Trend in Wheat Flour Consumption and Forecast of Future Wheat Flour Consumption in Sri Lanka

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ABSTRACT

This study estimated the past trend in wheat consumption and the most appropriate model to forecastfuture wheat consumption in Sri Lanka. Data on domestic wheat consumption over a period of fifty five years (1960 to 2014) was used and trends in five different periods (1960 - 2014, 1970 - 2014, 1980 - 2014, 1990 - 2014, and 2000 - 2014) were estimated separately. For each period considered, four functional forms (Simple linear, double-log, right-sided semi log and left-sided semi log) were estimated using the ordinary least square (OLS) technique. Based on the statistical and econometric criteria right-sided semi log equation was identified as the best fit for 1960 - 2014 period, and simple linear equation was the best fit for 1970 - 2014 period, double-log equation was the best fit for 1980 - 2014, 1990 - 2014, and 2000 - 2014 periods. When best fit equations were subjected to further econometric analysis using Theil's inequality coefficient, the double-log equation for the period 2000 – 2014 (adjusted R2 = 0.35) had the least value (0.175) and it was selected as lead time series to forecast future wheat consumption. The forecasted future wheat requirements based on the

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double-log equation for the period 2000 - 2014 are 876,800 MT, 885,000 MT, 891,900 MT, and 897,700 MT in 2020, 2025, 2030, and 2035 respectively if the current trends continue.

KEYWORDS: *Forecast, Trends, Wheat consumption*

1 INTRODUCTION

Wheat(*Triticum* spp.) is a cereal grain, originated in the Levant region of the Near East and wheat is grown in more land area than any other commercial crop today and continues to be the most important food grain. This is one of the most important food crop that provides nearly one-fifth of the world's calories (Mitchell and Mielke, 2003). Different wheat-based Products includes primary products such asroti, pan-cakes, cookies and cakes, bread (normal, special, roasted); special flour preparations (doughnuts, biscuits, pies)pastries(buns, rolls, and noodles) and pasta(Borsdorf, 1993).

Diet diversification, globalization, urbanization and changing lifestyle of the people have changed in food consumption pattern in Sri Lanka over the past few decades has resulted due to income induced. Rice is the staple food in Sri Lanka and more often Sri Lankans used to have three rice based meals per day with curry. Now a days, most of the urban dwellers in Sri Lanka have one or two rice based meals. The majority of the middle income consumers, especially the working mothers go for bread or "take away" meals due to convenience as well as busy life style and high cost of cooking energy.

Though wheat flour and wheat flour based food are becoming popular in Sri Lanka, wheat is not produced in Sri Lanka. Thus the total requirement of wheat flour is met through imports. According to the United States Department of Agriculture (USDA 2014), Sri Lanka's wheat imports were 1,232, 000 MT, 1,108,000 MT, 892,000 MT, 773,000 MT, 1,200,000 MT, and 1000,000 MT in the years of 2010, 2011, 2013, 2014 and 2015 respectively. According to the USDA (2014), Sri Lanka has ranked as the 61stcountry in terms of wheat flour consumption in 2015.

Sri Lanka spends a large amount of scarce foreign exchange on wheat imports. Sri Lanka imports wheat from Australia, Philippines, China, Singapore, Thailand, and Malaysia. At the same time domestic rice production also has increased causing marketing problems for rice. Rice production consumes a number of inputs which are imported spending foreign exchange. Under these circumstances, it is worthwhile to examine, as a developing country, whether Sri Lanka can afford continue to import wheat flour at the expense of rice production? Therefore, this paper analyses the past trends in wheat flour consumption and attempts to forecast future demand for wheat flour consumption in Sri Lanka. This type of empirical evidence would be useful to the government of Sri Lanka in developing policy instruments to strike a balance between rice production and wheat flour imports.

2 MATERIALS AND METHODS

Data on annual consumption of wheat flour and milled rice in Sri Lanka were collected from the Foreign Agricultural Service(FAS), Division of the United States Department of Agriculture (USDA-2014). Data covered a period of fifty five years from 1960 to 2014. Data were analyzed using time series data analyzing techniques. The following equations were estimated using ordinary least square regression technique.

Simple leaner, $Q = a + bT + e$ .....(1)

Double-log, $LnQ = a + bLnT + e$ .....(2)

Right-sided semi log, $Q = a + bLnT + e$ .....(3)

Left-sided semi log, $LnQ = a + bT + e$ .....(4)

Where Q = Quantity of wheat flour consumed in year 't', T = time variable (1,2,3..n) for each year. a = intercept, b = regression coefficients e = error term.

Above four equations were estimated for each of the following five different periods: 1960-2014, 1970-2014, 1980-2014, 1990-2014 and 2000-2014. This analysis was done because multi-period approach reduces that the prediction errors are reduced to the barest minimum by making allowance for the choice of the best out of many tested trend periods. Further statistical tests were employed to select the best model to predict the future wheat consumption trend. The Theil's inequality coefficient was the best tool used to choose the best model.

$$U = \left[\sum(Q_t - q_t)^2 / \sum\left(Q_t - q_{(t-1)}\right)^2\right]^{1/2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where Q_t is the actual observation in period t, q is the predicted value of the observations and $q_{(t-1)}$ is one year lag of the actual observation and U is the theil's index. U has a lower limit of zero but no upper limit. If $U = 0$, it implies that$Q_t = q_t$. There by the prediction is perfect. If $U = 1$, it implies that $q_t = q_{(t-1)}$ the prediction for a particular year was approximately equal to one year lag of the actual observation for the year. If, $U > 1$ the predictive power of the model is worse than the zero change prediction. The smaller the value of the inequality coefficient the better is the forecasting performance of the model (Koutsoyiannis, 1977).

3 RESULTS AND DISCUSSION

3.1 Trend in wheat flour consumption

Graphical analysis

The graphical representation of domestic wheat flour consumption is presented in Figure 1. The trend line indicated that wheat flour consumption was highly fluctuating from 1960 to 1967, including several rapid declines in 1960-1961, 1964-1965, and 1966-1967and rapid increases in 1963-1964, 1965-1966. The annual consumption of wheat flour has been increasing gradually from 1967 (513,000 MT) to 1977 (800,000 MT) including several lower

consumptions in 1972 (561,000 MT) and 1974(586,000 MT). Prior to the economic reforms, there was an import restriction and a rigorous food drive in Sri Lanka. At the same time, there was a prolonged drought and country received food aids. Those factors may have contributed to the observed fluctuations in wheat consumption.

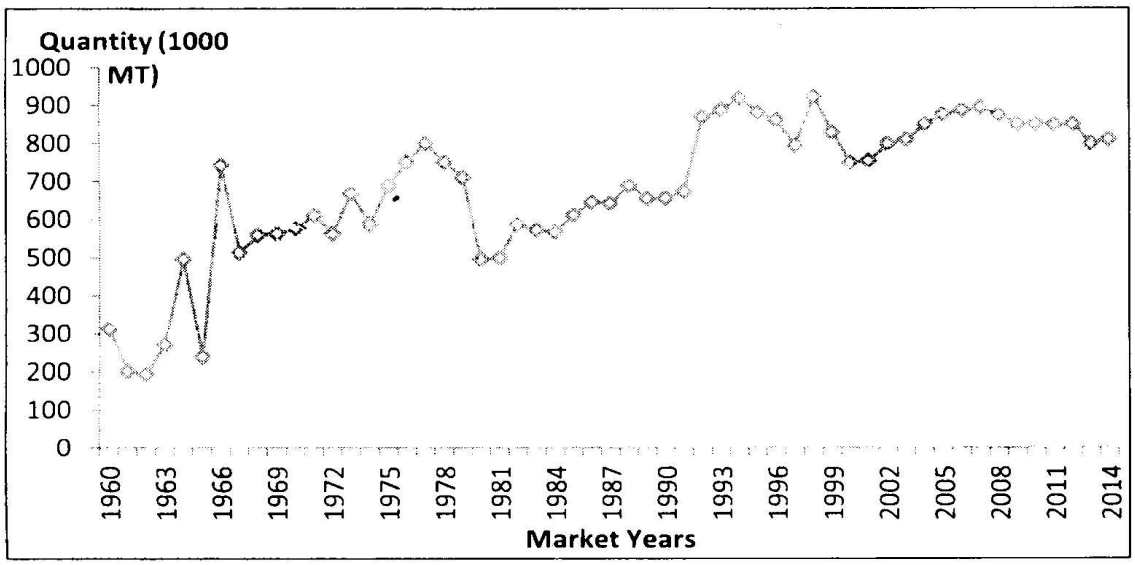

FIGURE 1: Trend in wheat flour consumption in Sri Lanka

Source: Developed by the authors (2016)

Between 1977 and 1980 the annual wheat consumption has declined drastically and has increased gradually thereafter up to 1990.During the period from 1960 to 2014, domestic consumption of wheat flour has increased by 499,000 metric tons from 311,000 metric tons in 1960 to 810,000 metric tons in 2014 and it is a 62 percent increase. This increase in wheat flour consumption could be attributed to the increase in income and population growth, changes in living styles of the general public and changes in government policies and financial supports. The previous three decades were recorded the maximum average wheat flour consumption and that was nearly about 834,500 metric tons.

Figure 2 presents wheat flour consumption as a share of total consumption of cereals (wheat flour and rice). The lowest share of wheat was recorded in 1962 (15.09%) and largest

was recorded in 1976 (36.35%). After 1976,it had been declining reveling that, the rational consumer has consumed more rice than wheat flour.

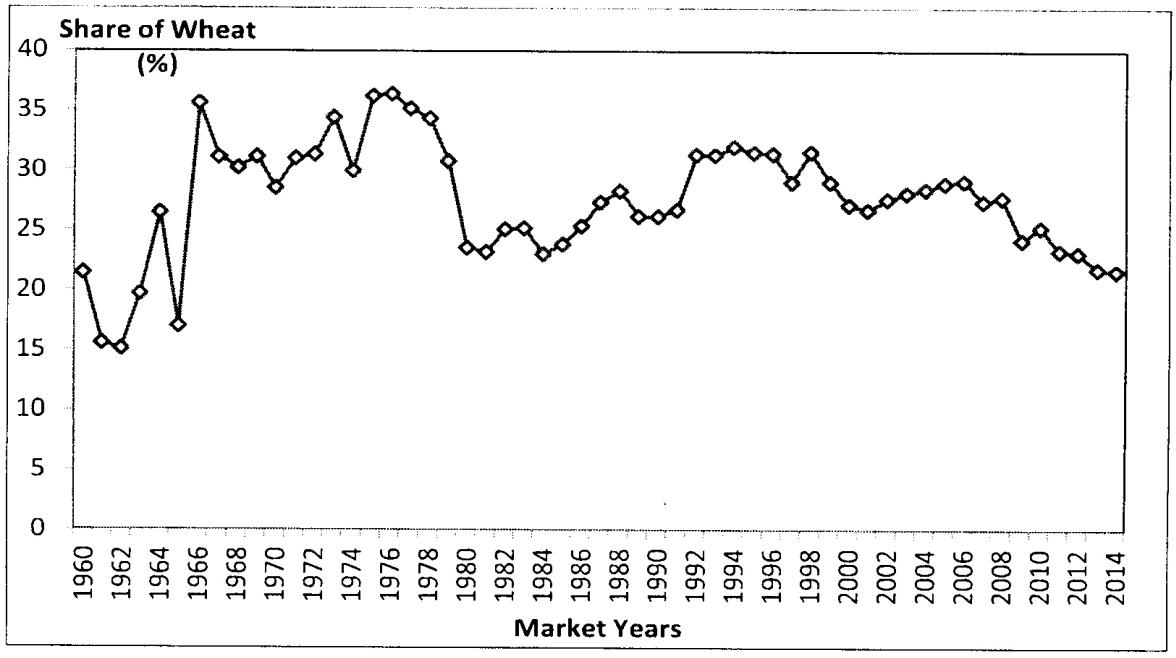

FIGURE 2: Wheat flour consumption as a percentage of total consumption of wheat and milled rice in Sri Lanka

Source: Developed by the authors (2016)

3.2 Regression analysis

In order to forecast future wheatrequirements, regression functions (Simple linear, double-log, right-sided semi log and left-sided semi log) were estimated and results are presented in table 1.

TABLE 1: Results of the OLS regressions of domestic wheat flour consumption

Period		Functional Forms	R^2	Adj.R^2	T-Stat	F-Ratio	P-value
1960 2014	to	1).Q = a+bT+e	0.6499	0.6433	13.54	98.40	<0.0001
		2).LnQ=a+bLnT+e	0.7265	0.7213	57.12	140.76	<0.0001
		3).Q=a+bLnT+e	0.7285	0.7233	2.76	142.18	<0.0001
		4).LnQ=a+bT+e	0.5544	0.5460	88.03	65.94	<0.0001
1970 2014	to	1).Q=a+bT+e	0.5325	0.5216	22.45	48.98	<0.0001
		2).LnQ=a+bLnT+e	0.4279	0.4146	90.23	32.16	<0.0001
		3).Q=a+bLnT+e	0.4370	0.4239	9.85	33.37	<0.0001
		4).LnQ=a+bT+e	0.5217	0.5106	170.9	46.90	<0.0001
1980 2014	to	1).Q=a+bT+e	0.5927	0.5804	20.9	48.02	<0.0001
		2).LnQ=a+bLnT+e	0.7939	0.7876	134.7	127.10	<0.0001
		3).Q=a+bLnT+e	0.7470	0.7394	12.09	97.46	<0.0001
		4).LnQ=a+bT+e	0.6094	0.5975	161.9	51.48	<0.0001
1990 2014	to	1).Q=a+bT+e	0.0551	0.0140	29.15	1.34	0.2586
		2).LnQ=a+bLnT+e	0.2024	0.1678	140.8	5.84	0.0240
		3).Q=a+bLnT+e	0.1729	0.1369	20.01	4.81	0.0387
		4).LnQ=a+bT+e	0.0692	0.0287	192.2	1.71	0.2039
2000 2014	to	1).Q=a+bT+e	0.1393	0.0731	34.54	2.10	0.1706
		2).LnQ=a+bLnT+e	0.3976	0.3513	221.6	8.58	0.0117
		3).Q=a+bLnT+e	0.3807	0.3331	30.81	7.99	0.0143
		4).LnQ=a+bT+e	0.1493	0.0839	237	2.28	0.1548

Note: (Best fit equations are underlined and in bold)

Source: Developed by authors (2016)

Both t-statistics and F-ratios of the models represented the periods 1960 - 2014, 1970 - 2014, and 1980 - 2014 were significant ($p<0.05$) in all four forms of equations. Models representing periods 1990 – 2014 (simple linear, and left-sided semi log) and 2000 – 2014(simple linear and left-sided semi log) were not significant. The adjusted R-squared

varies from 1% to 72%. The right-sided semi-log (adjusted R^2=0.7233) functional form was chosen as the best fit equation for the period from 1960 to 2014 and simple linear (adjusted R^2=0.5216) best fit for the period from 1970 to 2014, while double log equation was chosen as the best fit equations for three periods; 1980 to 2014(adjusted R^2=0.7876), 1990 to 2014 (adjusted R^2=0.1678) and 2000-2014 (adjusted R^2=0.3513).

TABLE 2: Intercepts and Slope Coefficients of the best-fitted equations

Period	Best-fitted Functional Forms	Intercept (a)	Coefficient (b)
1960 to2014	**Q=a+bLnT+e**	**132.3956**	**413.8402**
1970 to2014	**Q=a+bT+e**	**584.6465**	**6.9004**
1980 to2014	**LnQ=a+bLnT+e**	**2.66465**	**0.18559**
1990 to2014	**LnQ=a+bLnT+e**	**2.87208**	**0.04614**
2000 to2014	**LnQ=a+bLnT+e**	**2.88506**	**0.04375**

Source: Developed by authors (2016)

Table 2 represents the intercepts and coefficients of best fitted equations, obtained from the OLS regressions. The right-sided semi log regression function , Q=132.3956+413.8402LnT, was the best equation for the period 1960-2014 while the simple linear, Q=584.6465 + 6.9004 T was the best for 1970-2014. Double log equations, LnQ=2.66465 + 0.18559LnT, LnQ=2.87208 + 0.04614LnT and LnQ= 2.88506 + 0.04375LnT were best fit for periods 1980-2014, 1990-2014 and 2000-2014 respectively.

The slope of the each trend line represents the rate of change in consumption within a one unit change in time. According to the Figure 3, the actual observations have deviated from the trendlinewith showing upwards and downwards. To choose the best out of best fitted equations Theil's inequality coefficient was used.

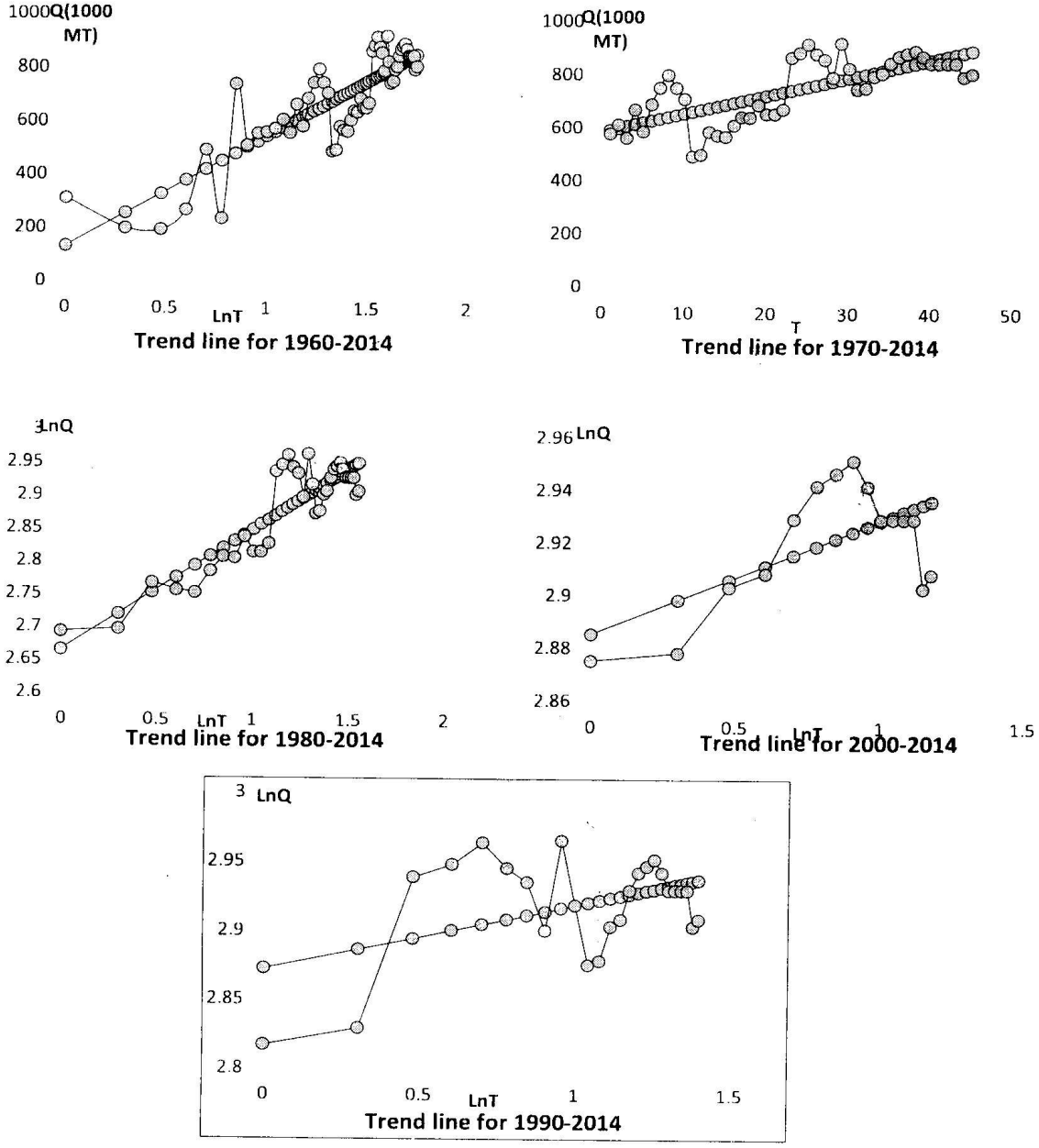

FIGURE 3: Trend line of best fitted equations for five different periods

Note: (Blue lines are predicted values and orange lines are actual values)

Source: Developed by authors (2016)

3.2.1 The Theil's inequality coefficient

Results of the Theil's inequality coefficient analysis revealed that, all the equations have good predictive power. The double-log equation(period 2000-2014) has the least valueof Theil inequality coefficient(0.175) which was close to zero (Table 3).Therefore, double log equation for the period 2000– 2014 was chosen as the lead equation to predict future trend inwheat consumption.

TABLE 3: U values for the best-fitted functional forms

Period	Best-fitted Functional Forms	$(Q_t - q_t)^2$	$(Q_t - q_{(t-1)})^2$	U
1960 to2014	Q=a+bLnT+e	521292.3071	730362	0.8448
1970 to2014	Q=a+bT+e	317279.0099	521934	0.7797
1980 to2014	LnQ=a+bLnT+e	141963.1035	343458	0.6429
1990 to2014	LnQ=a+bLnT+e	91512.10991	514658	0.4217
2000 to2014	LnQ=a+bLnT+e	17491.65277	570700	0.1751

Source: Developed by the authors (2016)

3.4 Forecasted requirements of wheat flour

Estimated values of wheat consumption in years from 2016 to 2035 are presented in table 4. According to the estimates, wheat consumption could be 876, 813 MT in 2020 and it represent an increase of 66,000MT compared to the amount consumed in 2014 (810,000MT).The equation LnQ = 2.88506 + 0.04375ln'T was used in forecasting.

Predicted milled rice consumption (Mrasinghe *et al.*, 2015) and wheat flour consumption plotted in figure 4 shows the trend of incremental total cereal consumption in Sri Lanka. It revealed that, the gap between the milled rice consumption and wheat flour consumption has increased with respect to the time from 2017 to 2035.

TABLE 4 : Predicted values of wheat consumption

Year	Predicted value ('000MT)	Year	Predicted value ('000MT)
2017	870.919	2027	887.918
2018	872.982	2028	889.282
2019	874.943	2029	890.602
2020	876.813	2030	891.881
2021	878.599	2031	893.121
2022	880.309	2032	894.324
2023	881.950	2033	895.493
2024	883.527	2034	896.629
2025	885.044	2035	897.735
2026	886.506		

Source: Developed by authors (2016)

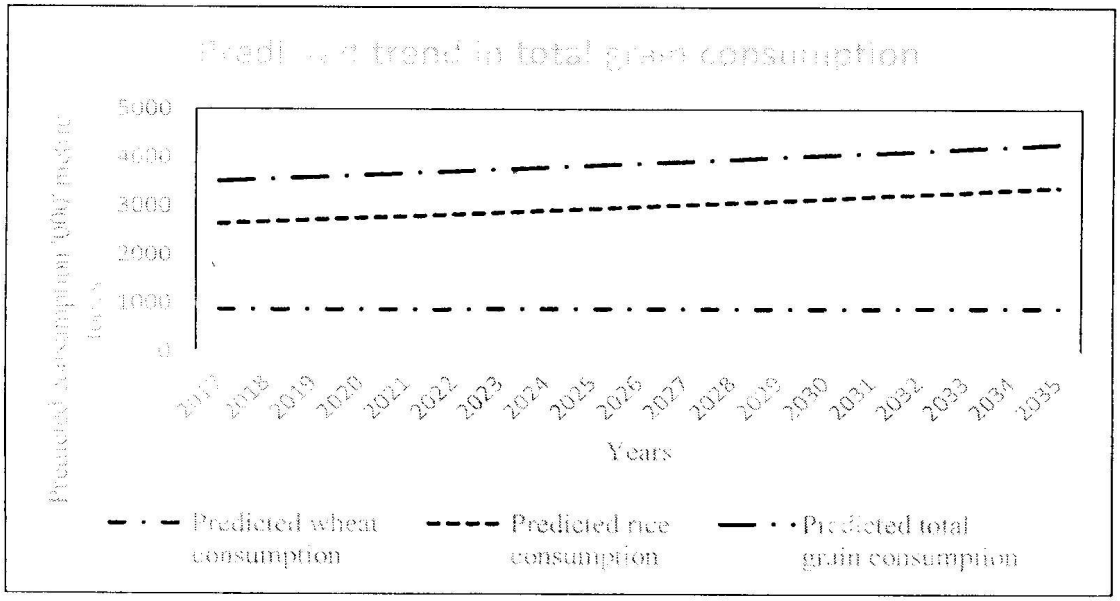

FIGURE 4: Estimated quantities for total cereal consumption from 2017 to 2035

Source: Adopted from USDA (2014)

4 CONCLUSION AND RECOMMENDATION

Initial focus of the study was to identify the trends in domestic wheat flour consumption in Sri Lanka and major concern wasto forecast future requirements of wheat. Consumption of wheat has a positive increasing trend with having creep and rapid increases and decreases. Wheat consumption by decades showed a high fluctuationsin first three decades and a tiny fluctuation thereafter. Both wheat flour and rice consumption showed high and minor fluctuations. LnQ=2.88506 +0.04375LnT was the equation used in forecasting future requirements of wheat flour. If the present growth rates continued, wheat requirements in Sri Lanka would be 876.813, 885.044, 891.881, 897.735, 902.858 million tons in 2020, 2025, 2030, 2035 and 2040 respectively.

It was clear that,consumption needs of rice in met through local production as well as thorough imports while wheat requirement is completely met with imports. If estimated trend in wheat consumption continued, it unnecessarily drains out scarce foreign exchange. So, a part of the requirement of wheat flour should be substituted with rice flour. In addition to that, if the estimated trend of wheat flour consumption continued, that would affect adversely on the rice market creating a series of new problems. Therefore, it is necessary to take policy initiatives to discourage wheat flour consumption and to promote rice and rice flour consumption. It is recommended to develop food items developed using wheat-rice flour mixtures and to discourage wheat flour consumption.

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