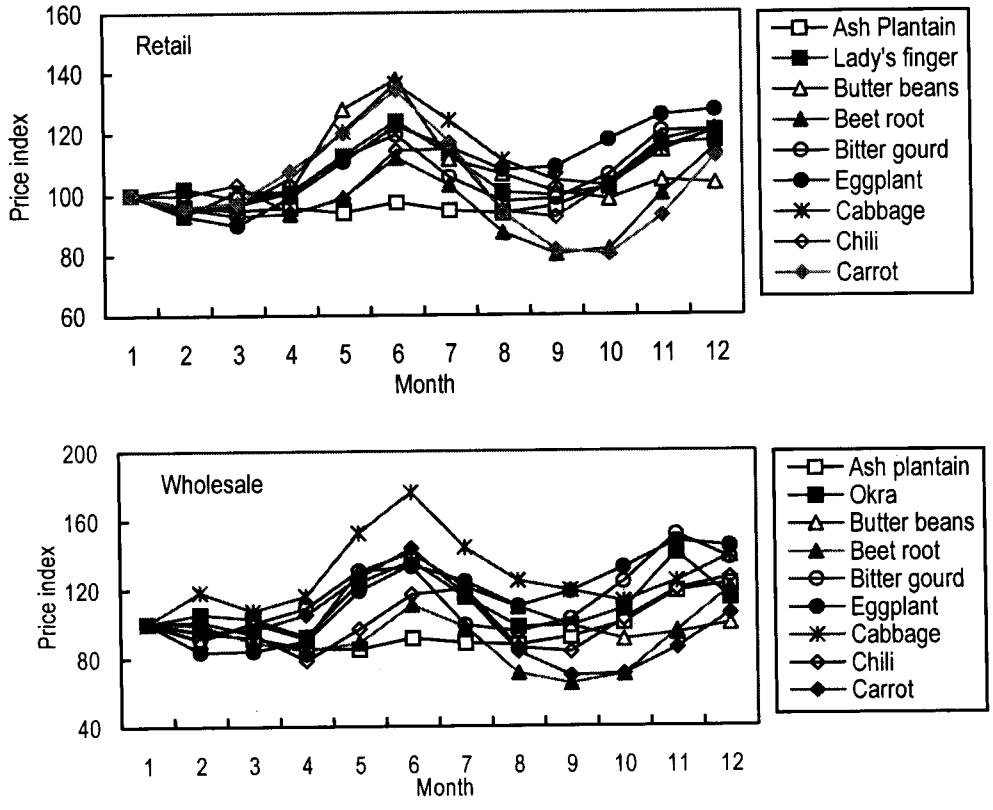

Fig. 3. Seasonality in the individual vegetable prices in Colombo market (average 1985-92)

The months in which prices of a vegetable are highest and lowest and the extent of seasonality at both the retail and wholesale levels are reported in Table 7. Generally, seasonality in wholesale prices is higher than in retail prices.

Table 7. The maximum and minimum vegetable price month, and extent of seasonal price variation in Colombo market (average of 1985-92)

Vegetable	Maximum price months	Minimum price months	Extent of seasonality(%)	
			Wholesale	Retail
Ash plantain	December	May	44	29
Beetroot	December	September	85	44
Butter beans	June	February	44	48
Butter gourd	November	February	67	28
Cabbage	June	March	76	42
Capsicum	December	April	61	31
Carrot	June	October	104	67
Cucumber	May	September	79	-
Eggplant	November	February	77	42
Green beans	June	April	61	-
Lady's finger	November	April	53	26
Leek	June	September	77	-
Long beans	May	August	38	-
Luffa	June	August	77	-
Pumpkin	May	February	82	-
Radish	December	February	61	-
Snake gourd	May	September	59	-
Tomato	December	August	112	-

Note: The maximum and minimum price months at wholesale and retail levels were the same in most cases, so only the peak months at wholesale level are reported in the table; - implies that data are not available.
Source: Estimated from the data of Agrarian Research and Training Institute, various issues[b] (1985 through 1992).

Risk in Production

Most vegetables are more risky to produce than field crops, such as rice (Table 8). The variability in yield of all individual and total vegetables is 2-3 times more than the variability in rice yield. However, with few exceptions, variability in vegetable area is very similar or even lower to that in rice area. The area of total vegetables is actually far less variable than that of most individual vegetables, suggesting that figures for vegetable area move in opposite directions, thus reduce the variability in total vegetable area.

Table 8. Detrended coefficient of variation in vegetable and rice during 1981-1995

Crop	Area	Yield	Production	Prices[a]	
				Wholesale	Retail
Ash plantain	7.6	22.7	28.4	14.4	8.6
Ash pumpkin	13.6	17.1	30.7	-	-
Beans	6.7	14.5	16.9	12.0	5.8
Beetroot	6.1	22.2	19.8	13.3	13.7
Bitter gourd	2.2	13.8	12.9	10.5	8.9
Cabbage	3.5	9.3	11.7	14.2	11.6
Carrot	11.7	18.8	24.8	8.9	9.8
Chili	14.3	15.1	21.5	10.3	6.7
Cucumber	8.4	15.6	14.4	7.6	6.0
Eggplant	4.9	23.0	22.0	10.4	7.5
Knol-khol	7.7	12.7	15.2	9.4	9.9
Lady's finger	3.8	19.0	18.8	-	-
Leek	10.4	22.8	30.8	8.9	9.9
Onion	16.6	17.3	26.0	-	-
Potato	22.7	10.5	28.0	-	-
Radish	6.5	15.6	22.7	7.6	7.6
Red pumpkin	7.1	27.9	33.6	10.3	6.9
Snake gourd	4.1	13.2	13.2	15.2	11.7
Tomato	7.2	15.2	15.6	12.5	8.5
Total (excl. potato)[a]	4.0	14.3	14.6	7.9	5.6
Rice	7.7	5.9	9.8	10.2	12.7

[a] The detrended coefficient for vegetable prices are for 1985-95 in Colombo market, while in rice it is for 1983-93 in the whole country. For the total vegetables, the detrended price variation is for the Layspare price index.

Source: Detrended coefficient for area, yield, and production were estimated from the official file data of the Department of Census and Statistics, and for prices the coefficients were estimated from Agrarian Research and Training Institute, various issues[b].

The higher variability in vegetable yields compared to field crops makes their production more variable as well. This suggests that technological innovations that can stabilize vegetable yield are more important to overcome inherent risk in vegetable production than policy related factors that can stabilize vegetable area in Sri Lanka.

The variation in vegetable production leads to variation in their prices (Table 8). Variation in individual vegetable prices are higher than variation in rice prices in most cases. However, total vegetable prices are less risky than those of cereal crops. Again, individual vegetable prices move in opposite directions, compensating for the high price of one vegetable with the low price of another.

For most vegetables, wholesale-level variation in prices is higher than variation at the retail level. Thus, retailers help to reduce the variation in prices by adjusting their margins. These variations at the wholesale level vary from 15.2% for snake gourd to 7.6% for radish and cucumber. At the retail level, variation ranges from 13.7% for beetroot to 5.8% for beans.

Economics of Cultivation

The Socioeconomics and Planning Centre of Department of Agriculture conducts studies into the costs and returns of vegetable cultivation. The following discussion is derived from the data furnished in these studies.

Input Use

Input use for selected vegetables is reported in Table 9. For comparison, the input use for rice is also included. Generally, labor use in vegetables is much higher than in rice. This suggests that vegetable cultivation can generate more employment. Fertilizer application in vegetable cultivation is also higher than in rice. In many cases, high chemical fertilizer applied is also supplemented with high compost manure. If fertilizer, compost manure, and lime applications are combined, vegetable crops are shown to be even more input-intensive than field crops, such as rice (Table 9). This suggests that vegetable cultivation needs stronger agricultural business links.

Table 9. Input use (ha^{-1}) in selected vegetables, 1992-93

Vegetable Crop/season	Place of study	Labor (days)			Seed	Fertilizer (kg)				Compost	Lime
		Hired	Family	Total	(kg)	N	P	K	Total	(t)	(t)
Maha season											
Carrot	N. Eliya	341	138	479	3	163	179	237	579	27.2	-
Pole beans	Badulla	109	207	316	39	130	195	130	455	1.1	-
Potato	Badulla	114	245	359	1791	220	240	320	780	-	-
Sweet potato	Ratnapura	145	152	297	3087 (seedling)	49	50	65	164	-	-
Tomato	Badulla	94	242	336	1	183	127	91	401	3.0	-
Rice	Kandy	40	168	208	102	79	37	38	154	-	-
Yala season											
Bush beans	Matale	48	162	210	30.1	134	52	35	221	-	-
Cabbage	N. Eliya	264	79	343	0.2	-	-	-	-	1.7	2.5
Pole beans	Badulla	141	308	449	46.5	256	225	150	631	-	-
Potato	N. Eliya	427	123	550	2224	208	229	302	739	33.7	-
Tomato	Matale	24	205	229	0.5	124	65	46	235	-	-
Rice	Kandy	58	118	176	100	93	22	37	152	-	-

Source: Socioeconomic and Planning Centre (1994).

Factor Shares

Factor shares of different inputs in the total cost of vegetable and rice cultivation are reported in Table 10. Labor and fertilizer are the major costs in vegetable cultivation. Labor cost claims more than half of the total cost in most cases. Power claims an insignificant proportion of the total cost in all crops. Despite excessive use of fertilizer, its share in total cost remains about 20%, except in carrot and cabbage. Similarly, with the exception of tomato, the share of pesticide is also less than 15%.

Table 10. Factor share (%) of different inputs in the total cost of selected vegetables, 1992-93

Crop/season	Place of study	Labor	Seed	Fertilizer	Pesticide	Power
Maha season						
Carrot	N' Eliya	40	4	38	9	8
Pole beans	Badulla	56	17	21	5	0
Tomato	Badulla	51	3	22	24	0
Yala season						
Bush beans	Matale	53	15	15	12	4
Cabbage	N' Eliya	42	9	30	18	0
Pole beans	Badulla	64	14	19	3	0
Tomato	Metale	61	4	19	14	2

Source: Estimated from the data obtained from the Socioeconomics and Planning Centre (1994).

Returns from Vegetable Cultivation

Per-hectare yield and gross and net return on vegetable and rice cultivation are reported in Table 11. Total cost of vegetable cultivation is higher than that of rice, and such is the case for gross and net return. While net benefit in vegetable cultivation is positive and benefit-cost ratios are in the range of 56-303%, net return in rice cultivation is negative, as is the benefit-cost ratio, in both Maha and Yala seasons. Despite high profitability, area under vegetable cultivation in the country is limited and not sufficient to meet the daily requirement of the population. The serious constraints limiting the expansion of vegetable area need to be studied.

Table 11. Returns from vegetable cultivation, 1992-93

Crop/season	Study place	Yield (kg/ha)	Price (LKR/kg)	Gross income (LKR/ha)	Total cost (LKR/ha)	Net income (LKR/ha)	Benefit-cost ratio	Cost (LKR/kg)
Maha season								
Carrot	N. Eliya	21349	10.50	224165	111924	112241	100	5.24
Pole beans	Badulla	10200	12.00	122400	46924	75476	161	4.60
Potato	Badulla	11391	28.48	324416	180828	143588	79	15.87
Sweet potato	Ratnapura	12857	4.30	55285	30715	24570	80	2.39
Tomato	Badulla	10956	12.50	136950	59675	77275	129	5.45
Rice	Kandy	3089	7.00	21623	24600	-2977	-12	7.96
Yala season								
Bush beans	Matale	2733	18.21	49768	31802	17966	56	11.64
Cabbage	N. Eliya	37302	5.76	214860	68249	146611	215	1.83
Pole beans	Badulla	9627	16.30	156920	61726	95194	154	6.41
Potato	N. Eliya	16395	31.85	522181	281447	240734	86	17.17
Tomato	Matale	7082	16.79	118907	29504	89403	303	4.17
Rice	Kandy	2575	7.50	19313	22937	-3624	-16	8.91

Source: Socioeconomics and Planning Centre (1994).

With few exceptions, the cost of production per kilogram of vegetable output is almost equal or lower than the cost of producing one kilogram of rice.

Marketing

Vegetable marketing in Sri Lanka is primarily in the hands of the private sector. The following are descriptions of different marketing agents, types of vegetable markets, marketing channels, and marketing functions and services in the country.

Marketing Agents

Major vegetable marketing agents in the country are as follows (Perera et al. 1991; Gunawardena 1992):

a. Assembly agents. Agents or brokers who collect the produce from farmers for the trucker-buyer or commission agents. They usually keep about 5% market margin.

b. Trucker-buyer. Traders who come in lorries and purchase the produce through the assembly agents or direct from the producers. They could be retailers or wholesalers.

c. Commission agents. These are wholesale traders at major wholesale markets who sell vegetables for the farmers or assembly agents on a commission basis. They usually keep a 10% margin as their sale commission.

d. Retailers. Retail traders who sell vegetables in vegetable stalls, general grocery shops, and at the roadside.

Types of Marketing

The following are the type of markets through which vegetables pass from producers to consumers.

a. Local periodic markets (weekly fairs). Periodic markets or weekly fairs are common in many rural towns and also in some semi urban communities. They are held once a week in a common place, such as an open wasteland belonging to the local council, or the waysides. Producers from the local area bring produce and traveling traders transport goods from one fair to another.

b. Retail outlets. Private retailers include stall-holders at market centers and fairs, pavement vendors, and village boutique owners. The retailers get vegetables from produces, assembly agents, or wholesalers. Some retailers are also producers, primary level collectors, or wholesalers.

c. Wholesale markets: Wholesale markets can be found in every main city. They obtain vegetables mostly from assembly agents. Retailers, including wayside vendors, buy from the wholesale markets. Some wholesale markets procure direct from producers.

Marketing Channels

The following alternative marketing channels through which vegetables reach consumers have been studied.

1. Producer →commission agent → retailer → consumer.

2. Producer → assembly agent → trucker/retailer → consumer.

Marketing Functions and Services

Important market functions and services are discussed below (Gunawardena 1992).

Cleaning

Farmers do not clean their produce thoroughly before selling. Cleaning is mostly limited to removal of spoilage and visible extraneous matter (except vegetables destined for highly commercialized markets).

Grading

Vegetable collectors usually pay a flat rate for produce and are not particular about grades. Very little grading is undertaken, even at major wholesale markets. Retailers who purchase in bulk get vegetables in the form sent by the producers.

Most farmers, therefore, are not keen on grading before selling. In up-country, where vegetable cultivation is highly commercialized, some producers have formed their own societies, where members grade certain vegetables, such as capsicum and tomato, before selling. The prices vary for different grades in these cases.

However, grading is practiced in all types of retail trade, from supermarkets to pavement vendors. It is undertaken based on cleanliness, size, appearance, and freshness of the produce. Prices differ accordingly.

Packing

Transport of vegetables from production areas to the terminal markets usually takes 1 to 1 1/2 days. Vegetables are transported in various containers, such as gunnies, polysacks, wooden crates, or simply wrapped in any available material, such as old gunny cloths or woven coconut leaves.

Producers minimize the cost of containers by packing the maximum possible weight. Traders and transport agents also overload vehicles. This has resulted in considerable loss of quality and produce in transit and handling.

Farm Financing

It is a well established practice for commission agents to provide credit to producers, agents, and retailers. Producers favor this informal credit arrangement and take loans for cultivation as well as to cover family expenses. While the producers get the benefit of easy credit, the commission agents on the other hand develop a close relationship with the producers, and they are assured supply of vegetables. The loans are free of formal interest, but the agents often pay their farmers less than the market price for their output, thus charging interest higher than that in the formal sector.

Provision of Marketing Information

Radio and newspapers are the main sources of price information available to vegetable growers.

Producers regularly get feedback on prevailing wholesale prices in major cities at the time they receive cash for the produce they have sold to commission agents. Personal communications with traders and neighboring producers are the other sources.

Marketing Margins

Macro-level Analysis

Marketing margin can be estimated from the retail- and wholesale-level prices. The margins estimated this way suggest that these vary across vegetable and over time. Generally, the margin in vegetable trade varies from 31% to over 70% (Table 12).

Marketing margins increased during 1986-92 in all the vegetables studied (Table 12). It is not clear whether the monopolistic power of the middlemen increased or the cost of some inputs (say labor or capital) increased over the period. The increasing margins explain the increasing retail prices, while the wholesale prices fluctuate around a stagnant trend.

Table 12. Changes in marketing margin for selected vegetables in Colombo market and its suburbs, 1986-95

Vegetable	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Ash plantain	38	31	38	38	41	43	38	40	46	51
Bandakka	47	48	52	49	47	54	51	54	53	60
Butter beans	32	31	33	34	34	36	34	38	37	45
Beet root	39	42	43	46	46	46	48	49	48	49
Bitter gourd	47	45	46	46	46	51	49	49	48	56
Eggplant	49	51	53	51	52	61	53	57	60	59
Cabbage	54	52	60	55	56	61	70	62	62	67
Chili	36	36	38	38	38	40	46	42	40	47
Carrot	35	33	41	37	39	42	37	44	44	46
Cucumber	55	56	58	59	56	63	61	62	61	63
Pepper	46	48	49	55	47	49	53	46	49	54
Knoh-khol	53	53	55	58	56	61	56	58	58	60
Long beans	44	48	45	48	48	54	49	51	52	55
Leeks	35	37	40	38	42	44	42	44	44	49
Luffa	48	49	51	52	50	58	52	53	53	59
Pumpkin	47	53	51	52	54	51	55	57	58	65
Radish	60	60	59	63	61	68	63	63	66	69
Snake gourd	53	54	56	57	50	58	55	53	55	65
Tomatoes	44	43	50	51	51	52	46	46	47	49

Source: Estimated from the wholesale and retail prices provided by the Agrarian Research and Training Institute (various issues[b]) as the difference of these prices divided by the wholesale prices and multiplied by 100.

Marketing margins also vary according to the time of year, depending upon the prices of vegetables. Usually when prices are high, marketing margins are low, and vice versa (Table 13). This suggests that retailers help to reduce the extent of seasonality in vegetable prices.

Table 13. Marketing margin (%) during the high- and low-price months of selected vegetables in Colombo market and its suburbs, (average of 1986-92).

Vegetable	Low-price months	High-price months
Ash plantain	41	38
Beetroot	46	43
Bitter gourd	50	44
Butter beans	36	30
Cabbage	57	54
Carrot	35	40
Chili	35	41
Eggplant	56	50
Okra	53	49
Carrot	54	85
Capsicum	53	76
Eggplant	98	149
Lady's finger	90	117

Source: Estimated from the wholesale and retail prices provided by the Agrarian Research and Training Institute (various issues[b]) by first isolating the three highest price and three lowest price months in every year for every crop, estimating the margin separately for each of these months, and then averaging these margins for the low- and high-price months throughout the period.

Review From the Micro-level Studies

The micro-level studies conducted on marketing margins also suggest that they vary for different vegetables and for different marketing channels. The available estimates of the gross marketing margins are quite high given the fact that vegetables are marketed in an unprocessed form. A study in 1978 (Gunawardena and Chandrasiri 1980) estimated that the gross marketing margins for 16 out of 17 individual vegetables were above 50%, and can be as high 84%. The net price received by the producers was thus below 50% for most vegetables. The latest study of Perera et al. (1991) has shown that marketing margin varies from market to market for the same commodity as well. The retail level consumes a major portion of the marketing margin in all commodities (Table 14). This is because of the small quantities of vegetables sold by each individual retailer, and probably because of the high physical losses at this level.

Table 14. Marketing margin (% of consumers' price) from selected studies

Study place	Market	Bean	Beet	Cabbage	Carrot	Leek	Tomato
Kandy	Wholesale	10.4	10.4	11.7	12.9	9.8	9.9
	Retail	49.6	46.6	60.3	33.1	50.2	34.1
	Total	60.0	57.0	72.0	46.0	60.0	44.0
Colombo	Wholesale	10.5	9.4	11.0	9.6	10.6	8.5
	Retail	33.2	50.7	55.4	49.8	47.1	54.6
	Total	43.7	60.1	66.4	59.4	57.7	63.1

Source: Perera et al. (1991)

International Trade

Total quantity and value of exports and imports and balance of trade during 1981-93 are reported in Table 15. The exports level is small and never exceeded 6000 t. Wide variation exists in the import quantity and value, resulting no trend in international trade.

Table 15. Vegetable import and export quantities (including onion and chili) (000 t) and values (million LKR)

	Exports		Imports		Balance of trade	
Year	Quantity	Value	Quantity	Value	Quantity	Value
1981	1.2	17.5	6.4	30.9	-5.1	-13.5
1982	1.2	10.9	16.6	138.1	-15.4	-127.2
1983	1.7	36.1	26.2	269.5	-24.5	-233.4
1984	2.3	39.0	103.9	833.5	-101.5	-794.5
1985	0.3	4.0	128.9	838.2	-128.6	-834.2
1986	0.6	16.2	99.0	757.4	-98.5	-741.2
1987	1.6	60.3	71.1	691.6	-69.4	-631.3
1988	3.0	71.7	32.4	484.3	-29.4	-412.6
1989	-	-	5.6	119.2	-5.6	-119.2
1990	-	-	78.4	752.2	-78.4	-752.2
1991	2.9	181.6	101.8	1778.5	-98.9	-1596.9
1992	5.5	116.7	74.2	1227.7	-68.7	-1111.0
1993	4.0	147.1	72.9	940.2	-69.0	-793.2

- implies that data are not available.
Source: Office files of Department of Customs.

Sri Lanka has a deficit in vegetable trade, and the country loses up to 1.6 billion LKR in vegetable trade annually. Onion and chili, mainly from India, account for the major share of imports. There is a need to study the domestic resource costs of vegetables in order to pinpoint the technological and institutional constraints that limit vegetable exports from Sri Lanka.

Supply and Demand

Availability

About 800 g of total food are available for an average Sri Lankan, out of which 13% comes from vegetables. Rice accounts for about 45% of the total available food (Table 16).

Table 16. Food availability in Sri Lanka, 1993

Food item	Availability (g/day)	Share (%)
Cereals	359.72	45.0
Fruits	8.41	1.1
Meat, fish, eggs	50.73	6.4
Milk	41.35	5.2
Oils & fats	93.45	11.8

Contd. Table 16.

Food item	Availability (g/day)	Share (%)
Pulses & nuts	15.83	2.0
Roots & tubers	50.35	6.3
Sugar	70.33	8.0
Vegetables	116.00	13.4
Total food	797.45	100.0

Source: Department of Census and Statistics (1994a).

Per capita availability of vegetables in the country is about 116 g/day, or about 42 kg/year. However, these estimates might underestimate actual availability, as vegetable consumption from home gardens, especially in rural areas, is not accounted for in these calculations. Vegetable availability remained almost stagnant during 1981-93. Following the production trend, the annual per-capita availability first increased, reached its highest level in 1986, and then declined until 1992 (Table 17).

Table 17. Trend in per capita availability of vegetables, 1981-93

Year	Total prod (000t)	Population (million)	Trade surplus (000t)	Net availability (000 t)	Annual per capita (kg)	Per capita per day (g)
1981	535.5	15.10	-5.1	540.6	40.8	111.7
1982	448.8	15.28	-15.4	464.2	35.8	98.1
1983	742.1	15.47	-24.5	766.6	30.4	83.2
1984	773.0	15.65	-101.5	874.5	49.6	135.8
1985	793.8	15.84	-128.6	922.4	55.9	153.1
1986	782.3	16.03	-98.5	880.8	58.2	159.5
1987	767.4	16.22	-69.4	836.8	55.0	150.6
1988	829.8	16.41	-29.4	859.2	51.6	141.4
1989	714.6	16.61	-5.6	720.2	52.3	143.4
1990	711.5	16.81	-78.4	789.9	43.4	118.8
1991	646.4	17.01	-98.9	745.3	47.0	128.8
1992	656.3	17.21	-68.7	725.0	42.1	115.4
1993	630.5	17.41	-69.0	699.5	42.3	115.9

Source: Estimated from production data, excluding potato, but including chili and onion.

Consumption

The latest detailed vegetable consumption survey was conducted in 1986-87 (Table 18). The survey, although somewhat outdated, provides important information about vegetable consumption across income groups in Sri Lanka. Average monthly vegetable consumption by all income groups was 2666 g (89 g/day), which is consistent with the availability estimates.

Table 18. Per capita monthly vegetable consumption (g) by income group, 1986-87

Vegetable	Income group												Mean
	0-100	101-200	201-400	401-600	601-800	801-1000	1001-1500	1501-2000	2001-3000	3001-5000	5001-10000	>10000	value
Fruit and root vegetables													
Ash plantain	_	42	88	84	82	95	99	102	122	112	110	120	106
Ash pumpkin	_	_	1	2	4	7	5	6	9	4	5	10	6
Beans	273	245	209	205	235	234	262	314	335	398	419	450	320
Beetroot	89	256	52	60	63	67	75	99	117	129	152	156	103
Bitter gourd	9	62	65	67	56	55	52	60	66	78	89	68	65
Capsicum	27	8	16	31	30	32	42	56	49	62	73	78	51
Carrot	28	63	38	23	32	28	38	49	67	101	154	157	66
Cucumber	_	16	13	21	17	18	21	25	31	32	85	64	31
Drumstick	17	131	74	115	94	95	99	101	95	95	73	102	96
Eggplant	61	164	291	237	246	256	280	266	274	238	252	181	260
Eggplant (small)	61	39	39	43	33	17	23	27	28	31	30	18	27
Golden melon	_	6	75	32	36	49	39	45	48	30	40	22	41
Knol-khol	_	17	17	27	35	36	37	48	45	49	44	46	43
Kohilala (Spinyelephantsear)	_	72	7	6	15	14	16	21	23	27	29	26	21
Kohila yams	_	_	7	9	8	9	14	12	14	26	27	20	16
Lady's finger	94	65	32	62	74	64	70	76	94	111	112	101	86
Long beans	180	82	99	106	139	128	130	136	140	134	124	74	132
Luffa	56	94	81	87	68	75	57	67	73	63	59	76	66
Pumpkin	173	46	118	168	150	185	193	189	211	213	182	177	194
Radish	99	113	54	35	61	57	46	54	49	47	47	43	50
Snake gourd	0	128	34	70	78	67	71	65	75	72	63	78	70
Tomato	33	44	63	48	48	38	42	49	49	51	54	87	49
Winged bean	_	_	9	24	23	23	20	22	22	27	27	26	23
Other	65	218	58	104	81	89	80	69	61	57	79	51	71
Leafy vegetables													
Amaranths	_	_	1	8	9	8	14	18	13	11	8	11	12
Cabbage	56	125	102	123	137	135	163	184	197	186	162	176	173
Cabbage leaves	_	_	10	17	14	18	18	18	23	14	11	16	18
Gotukola (Asiatic penny wort)	71	58	56	53	50	65	63	66	74	90	101	85	73
Kangkong	_	_	18	21	21	15	19	25	32	42	43	46	29
Kathurumurunga (Sesbania)	32	33	12	16	15	10	14	18	28	35	54	37	25
Leek	121	135	25	24	30	37	44	53	67	90	107	129	63
Mukunuwenna (Alternanthera)	280	222	110	85	108	112	125	139	162	194	229	248	155
Other leafy vegetables	11	69	174	139	126	102	125	114	124	129	165	119	125
Total	1836	2553	2049	2150	2218	2240	2395	2592	2817	2977	3209	3098	2666

Source: Central Bank of Sri Lanka (1991).

– implies less than one or zero.

No significant trend in monthly consumption was observed until income reached beyond LKR 1500. However, consumption is seen to progressively increase after that level.

The vegetable mix varies by income group. For example, the lowest income group consumes more radish, mukunuwenna, long beans, and small eggplant than the highest income group. The spread of the consumption is more diversified for the higher income groups. Thus, with development, consumers not only demand more vegetables, but also more diversity.

On average, households use 6.6% of their income to purchase vegetables. For the lower income groups, as much as 21% of the household income goes for vegetables (Table 19).

Table 19. Percentage of monthly household income spent on vegetables, 1991

Income group (LKR/month)	Percentage of income spent on vegetables
Overall	6.6
0-961	20.6
962-1353	14.6
1354-1724	12.5
1725-2076	10.7
2077-2448	9.5
2449-2879	8.4
2880-3500	7.7
3501-4474	7.0
4475-6440	5.8
6441 and above	3.0

Source: Department of Census and Statistics (1993).

The rural population and the estate sector workers (predominately laborers in tea and rubber plantations) spend more on vegetables out of their total expenditure on food and drinks, than do members of the urban sector; however, the differences are relatively small. The expenditure on vegetables as a percentage of expenditure on food and drinks increased in all sectors during 1986 to 1991 (Department of Census and Statistics 1993). This might have been due to the increase in vegetable prices as discussed earlier.

Demand and Income Elasticities

Demand elasticities are not available for vegetables, except for one study on cowpea and mungbean (Table 20). The own-price elasticities are very high compared to income elasticities, suggesting that reduction in vegetable prices through improved production technology, rather than increase in income, can substantially improve vegetable consumption.

Table 20. Own- and cross-price, and income elasticities for cowpea and mungbean

Commodity	Own price	Cross price	Income
Cowpea	-2.816	0.238	0.435
Mungbean	-0.913	0.437	0.271

Cross Price = Red lentic for cowpea and cowpea for mungbean.
Source: Balasuriya (1992).

Supply Elasticities

Only a few studies are available on the supply elasticities of vegetables. Gunawardena (1977) estimated supply elasticities of three vegetables (Table 21). The supply elasticities are quite low in the short-term, indicating production and institutional constraints blocking additional supply in the short-term.

Table 21. Supply elasticity for selected vegetables

Vegetable	Short-term		Long-term	
	Linear model	Log linear model	Linear model	Log linear model
Cucumber	0.46	0.51	0.84	1.13
Red pumpkin	0.30	0.30	0.61	0.69
Snake gourd	0.53	0.54	1.02	1.06

Source: Gunawardena (1977).

Research Achievements

The Department of Agriculture is the principal organization conducting research on vegetables. In 1994, a separate institute called the Horticultural Research and Development Institute was established under the Department of Agriculture to promote vegetable research. The institute has regional research centers located in various agroecological zones. The main disciplines of research include varietal development and evaluation, crop management, soil science, crop protection, and food technology.

The varietal development program is essentially a breeding program for low-country vegetables and evaluation and selection of introduced germplasm for up-country vegetables. The overall goal is to identify high yielding varieties with desired traits. Regular hybridization programs are restricted to tropical vegetables.

Research is also carried out for suitable agronomic practices, fertilizer levels, seed rates, nursery management practices, and crop protection measures. To address rising concerns on the overuse of hazardous insecticides, which damage the environment, research is carried out on integrated pest management.

Despite a serious shortage of technical personnel, and the fact that most social scientists in the country are mainly engaged in major field crops, such as rice, modest success has been achieved in socioeconomic research. Table 22 shows a number of studies conducted in the discipline on various issues. Eighteen studies were reviewed relating to production and consumption, six on cost of

production, eleven on marketing, one on credit, seven on prices, three on extension, four on vegetable research, and five on policy.

Table 22. Main research fields in bibliography

Name of author	Production & consumption	Cost of production	Market-ing	Credit	Prices	Exten-sion	Research	Policy
Abeytunge and Arulnandhy, 1990	*						*	
Abeysekera and Senanayake, 1974		*	*		*			
Agrarian Research and Training Institute, various issues[a]					*			
Agrarian Research and Training Institute, various issues[b]					*			
Arasasingham and Schmidt, 1964	*							
Central Bank of Sri Lanka, various issues	*							
Charles et al., 1984						*		
Dasanayake, 1996			*					
De Silva and Sathasivampillai, 1976	*	*						
Department of Agriculture, 1990						*		
Department of Census and Statistics, 1990			*					
Department of Census and Statistics, various issues (1981-93)	*							
Evans, 1986	*							
Gunasekara, 1991	*							
Gunawardena, 1977	*				*			
Gunawardena, 1992			*					
Gunawardena and Chandrasiri, 1980	*		*					
Herath, 1983	*							
Herath, 1985	*	*						
Hettige and Senanayake, 1992	*	*	*	*				
Klaus, 1976							*	*
Nutrition and Janasaviya Division, 1992	*				*			
Padmasiri, 1987								*
Perera, 1989	*		*					
Peris and De Silva, 1966	*							
Senanayake, 1977	*		*					*
Socioeconomics and Planning Centre, 1994		*			*			
Suraweera and Agalawatte, 1980			*		*			
Vaz De, 1991	*	*					*	
Weerasinghe and Arulnandhy, 1990	*		*				*	
Weragoda, 1983						*		*
Wijayapala, 1991			*					*

The Socioeconomic and Planning Center has completed cost of production studies on different vegetables. Although only a few vegetables are covered, the information generated is very useful in understanding the input regime. These studies should be expanded to include other vegetables. Moreover, in order to understand farmers' practices under different environments, production studies should be conducted at the ecoregional level. Very little is known about the extent of losses due to different biophysical constraints in vegetable production. Marketing is the most important research area, but the least researched. It has been established by this study that input use in vegetables in Sri Lanka is high. However, the socioeconomic reasons for overuse of material inputs are little understood. Moreover, the effect of the overuse on resources, on consumers' and producers' health, and the environment has not been quantified. A few studies are available on marketing margins, but the interplay of policy environment and marketing efficiency has been completely ignored by researchers. The household consumption survey conducted in the mid-1980s provides complete information on vegetable consumption by income group, and rural versus urban sector of the economy. These surveys need to be continued to discern the dynamics of vegetable consumption across income groups. Moreover, seasonal variation in vegetable availability affects consumption, and ultimately micronutrient intake. This needs to be taken into consideration when planning these surveys, as it has been ignored in the past.

Summary and Discussion of Policy Implications

Vegetables in Sri Lanka are grown in various cropping systems, ranging from the year-round intensive commercial cultivation in the cool highlands to the rice-based cropping system, mainly in the Yala season after rice harvest. Home gardens are an important source of vegetables for families, but their contribution to the total vegetable supply is unknown. Cultivation is almost equally distributed between the two rainy seasons of Maha and Yala.

Vegetable production in the country increased during the early- to mid-1980s, but has stagnated since then. Per capita availability has declined as the population has continued to increase. On the other hand, there is strong pressure on vegetable prices at the retail level to rise while wholesale prices fluctuate around a stagnant trend. Thus, while no price incentive is generated for farmers to increase vegetable supplies, their availability to the poor is threatened.

During 1993, annual per capita vegetable availability stands at about 42 kg, about half of the recommended level. However, strong seasonality in vegetable supply, indicated by seasonal price swings, suggests that the problem of low availability is more serious in some months than in others. The seasonality in individual vegetable prices, based on a monthly price estimate, can be as high as 120% of the price in the peak supply season.

Individual vegetables are more risky to produce, indicated by a high coefficient of variation in production. Most of the variability in vegetable production comes from vegetable yield, rather than from area, implying that stable technologies can help to reduce vegetable production risk in the country.

Vegetable cultivation generates more jobs, although it requires high investment to purchase inputs, such as fertilizer, lime, chemicals, etc. Despite high investment, vegetable cultivation produces a high benefit-cost ratio.

Marketing margins between wholesale and retail levels in vegetable trade are as high as 70%. These margins have increased since the mid-1980s, which explains the increase in retail prices without any change in the wholesale prices. The margins are high during the peak supply period, and low during the lean vegetable supply period. The highest margin is added at the retail level because of the small scale of operations.

Sri Lanka has an international trade deficit in vegetables, mainly because of high imports of onion and chili from India. The country could save much foreign exchange by encouraging domestic production of vegetables. For this, however, a systematic effort would be required to identify the vegetables most suited for production in Sri Lanka, and to identify constraints limiting their cultivation.

Future Research Agenda for Socioeconomists

1. Cost of production and input use studies in different ecoregions to define the optimum input use by ecoregions.

2. Quantification of the extent of losses due to different biophysical constraints in vegetable production will help to prioritize vegetable research in the country.

3. Identification of constraints on the diversification of the rice-based cropping system with vegetables will help to improve and diversify farmers' incomes, and enhance vegetable supply in the country.

4. Estimating the domestic resource costs for vegetables will help to define international trade regimes for different vegetables.

5. Estimation of residual impact of high output use – in terms of resources productivity, consumers' and producers' health, and environmental pollution – will increase awareness among producers, consumers, and policy makers regarding the consequences of high input use in vegetable production.

6. The market inefficiency in vegetable trade is an open secret; there is a need to study the interface of policy regimes and market inefficiency to suggest practical ways and means to reduce this inefficiency. The market margins due to transportation cost, physical losses, profit of various agents, etc., need to be quantified.

7. Quantification of the effect of seasonality on micronutrient intake and health would highlight the importance of vegetable production and consumption in the country.

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