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ABSTRACT

This paper assesses the economic value of climate variability, employing a percentile analysis on an array of 31-years national annual coconut production data from 1971 to 2001. Of the production array, 10% and 90% percentiles have been considered respectively as lower and upper production extremes. The 60% of production departures of each year of extremes with respect to the mean production of 10% to 90% percentile were attributed to climate variability because studies show that the 60% of the variation of coconut production is explained by climate. These production deviations were then valued multiplying by free-on-board (FOB) prices of fresh coconuts. Results show that the foregone income from coconuts due to low rainfall varied between US$ 32 million to US$ 73 million while the incremental coconut income in crop glut extremes due to high rainfall varied between US$ 42 million and US$ 87 million. Results show that the climate variability causes income losses to the economy estimated at US$ 32 million to US$ 73 million in years of extreme crop shortage. And in years of extreme crop surplus, the economy realises income gains of US$ 42 million to US$ 87 million. These indicate the potential for significant economic benefits from investments in adaptations that would reduce variability in nut production which is caused by variations in climate. Further work is however needed to estimate the effectiveness and economic benefits that might be achieved from investments in adaptation.

1. INTRODUCTION

Coconut (*Cocos nucifera* L) is a perennial tree crop that contributes significantly to the economy of Sri Lanka. Coconut cultivation spans about 402 649 ha which accounts for 21 per cent of agricultural lands in the country. It contributes 2 per cent to Sri Lanka's GDP, 2.5 per cent to export earnings and 5 per cent to employment. Although these numbers are modest, coconut is an important food crop in Sri Lanka in that it provides about 22 per cent of the per capita calorie intake in the diet, being second only to rice paddy, the staple food of Sri Lankans. Coconut is almost exclusively grown as a rain fed crop in Sri Lanka. Rainfall and temperature are the important climatic factors influencing the coconut yield (Peiris *et al*. 1995), and by extension the national coconut production, upon which domestic culinary consumption and processing industry depend. Although the influence of climate variability has been quantified (Peiris *et al*. 1995), there has been no estimate of the economic value of climate on coconut production. Such a valuation of the climate influence on coconut is needed to understand the significance of climate variability and to provide an estimate of the investments that are justified in any adaptation strategy for climate variability and by implication for climate change. We attempt to do that in this paper.

The immediate effect due to variability of rainfall involves the decrease/increase in national coconut production, which we call as the first order effect, the impact of first order effect being negative and positive respectively in the lower and upper production extremes.

Of the national coconut production, the biggest single use (60% - 75%) is for the domestic culinary consumption (Table 1), followed by desiccated coconuts (DC), coconut oil and so on.

Table 1: Pattern of utilization of national coconut production (from 2000 to 2004)

Category	2004		2003		2002		2001		2000	
	million nuts	%	million nuts	%	million nuts	%	million nuts	%	million nuts	%
• Coconut oil production	127.6	4.86	110	4.29	264.88	10.8	566.02	19.53	390.78	12.62
• Desiccated coconut production	439.1	16.74	369.19	14.14	245.6	10.01	407.64	14.06	712.24	23
• Net copra exports	86.61	3.29	100.96	3.94	70.76	2.88	81.06	2.8	84.1	2.72
• Fresh nut exports (No.s)	41.36	1.57	34.53	1.35	23.68	0.97	27.52	0.95	29.02	0.94
• Coconut cream & coconut milk exports	45.71	1.74	37.66	1.47	10.04	0.41	10.05	0.35	9.99	0.32
• Fresh nut for local consumption	1853	70.59	1834	71.58	1815.55	74.01	1786.2	61.61	1849.17	59.73
• Defatted coconut	.	.	.	.	.	.	.	.	.	.
• Coconut milk powder	32.02	1.21	25.22	0.99	22.47	0.92	20.16	0.7	20.68	0.67
• Adjustment for year end stock	-35	.	50.44	1.97	60	.	130	.	.	.
Total Nut Production	2590.4	100	2562	100	2392.98	100	2768.7	100	3095.98	100

Source: Sri Lanka Coconut Statistics (various years).

When the national coconut is in a glut, local market consumer price of coconuts drops, DC production rises, coconut oil production rises. The above economic effects of coconut glut/shortage in the industrial sectors would be considered as second and higher order effects.

2. METHODOLOGY

Data

Annual national coconut production data from 1971 to 2001 was obtained from Sri Lanka Coconut Statistics published in various years. The annual average free-on-board (F.O.B) prices of fresh coconuts exported in focused years of the study were also collected from the above source.

Analytical Procedure

We first identify the climate extreme years, using 1971 to 2001 national coconut production data, employing percentile analysis. Then the climate characteristics of the identified extreme years are examined, followed by a simple estimate of economic value of climate variability on coconut production in the identified extreme years.

- ***Identification of extreme years***

During 1971 to 2001 (31 years), national coconut production varied from 1821 million nuts (minimum in 1977) to 3096 million nuts (maximum in 2000) with a mean of 2435.90 million nuts (cv= 14%). The lower and upper bounds of extreme production years were assumed respectively as 10% and 90% percentiles of the production array.

- ***Valuation of first order climate impacts on coconut industry***

The departures of production in each year of the lower and upper production extreme years with respect to the mean production of the 10% to 90% percentile (which is 2432 million nuts), were computed. These production departures would not be attributed solely to climate variability, because the changes in other factors such as fertilizer use, level of technology adoption, management etc. would also intervene. The effect of the latter factors could be crudely excluded by considering that only a 60 per cent of the production departures are due to the climate variability because Peiris (2006) found that 60 per cent of the variation of coconut production is explained by climate. The 60 per cent of the production departures were then multiplied by free on board (F.O.B) prices of coconuts to derive the foregone/additional economic values to the economy in nominal terms.

4 RESUTLS AND DISCUSSION

Based on percentile analysis, the extreme production years were identified (Table 2).

Table 2: Extreme production years resulted from to percentile analysis

Percentile	Production extreme	Million nuts	Extreme years
10%	Shortage	< 1948	1973, 1977, 1984, 1988

90%	Glut	> 2828	1985, 1986, 1999, 2000

- ***Climate characteristics of the extreme years***

Some 75% of the lands under coconuts are located in the area called “coconut triangle”, and hence the coconut triangle significantly contributes to the national production in a given year. Therefore, we present the climate characteristics of the identified extreme years only of the coconut triangle.

Since it is well established that the t^{th} year coconut yield is significantly influenced by the rainfall of the $t\text{-}1^{th}$ year (Peiris, 2006), we present in Table 3 the annual average rainfall of the coconut triangle in the immediately preceding years to the identified extreme years.

Table 3: Annual average rainfall of the coconut triangle in immediately preceding years of extreme production years

Production extreme	Year	Rainfall (mm) $_{t-1}$
Shortage	1972	2278
	1976	1574
	1983	1475
	1987	2036
Glut	1984	2451
	1985	2047
	1998	2059
	1999	2208

As Table 3 shows, there is no discernible relationship between the coconut production and the rainfall of the coconut triangle in shortage and extreme gluts. This may be at least partly because the temporal distribution of rainfall influences the yield than the total rainfall.

Table 4 shows that the foregone income to the economy in crop shortage extremes varied between US $ 54 million to US $ 73 million while the additional income accrued in crop glut extreme varied between US $ 42 million to US $ 87 million, all figures in nominal terms.

Table 4: Departures of coconut production from the mean in extreme years and their economic values

Production extreme	Corresponding year	Production (million nuts)	Change in production (million nuts) wrpt* mean production – A	60% of column A	F.O.B** price (Rs/nut)	Foregone/incremental Value (Rs million) (Figures in parentheses are million US $)
Shortage	1973	1948	484	290.4	0.68	197 (32)
	1977	1821	611	366.6	1.15***	422 (49)
	1984	1942	490	294	6.48	1905 (73)
	1988	1937	495	297	5.82	1728 (54)
Glut	1985	2958	526	315.6	3.59	1133 (42)
	1986	3039	607	364.2	3.50	1275 (46)

	1999	2828	396	237.6	17.61	4184 (59)
	2000	3096	664	398.4	16.57	6601 (87)

*- with respect to.

**- Free on board.

***- No shipments of fresh nuts were allowed in 1977, but we approximated the f.o.b. in 1976.

1 US $ = approx. Rs 105 as on 20 December 2004.

4. CONCLUSIONS AND IMPLICATIONS

The economic value of climate variability in terms of foregone/additional coconut production to the economy has been estimated, employing a percentile analysis using a national coconut production data array of 1971 to 2001 (31 years). The foregone income to the economy in crop shortage extremes varied between US$ 32 million and US$ 73 million while the incremental income to the economy in crop glut extremes varied between US$ 42 million and US$ 87 million. It was found that the climate variability causes income losses to the economy estimated at US$ 32 million to US$ 73 million in years of extreme crop shortage. On the other hand, in years of extreme crop surplus, the economy realises an income gain of US$ 42 million to US$ 87 million. These imply the potential for significant economic benefits from investments in adaptations that would reduce variability in nut production that is caused by variations in climate. Further work is however needed to estimate the effectiveness and economic benefits that might be achieved from investments in adaptation.

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Sri Lanka Coconut Statistics (various years). Coconut Development Authority, Colombo.

ANNEX

Table A1: National coconut production (1971 to 2001)

Year	Million nuts
1971	2668
1972	2812
1973	1948
1974	2030
1975	2585
1976	2330
1977	1821
1978	2207
1979	2393
1980	2026
1981	2258
1982	2521
1983	2312
1984	1942
1985	2958
1986	3039
1987	2292
1988	1937
1989	2484
1990	2532
1991	2184
1992	2296
1993	2164
1994	2622
1995	2755
1996	2546
1997	2630
1998	2522
1999	2828
2000	3096
2001	2769

Source: Sri Lanka Coconut Statistics (various years).