

POTATO (*Solanum tuberosum* L.) TUBER YIELD AS INFLUENCED BY PLANTING DATE IN THE NORTH WESTERN REGOSOL BELT OF SRI LANKA

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ABSTRACT

Planting of potato in the warmer areas should be well timed to synchronise the tuber initiation and bulking phase, with the periods of cool nights in the area, as well as the market condition at the time of harvest. Eighty per cent of the total annual rainfall of 1000 mm, in the Kalpitiya peninsula is received during maha (from October to March). Maximum and minimum temperatures ranged from 30/20°C in December to 33/23°C in March.

Experiments conducted over four years (from maha 1983/84 to maha 1986/87) showed that mid-November planting increased the total tuber yield over October and December plantings by 30 and 40% respectively. However the marketable tuber yield was not significantly different between October and November plantings. Cooler temperatures during harvesting time influenced the tuber dry matter content. Although earlier plantings (October) resulted in slightly lower yields, the loss in tuber yield may be compensated by the higher market prices in December and early January.

INTRODUCTION

Kalpitiya peninsula in the north western dry zone of Sri Lanka is suited for temperate crop production during maha (October to March) season. During this period 80% of the total annual rainfall of 1000 mm is received and the minimum air temperature drops below 23°C.

Potato as a food item probably gained popularity in Sri Lanka during the Dutch period and over the years the potato gained wider popularity among all classes of people as a vegetable, causing the per capita consumption, which was 2.9 kg in 1956 to rise to 6.3 kg in 1964 (Albert, 1984).

Presently, commercial scale potato production in the country is mainly concentrated in three distinct agroecological zones, the Badulla district of the upcountry intermediate zone, the Nuwara-Eliya district of the upcountry wet zone and Jaffna peninsula of the low country dry zone. The cycles of planting and harvesting in these three regions are largely determined by the rainfall pattern and the temperature regime. In Sri Lanka potato marketing operates on the basis of a completely free market where price is determined by supply and demand (Suraweera and Agalawatta, 1983). Therefore price fluctuations over the years clearly reflects the pattern of production and market entry.

It has been shown that there are two glut periods during an year, (Gunawardana and Chandrasiri, 1980) one in February and March following the harvest of Badulla (hill slope planting), Nuwara Eliya (late planting) and Jaffna crop, and the other in September and October consequent to the yala harvest in the Badulla district. There are also two lean periods, one in May, June and July and the other in December and January, when the price level reaches the highest due to limited quantities entering the market. Thus research is needed to ascertain the potential of producing potato crop in Kalpitiya to gain the market benefits and also to even the shortage during December and January.

Potato performs best at average temperatures between 15 and 20°C (Murti *et al.*, 1976). Vander Zaag *et al.* (1984) observed wide range of adaptation among cultivars, with minimum temperatures of 14°C at planting to 21°C at maturity. Based on the temperature data available it appears that November to December would be the best time for planting potato in Kalpitiya. However, in order to obtain the harvest during December and January, planting has to be advanced to October.

The study was designed to determine the ideal planting time of potato in the area and to examine the feasibility of advancing planting date to early October in order to achieve the market benefits.

MATERIALS AND METHODS

The trials were planted at the Agricultural Research Station, Kalpitiya during the maha seasons, 1983/84, 1984/85, 1985/86 and 1986/87. The soil which is classified as Regosol (De Alwis and Panabokke, 1972) contains 95—98% fine and coarse sand and has a pH of 6.5.

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Experiments were laid out in randomized complete block design, in 3 replicates in all seasons except in maha 1986/87 where 4 replicates were used. Tubers were planted in plots of 3m × 5m at a spacing of 70cm between rows and 30cm within rows. Cultivar Desiree was planted in all seasons except in maha 1985/86 where variety Arka was used. Plots were irrigated daily using overhead hoses; however irrigation was not done if the rainfall during the previous 24 hours exceeded 10 mm. Fertilizers were applied at the rate of 200 kg N, 200 kg P₂O₅ and 200 K₂O per ha in the form of urea (46% N), triple super phosphate (45% P₂O₅) and muriate of potash (60% K₂O) respectively equally split as basal and 4 top dressings at two-week intervals. Cattle manure at 10 t/ha was also applied before planting. Carbofuran 3G at a rate of 20 kg/ha was basally applied. Mites were controlled with Sulphur and insect pests with Tameron during the first two seasons and by Selecron during the third and fourth. Physiologically young seed tubers were obtained from the Sita Eliya Government Farm and transported in batches every 4 weeks in order to avoid long period of storage under warm conditions at Kalpitiya. Harvesting was done at 80 days after planting (DAP). At harvest, number of plants harvested, tubers per 10 plants and total tuber number and weight per net plot (2.4 × 3.5m) in each of the tuber size catogeries (ie. 25mm, 25—50mm and 50mm in diameter) were recorded. Tubers less than 25mm in diameter were considered unmarketable. Daily maximum and minimum air temperatures, soil temperatures, RH and pan evaporation data were collected at the station.

Details regarding planting dates during the four maha seasons were as follows:

Maha season 1983/84: Planting commenced from the 45th week (6/11) and then continued at weekly intervals till the 50th week (12/12). Number of haulms per hill were recorded at 60 DAP.

Maha season 1984/85: Treatments consisted of 8 planting dates, beginning from the 39th week (25/9) at 2 week intervals till the 1st week (2/1) of the following year.

Maha season 1985/86: Treatments consisted of 7 planting dates, commencing from the 40th week (2/10) at 2 week intervals till the 52nd week (24/22). Tuber specific gravity was determined on 2 kg samples of 25—50mm sized tubers by water and air method (Murphy and Goven, 1959).

Maha season 1986/87: Treatments consisted of 7 planting dates, beginning from the 41st week (5/10) at 2 week intervals till the 2nd week (8/1) of the following year.

RESULTS

Climatic conditions

Mean minimum temperatures ranged from 21.6°C in December to 24.2°C in March during maha 1983/84, 22°C in December to 24.7°C in March during maha 1984/85, 21.7°C in November to 25.6°C in March during maha 1985/86 and 21.0°C in December to 26.5°C in March during maha 1986/87 (Table 1). The total rainfall values during maha season (from November to March) were 1040 mm with 54 rainy days in 1983/84, 558 mm with 34 rainy days in 1984/85, 680 mm with 39 rainy days in 1985/86 and 389 mm with 21 rainy days in 1986/87.

Maha season 1983/84

The germination was unaffected by the date of planting; however the number of haulms per hill at 60 DAP was significantly lower for the last two plantings (Table 2). The highest tuber yields were obtained from 6/11 planting (26.1 t/ha) and yields tended to decrease gradually with late plantings, while 12/12 planting recorded the lowest yield (10.3 t/ha). Plantings after 20/11, recorded significantly lower marketable tuber yields. Number of tubers per hill decreased from early November planting (23.2) to mid-December planting (10.0). Small tuber (less than 25 mm) and diseased tuber percentages increased with late plantings and treatments planted after 20/11, recorded significantly higher percentage of small tubers. Average tuber weight was lowest in the mid-December planting.

Maha season 1984/85

The highest total mean yield was obtained from 18/12 planting (21.2 t/ha), which was significantly higher than early and late plantings except 4/12 planting (Table 3). Tuber yield had increased gradually from 25/9 planting up to 18/12 planting and then dropped significantly; 2/1 planting recorded the lowest yield (9.5 t/ha). Number of tubers per hill, percentage small tubers and number of haulms per hill did not follow a definite trend with the time of planting; however, number of tubers per hill was highest with 18/12 planting while the lowest was observed from 9/10

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and 20/11 plantings. Per cent small tubers was highest with 2/1 planting while 25/9, 4/12 and 18/12 plantings recorded the lowest. Average tuber weight was highest with 9/10 planting which thereafter decreased gradually with 2/1 planting recording the lowest.

Maha season 1985/86

Total tuber yield was highest (14.6 t/ha) when planted on 13/11 (Table 4). Tuber yield had increased steadily up to mid-November and then decreased gradually. Plantings after November 13th recorded significantly lower yields. Number of tubers per hill followed almost a similar trend as the total yield. Percentage small tubers was significantly higher when planted after 30th October.

Tuber specific gravity had increased appreciably in the November and early December planting compared to October and late December plantings. Percentage diseased tubers had increased in plantings after October 30th.

Maha season 1986/87

November 26th planting recorded a significantly higher total tuber yield over all other planting dates except 12/11, where as only January 8 planting recorded significantly lower marketable tuber yield (Table 5). Average number of tubers per hill also followed almost similar trend as the total tuber yield. Percentage smaller tubers increased progressively with later plantings. January 8th planting recorded the highest per cent of small tubers. Tuber specific gravity increased slightly in late November and December plantings and then dropped in the January planting although the differences were not significant. Per cent diseased tubers, had not shown any distinct trend with planting dates.

DISCUSSION

The growth parameters such as canopy cover and stem/hill (not shown) varied with no consistent trend. Total tuber yield was highest in mid-November planting in three out of four seasons tested, with the exception of maha 1984/85 where the highest tuber yield was recorded in mid-December planting (Tables 2—5). Higher number of tubers per hill mainly contributed to the significantly higher total tuber yields. Lower night temperatures that prevailed during tuber initiation (4—6 weeks after

planting) in mid-November planting may have favoured the tuber initiation (Table 1). Murthi *et al* (1976) showed that under warmer conditions tuber initiation is influenced greatly by night temperatures. In maha 1984/85 lowest night temperatures were recorded during the month of January (Table 1); thus the December plantings were benefitted. However, generally the marketable tuber yield was not significantly different with planting dates (Tables 2—5) except in late plantings (Late December and January). Per cent small tubers were significantly lower in October and early November plantings and increased gradually up to January planting. This indicated that the air temperature and other climatic factors do have an influence on the bulking phase. Vander Zaag *et al* (1984) showed the importance of the diurnal temperature difference and lower night temperatures for satisfactory bulking. Also the percentage diseased tubers was higher with late plantings in two out of three seasons observed. Thus, although the mid-November planting recorded a significantly higher total tuber yields, marketable tuber yields were not significantly higher over earlier plantings as the bulking phase of the latter entered into the periods of rising soil temperature, in late January and February.

Tuber specific gravity, which is directly related to the tuber dry matter content D. G., (Robertson 1984, unpublished data), increased in mid-November and early December plantings. Taja *et al.* (1984) recorded higher tuber specific gravity by planting during the cooler part of the season. However, the present results indicate that tuber specific gravity decreased in late plantings (during cooler period) which were harvested during warmer part of the season, showing that cooler temperatures during harvesting time is more crucial to the tuber dry matter content under warmer conditions. Midmore (1984) also noted that lowering of the soil temperature during the bulking phase through mulching had an influence on the increase of dry matter levels.

Studies made over the four seasons indicated that the environmental factors do have a direct influence on the tuber yield. Also the results obtained showed the feasibility of planting in October at Kalpitiya, which would be more economical based on market conditions (Fig. 1). A staggered planting commencing from October may be desirable due to unpredictable weather in the area.

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Table 1: Temperature data at Kalpitiya (°C).

Month	Week	1983 / 84 maha season				1984 / 85 maha season				1985 / 86 maha season				1986 / 87 maha season			
		Air Temp.		Soil Temp. at		Air Temp.		Soil Temp. at		Air Temp.		Soil Temp. at		Air Temp.		Soil Temp. at	
		Maxi.	Mini	6.30	15.30	Maxi.	Mini.	6.30	15.30	Maxi.	Mini.	6.30	15.30	Maxi.	Mini.	6.30	15.30
September	37	31.4	26.7	30.4	33.5	31.2	24.8	31.8	34.5	31.0	25.5	33.6	36.8	29.4	25.0	32.9	34.9
	38	31.2	27.1	30.3	33.7	31.5	25.1	32.8	35.3	31.5	25.2	39.3	36.9	29.9	24.5	32.9	35.7
	39	32.3	26.9	31.6	36.3	32.3	24.8	30.5	33.8	30.7	24.1	30.5	40.7	30.1	25.5	33.4	35.5
October	40	32.5	27.1	32.3	35.5	30.6	25.3	29.8	33.2	30.7	25.3	30.4	36.0	30.0	25.7	33.4	35.3
	41	32.0	27.4	32.8	35.2	32.1	24.2	31.1	35.2	30.7	25.9	31.4	36.1	30.6	24.4	32.1	36.1
	42	31.4	25.2	31.2	34.0	31.5	23.2	31.9	34.9	31.3	25.5	32.0	36.1	27.7	21.6	29.1	34.1
November	43	30.3	25.7	29.7	33.7	32.3	23.7	32.1	35.1	32.1	23.7	31.4	36.0	30.6	22.4	29.0	35.2
	44	30.6	24.5	26.1	30.9	29.8	23.2	29.8	33.2	32.2	23.2	27.9	37.1	30.1	24.4	29.0	34.3
	45	27.8	24.6	27.3	33.6	30.3	23.6	27.3	34.6	29.8	23.1	27.1	26.9	30.0	24.9	28.1	33.2
December	46	27.4	23.9	29.6	34.9	28.8	24.0	28.6	34.9	30.6	22.2	27.1	33.3	31.4	20.5	30.2	35.2
	47	26.1	24.2	28.3	34.5	28.9	23.2	26.6	30.1	29.5	24.0	28.7	35.3	31.1	23.6	31.3	34.1
	48	28.8	23.5	27.9	33.9	29.2	22.6	26.5	29.9	29.9	22.6	29.6	33.5	31.0	23.8	28.9	31.9
January	49	27.0	23.7	26.5	32.4	28.4	22.8	27.1	32.7	29.9	22.7	26.7	31.5	31.0	23.9	27.5	32.4
	50	26.9	23.9	26.7	31.3	27.5	23.5	28.1	33.8	31.4	22.9	29.6	34.4	31.4	22.6	30.3	35.4
	51	26.7	23.7	25.6	29.2	28.7	23.2	28.9	33.5	29.9	22.5	27.9	33.5	32.7	21.6	30.3	33.7
February	52	27.2	23.5	26.4	33.6	27.2	22.3	28.8	33.2	30.4	22.4	27.1	32.7	32.8	24.1	27.9	35.9
	1	26.8	23.6	26.5	32.6	27.2	22.6	28.7	33.1	28.9	22.6	27.8	31.2	32.9	23.1	27.7	32.6
	2	28.3	23.1	25.8	31.5	26.8	23.2	28.8	34.7	27.1	23.2	29.7	27.1	33.0	22.6	29.2	33.1
March	3	27.4	23.3	26.9	32.1	29.5	23.3	27.7	33.3	30.2	22.0	28.0	34.4	30.7	22.9	29.1	32.8
	4	27.6	24.0	28.9	32.1	30.7	22.6	29.5	34.5	30.3	22.4	29.7	32.6	29.9	22.2	30.5	32.9
	5	27.2	23.4	27.6	31.0	30.1	22.6	27.6	31.5	31.0	20.9	30.1	33.4	30.2	22.2	30.8	32.8
April	6	28.6	23.6	26.2	31.4	31.7	22.4	27.8	34.2	31.6	21.9	31.3	34.3	30.1	21.7	31.0	33.3
	7	29.2	23.7	25.8	29.1	31.4	23.8	30.8	35.6	31.8	23.4	30.6	34.7	29.9	22.3	31.1	33.5
	8	29.8	23.5	26.5	34.9	31.0	22.9	30.7	36.1	30.9	21.5	30.1	34.8	32.1	21.9	32.2	34.9
May	9	28.0	23.5	27.8	31.9	31.9	23.5	29.9	35.5	31.3	22.8	28.6	33.9	31.1	22.4	32.4	34.9
	10	32.7	24.4	25.2	34.7	32.7	23.5	32.5	36.9	31.0	22.7	28.6	34.6	32.4	23.6	33.5	36.7

Table 2. Influence of planting date on components of yield of potato at Kalpitiya — maha 1983 / 84

Planting dates	Total tuber yield (t/ha)	Marketable yield (t/ha)	No. of tubers / hill	No. of haulms / hill at 60 DAP	Av. tuber weight (g)	% No. of smaller tubers (<25mm)		% germination at 15 DAP.		% No. of diseased tubers	
						*Transfor- med values	Original values	*Transfor- med values	Original values	*Transfor- med values	Original values
06-11-1983	26.1	24.9	23.2	4.76	30.9	27.3	21.5	66.2	82.6	0.0	0.0
13-11-1983	21.4	17.3	20.1	4.83	35.3	27.2	21.3	56.4	69.3	15.3	8.7
20-11-1983	22.6	20.2	17.6	3.76	38.9	33.6	30.9	57.5	70.6	12.1	5.0
27-11-1983	21.2	16.9	16.3	5.06	26.5	41.5	43.9	73.7	90.6	18.0	10.3
04-12-1983	19.5	16.4	8.6	2.91	31.8	36.2	34.9	68.0	85.3	24.2	16.9
12.12-1983	10.3	7.0	10.0	2.35	24.4	40.7	42.6	67.5	84.6	23.7	17.6
Mean	20.2	17.1	15.1	3.95	31.3	34.4	32.5	64.9	80.5	15.5	9.7
C. V. %	15.7	20.2	25.0	22.4	17.1	14.7	—	10.9	—	34.0	—
L. S. D. (0.05)	5.7	6.3	7.2	1.56	n.s.	8.7	—	n.s.	—	12.4	—

*Mean values after arc sine transformation

n.s. — not significant

Table 3. Influence of planting date on components of yield of potato at Kalpitiya — maha 1984 / 85

Planting dates	Total tuber yield (t / ha)	Marketable yield (t / ha)	No. of tubers / hill	No. of haulms / hill	Av. tuber weight (g)	% No. of smaller tubers (< 25mm)	
						*(Transformed) values	Original values
25 - 09 - 1984	10.2	8.5	15.1	3.06	22.3	24.2	16.8
09 - 10 - 1984	10.4	8.5	9.6	3.08	38.2	25.1	18.0
23 - 10 - 1984	10.4	7.8	10.6	2.66	35.8	29.4	24.2
06 - 11 - 1984	11.9	8.6	12.5	3.33	33.0	31.6	27.5
20 - 11 - 1984	12.5	9.0	9.6	3.73	30.0	31.5	27.3
04 - 12 - 1984	15.1	12.4	14.2	4.13	31.9	25.0	17.9
18 - 12 - 1984	21.2	17.4	19.6	3.80	20.0	24.4	17.1
02 - 01 - 1984	9.5	6.5	10.7	2.66	19.0	33.4	30.3
Mean	12.6	9.8	12.7	3.30	28.7	28.0	22.3
C. V. %	30.0	25.0	25.0	30.0	28.0	24.0	—
L. S. D. (.05)	7.0	n. s.	5.6	n. s.	n. s.	n. s.	—

*Mean values after arc sine transformation

Table 4. Influence of planting date on components of yield of potato at Kalpitiya — maha 1985/86

Planting dates	Total tuber yield (t/ha)	Marketable yield (t/ha)	No. of tubers/hill	Av. tuber weight (g)	Av. tuber specific gravity	% No. of smaller tubers (> 25mm)		% No. of diseased tubers	
						*Transformed values	Original values	*Transformed values	Original values
02-10-1985	6.9	6.3	5.3	35.4	1.047	15.3	7.0	2.2	0.3
16-10-1985	10.1	9.4	8.1	37.7	1.047	10.0	3.2	10.1	3.3
30-10-1985	12.6	11.9	8.6	32.7	1.047	10.0	3.2	5.3	1.2
13-11-1985	14.6	10.7	6.7	32.3	1.061	17.7	9.4	23.1	17.0
27-11-1985	7.7	5.9	5.4	30.8	1.052	19.3	10.9	18.8	12.6
11-12-1985	5.4	3.6	5.5	26.4	1.052	23.6	17.3	23.5	16.6
24-12-1985	6.7	3.9	5.7	16.7	1.047	29.7	25.1	24.0	17.0
Mean	9.1	7.4	6.5	30.3	1.050	17.9	10.9	15.3	9.7
C. V. %	19.6	22.0	18.0	20.0	2.1	32.0	—	30.0	—
L. S. D. (.05)	3.0	n. s.	1.9	10.3	0.015	10.4	—	14.1	—

* Mean values after arc sine transformation

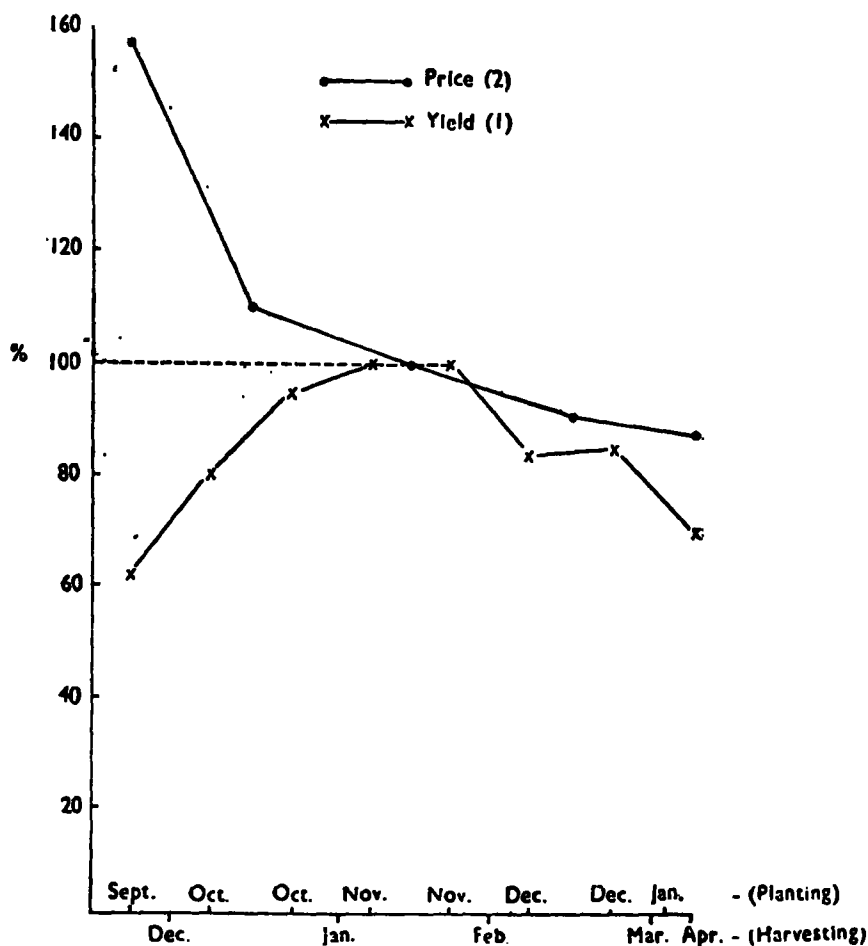
Table 5. Influence of planting date on components of yield of potato at Kalpitiya — maha 1986/87

Planting dates	Total tuber yield (t/ha)	Marketable yield (t/ha)	No. of tubers / hill	Av. tuber weight (g)	Av. tuber specific gravity	% No. of smaller tubers (<25mm)		% No. of diseased tubers	
						*Transformed values	Original values	*Transformed values	Original values
15-10-1986	13.6	10.6	10.4	20.4	1.062	41.0	43.2	14.7	6.7
29-10-1986	15.4	12.4	9.5	24.4	1.064	44.5	49.1	8.0	2.8
12-11-1986	16.7	11.3	11.5	21.9	1.062	47.4	54.2	10.9	3.6
26-11-1986	20.3	11.8	12.6	23.1	1.077	46.4	52.4	19.0	11.5
10-12-1986	15.7	10.6	9.4	23.3	1.072	48.7	55.7	9.3	2.8
24-12-1986	14.3	8.2	7.9	23.9	1.072	50.8	59.8	10.7	3.9
08-01-1986	8.4	2.1	6.7	19.3	1.062	62.9	78.8	11.2	4.1
Mean	14.9	9.6	9.7	22.3	1.067	48.8	56.2	12.0	5.1
C. V.	20.5	27.0	27.5	18.5	—	12.2	—	30.0	—
L. S. D. (.05)	4.5	3.9	4.0	n. s.	—	8.9	—	n. s.	—

*Mean values after arc sine transformation.

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Fig. 1. Change in marketable yield and market prices as a % of mid - November Planting and February prices respectively. (November planting harvested in February)



1. Marketable tuber yield from 83 / 84 — 86 / 87 at Kalpitiya were averaged to get % yield values.
2. Monthly average retail prices of potato in Colombo Market from 1980 — 84 were used to get % price values.
(Source. — Food Commodities Bulletin No. 31, A. R. I. I., Sri Lanka).