

Was the 2002/03 Maha's Bumper Paddy Harvest due to El Niño?

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Abstract: During the last six decades, Sri Lankan paddy production has systematically increased due to improved technology and enhanced cultivation. Along with this trend, there is also a year-to-year variation in harvest primarily due to rainfall variations. An analysis of these variations shows that during the global El Niño climatic episodes, the odds are that Yala harvest decreases and Maha harvest increases. During El Niño episodes, there is usually an increase in the rainfall from October to December which is the planting phase of the Maha season leading usually to an increase in paddy production. The 2002/2003 Maha was during an El Niño season and heavy rains fell during this period and it is likely that 2002/2003 bumper Maha crop was influenced by the El Niño event. Since the rise in paddy production was likely due to a climatic anomaly, it would be unwise to change agricultural policy to discourage paddy cultivation.

1. Introduction

During the last six decades, national paddy production has systematically increased due to factors such as high-yielding seed varieties, increased fertilizer application, increases in land under cultivation and use of tractors ([16], [5], [13]). Along with this trend, there is also a year-to-year variation in harvest primarily due to rainfall variations [15]. An analysis of the year-to-year rainfall variations shows that during the global El Niño climatic episodes, the odds are that Yala harvest decreases and Maha harvest increases ([7], [17]). There are exceptions to this association. This may indeed have been the cause of the rise in paddy production in last Maha as an El Niño persisted through it.

The term El Niño was coined by fisher folk a century ago to describe the unusually warm waters that would occasionally form along the coast of Ecuador and Peru. This phenomenon typically occurred late in the calendar year near Christmas, hence the name El Niño (in Spanish for "the boy child", referring to the Christ child). Today the term El Niño is used to refer to a broader global scale phenomenon associated with changed oceanic and atmospheric states in the tropics [6].

The Pacific is a large ocean and changes in its surface temperatures affect other tropical regions through an atmospheric "bridge". Just as much as there is a land-sea-breeze day and night because of contrasts in heating rates of the land and oceans, there are east-west patterns of circulation caused by the successive layout of

oceans and continents as one follows the equator. It is this circulation pattern that is affected by the warm Pacific and which in turns affects Sri Lanka on the other side of the world.

La Niña is the opposite phase of the El Niño and is characterized by cooler than normal sea surface temperatures across much of the tropical eastern Pacific. A La Niña event often, but not always, follows an El Niño and vice versa. Once developed, both El Niño and La Niña events tend to last for roughly a year although occasionally they may persist for 18 months or more. The time between successive El Niño events is irregular but they typically tend to recur every 3 to 7 years. El Niño and La Niña are both a normal part of the earth's climate and there is recorded evidence of their having occurred for hundreds of years.

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The impact of El Niño on Sri Lanka is to increase the rainfall in the last quarter of the year and to reduce the rainfall thereafter ([8], [12], [11], [7]). The El Niño is the major large scale influence, but its influence may be counteracted in some seasons by impacts such as variations in the Indian Ocean, Asian land mass changes and volcanoes. Thus in considering predictions based on El Nino, one needs to make allowance from one El Niño event to the next.

The bumper paddy harvest during the 2002/2003 *Maha* season led to some celebration and left farmers with poor prices and inadequate storage. Sri Lankan policy makers wondered whether this bumper harvest shall be sustained. Indeed in 1982/83, after three decades of sustained increases in paddy production, there was a bumper harvest in both *Yala* and *Maha* seasons and subsidies were reduced. Here, it is argued that it would be unwise to change agricultural policy to discourage paddy cultivation on the basis of the past bumper yield as the bumper harvest was mostly likely due to the climatic phenomenon known as El Niño.

2. Data and Methods

2.1 ENSO Identification

The El Niño and La Niña years were identified following Trenberth [14]: El Niño conditions persist when the average sea surface temperature in the NINO3.4 area of the equatorial Eastern Pacific Ocean (5°N-5°S, 120-180°W) exceeds a threshold of 0.4°C. The sea surface temperatures were obtained from the estimates of Kaplan *et al.*,

[4]. This data can be obtained from <http://iridl.ldeo.columbia.edu/SOURCES/.KAPLAN/.Indices/.NINO34/>. La Niña conditions are associated with the NINO3.4 index being below -0.4 °C. *Maha* and *Yala* seasons were associated with El Niño and La Niña when the NINO3.4 values surpassed their respective thresholds during at least three months of that season (table 1).

2.2 Rainfall Index for Sri Lanka

Sri Lanka has been divided into three principal agro-climatic zones [10]. The Wet, Intermediate and Dry zones have been demarcated based on hydrology, meteorology, soils and vegetation [10]. The Wet zone receives an annual rainfall of more than 2500 mm; the Intermediate zone receives between 1750 and 2500 mm; and the Dry zone receives less than 1750 mm in a year. A district-wise analysis of paddy production (Department of Census and Statistics, Sri Lanka, [1-3]) shows that the contribution to the island-wide paddy production from the Dry, Intermediate and Wet zone districts are in the ratio of 3:1:1.

The rainfall records from five stations located in paddy growing areas were used to compute a rainfall index for paddy production in Sri Lanka. Three rainfall-measuring stations were selected in the Dry zone at Anurhadhapura, Batticaloa and Amparai. The fourth rainfall measuring station at Kurunegala is located in the Intermediate zone and the fifth station was chosen from the Wet Zone at Ratnapura. The average of the rainfall in these five stations is used in this paper as a representative index. The annual climatology for

Table 1:

Maha (October to March) and Yala (April to September) seasons that are associated with El Niño and La Niña based on the SST in the NINO3.4 region of the equatorial Eastern Pacific ocean.

Maha			Yala		
El Niño		La Niña	El Niño		La Niña
1951/52, 1957/58, 1963/64,	1954/55,	1955/56,	1953, 1957, 1963, 1965,	1954,	1955, 1956,
1965/66, 1968/69, 1969/70,	1964/65,	1970/71,	1969, 1972, 1982, 1983,	1964,	1971, 1974,
1972/73, 1976/77, 1977/78,	1973/74,	1974/75,	1987, 1991, 1992, 1993,	1975, 1988	
1979/80, 1982/83, 1986/87,	1975/76,	1984/85,	1994, 1997		
1987/88, 1991/92,	1988/89,				
1994/95	1995/96				



this rainfall index shows a bimodal variation with one mode peaking in May and the other in November (Figure 1). The two cultivation seasons commence with these rains. A composite climatology for periods when only El Niño, Normal or La Niña conditions persisted is also shown in figure 1. The rainfall in May, October, November and December shows an increase in rainfall during the El Niño period and the rainfall in January, February, March, July and August shows a decline in rainfall during El Niño months (Table 2). The departures from climatology are in the opposite sense for La Niña episodes in July, August, October, November and December but not for January, February and March.

3. Analysis

3.1 Paddy Production

The trend of the paddy production in Sri Lanka for both *Maha* and *Yala* from 1952 to 1997 ([1-2]) was estimated from a five-year running mean (Figure 2 and 3). The seasonal production anomaly is computed as the difference between the paddy production in a given year and the running mean computed with a 5-year window centered on that year. The fractional production anomaly is the production anomaly normalized by the running mean production for a given year. The yield too shows an increasing trend and the yield anomaly is computed in the same manner as the production anomaly.

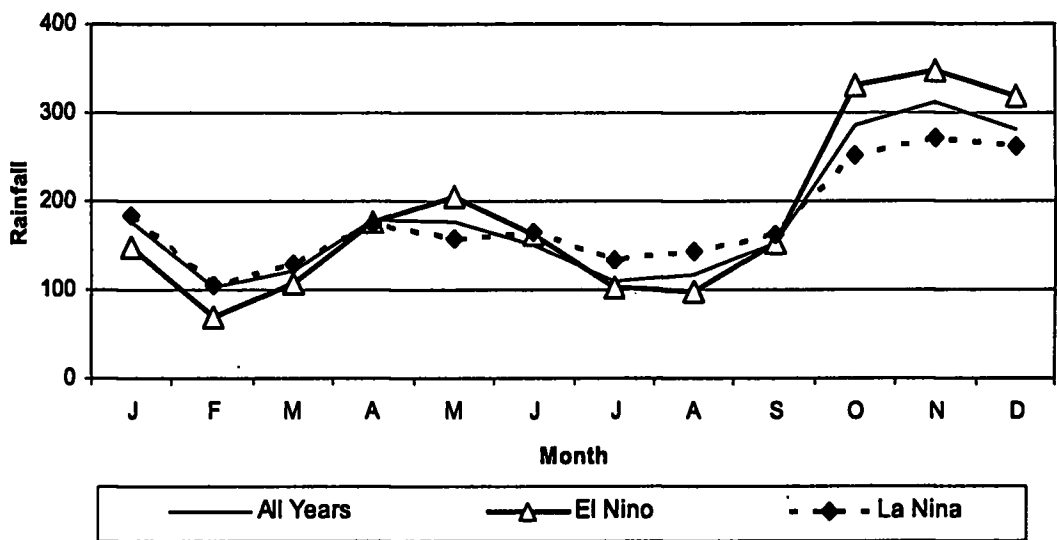


Figure 1: The monthly climatology of rainfall index for the paddy producing areas of Sri Lanka.

Table 2:
Average seasonal rainfall for Sri Lanka in paddy farming areas during all years from 1952 to 1997 and El Niño and La Niña seasons. ONDJFM refers to the collection of months from October to March period and AMJJAS for April to September. The percentage departure from average is provided in the brackets.

Rainfall (mm)		All Years	El Niño	La Niña
Maha	ONDJFM	1278	1320 (+3%)	1196 (-7%)
	OND	878	998 (+14%)	783 (-11%)
	JFM	400	323 (-19%)	413 (+3%)
Yala	AMJJAS	883	898 (+2%)	931 (+5%)
	AMJ	505	543 (+8%)	494 (-2.2%)
	JAS	378	355 (-6%)	437 (16%)



The trend for both *Maha* and *Yala* paddy production (figure 2 and 3) shows a steady increase from 1952 to 1983. A reason for the decline in yield from 1989 to 1992 was the withdrawal of the subsidy given for fertilizer purchases to farmers [9]. Cultivation was affected in the northern regions of the island after 1983 due to civil disturbances. A declining trend in *Maha* rainfall contributed to the declining

production trends. The mean *Maha* rainfall from 1983-1997 was 1110 mm compared with 1233 mm from 1952-1982. However, the declining rainfall trends was not the only cause of declining production; a similar analysis for *Yala* shows that while rainfall did not drop, there was a decline in production from 1983 to 1997.

3.2 Seasonal Rainfall, Paddy Production and Anomalies of Production

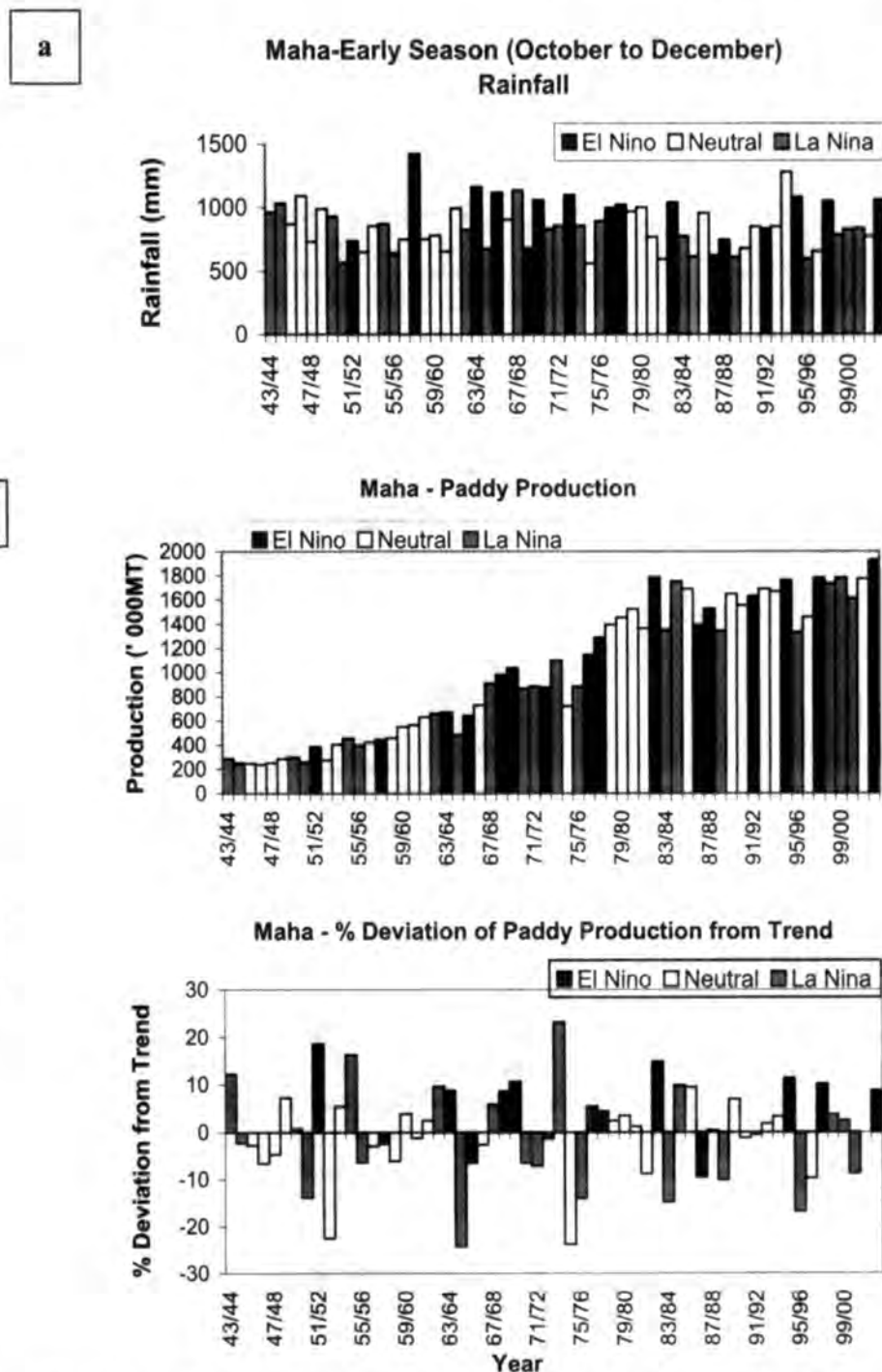
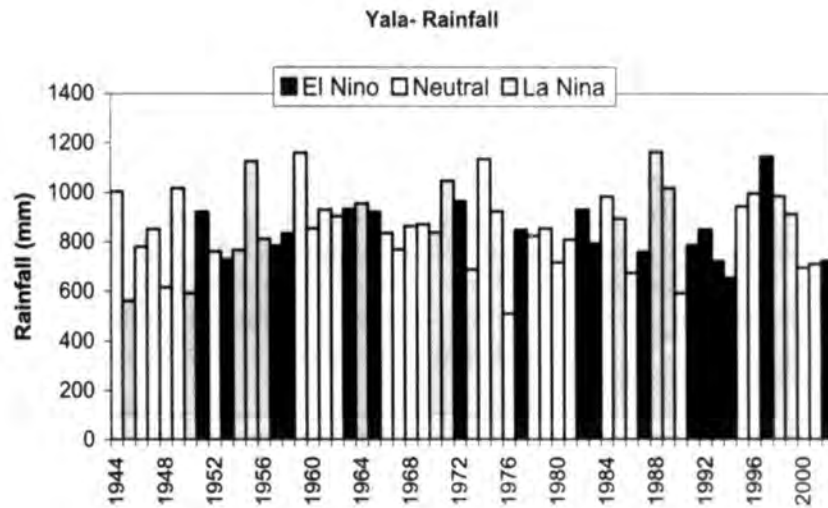
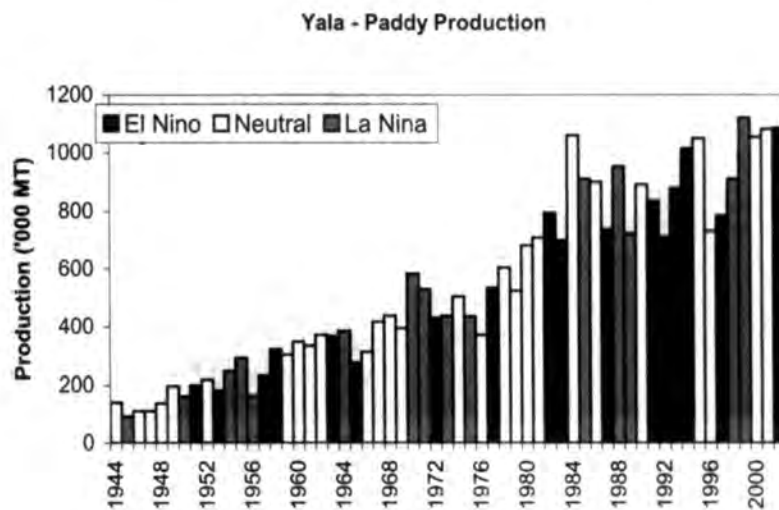


Figure 2 : (a) October to December Rainfall during the planting phases of the Maha season. (b) The seasonal paddy production in Maha. (c) The departure of the seasonal production from the five year running average is shown normalized by the five year average. All parameters are identified with different phases of El Nino, Neutral and La Nina.

a



b



c

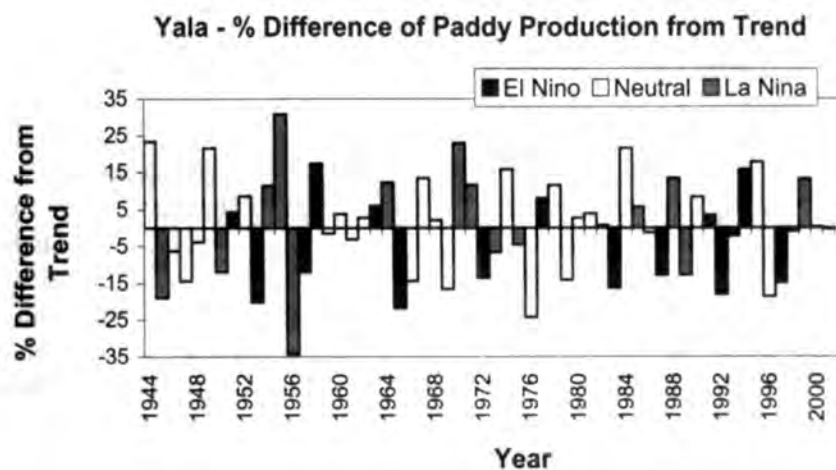


Figure 3: (a) The Rainfall during the planting phases of the Yala season. (b) The seasonal paddy production in Yala. (c) The departure of the seasonal production from the five year running average is shown normalized by the five year average. All parameters are identified with different phases of El Nino, Neutral and La Nina.



3.3 Statistics of Maha and Yala production anomalies during El Niño and La Nina seasons

Table 3:
Summary of historical rainfall and paddy harvest anomalies in Sri Lanka for El Niño and La Niña seasons from 1952 to 1997. Rainfall anomaly is defined as the departure of season’s rainfall for that particular year from the season’s mean rainfall computed from 1952-1997. Paddy harvest anomaly is defined as the departure of the season’s production for a particular year from five year running average for that season (Five year running average = average of production for the period two years before it, that year and two years after it).

Season	Anomaly	El Niño Seasons	La Niña Seasons
<i>Maha</i>	Rainfall	Rise in 10 out of 15	Drop in 7 out of 10
	Rice Harvest	Rise in 10 out of 15	Drop in 7 out of 10
<i>Yala</i>	Rainfall	Drop in 8 out of 14	Rise in 6 out 8
	Rice Harvest	Drop in 10 out of 14	Rise in 6 out of 8

During El Niño periods, the *Yala* rainfall drops from the seasonal mean usually. Since *Yala* is a water-constrained season, only half the land is cultivated and the impact of rainfall anomalies is brought out more clearly and there is a slightly stronger relationship between El Niño and production. If the La Niña lasts through both, a *Maha* and a *Yala* then the combined paddy production tends to drop in Sri Lanka as the *Maha* harvest is about twice that of *Yala*.

If the El Niño lasts longer than two seasons, then the drop in *Yala* cultivation may be offset by the increase in *Maha* harvest. Indeed, since the cultivation in *Yala* is only half as that in *Maha*, the combined harvest shows only a weak increase during El Niño episodes. However, this tendency for one season to be more bountiful than the other has important consequence for the livelihood of the farmers, marketing, storage, national policy and historical outcomes.

3.4 What happened during Maha 2002/2003

During 2002/2003 *Maha*, an El Niño started in July 2002 and went on until May 2003. Indeed, the agro-meteorologist of the Department of Agriculture, Dr. Ranjith Punyawardhene, who has undertaken research on this topic, did issue this forecast to extension officers of the Agriculture Department in early October 2002.

‘According to the last update on the current El Niño conditions issued by the International Research Institute for Climate

Prediction, there is nearly 100% chance that El Niño conditions will continue for the remainder of 2002 and up to early 2003.

Studies conducted in Sri Lanka have revealed that El Niño events are more likely to cause near or above normal rains during October and November of *Maha* season. Thus, it could be safely assumed that prevailing rainy weather may continue during October-November, 2002.’

4. Conclusions

During El Niño episodes there is usually an increase in rainfall over Sri Lanka from October to December at the start of the *Maha* season, and an increase in paddy production. In certain years, the rainfall was so heavy that there were floods so that the production got disrupted. Factors such as war, sudden changes in fertilizer policy and a hike in the previous seasons harvest can influence the paddy production along with the climate. Not every El Niño results in an increase in rainfall at the planting season and it is only the most important of several global climatic factors that influences Sri Lanka’s climate.

The 2002/2003 *Maha* was during an El Niño season and as is likely heavy rains did transpire for the *Maha* of 2002-2003. In keeping with the historical relationship between heavy *Maha* rainfall and increased paddy harvest, it is likely that 2002-2003 bumper *Maha* crop was influenced by the El Niño event significantly.

Production may increase for various reasons such as subsidies, price changes, new irrigation schemes, previous seasons' poor harvests and war. Of these conditions, only the ceasefire in the civil war in February 2002 could have led to cultivation of enhanced area. It is likely that both peace and El Niño conditions contributed to the increased cultivation. One cannot be certain to be definitive about the relative weight of both factors, yet at least in terms of the El Niño factor, this anomalous increase in production was not part of a trend. National planning must not assume that it shall be replicated.

Indeed, the national paddy production for *Maha* of 2003/2004 has dropped to 1,669,663 MT from 1,894,694 MT in the previous *Maha* [3].

After the subsidies were reduced subsequent to the bumper harvest in 1982/83 (which was again an El Niño year), there was a dramatic drop in paddy production in the following years. Indeed, the rate at which the paddy production increased decade after decade dropped in 1982. There could be several reasons for that such as the reluctance of the government to provide subsidies, a reduced emphasis on self-sufficiency, the exhaustion of the so-called green revolution, urbanization, labour shortages, low prices, irrigation shortfalls and the civil wars. In retrospect, the withdrawal of the subsidies in 1983 was the wrong incentive. Of course, the policy makers were oblivious to the El Niño and indeed it was in 1982 that the first research paper on the relationship between Sri Lankan rainfall and El Niño [8] was published. Shortly thereafter they reversed their decisions at tremendous cost. Two decades later, this mistake should not be repeated.

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