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A statistical investigation on analysis of food consumption pattern in India

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ABSTRACT

Diets, change over time and are influenced by factors such as income, prices, individual preferences and beliefs, cultural traditions, as well as geographical, environmental, social and economic factors. Food consumption pattern in India over the past two decades (period of 10 years) due to income induced diet diversification, impact of globalization, increasing urbanization and changing lifestyle of people. Thus per capita income steadily is increasing in real terms as well as at market prices both in urban and rural areas. The present context made an attempt to analyze the per capita consumption pattern for both rural and urban areas as well as to estimate the consumption trend for both the areas. The study of shift in food consumption pattern is also considered in this research. Changing pattern of food consumption is assessed by various linear and non-linear models for all data series. It is observed that Cubic model is best fitted model for wheat, coarse cereals, and pulses consumption data series for rural and urban areas. In case of rice consumption data set Quadratic model is found best fitted model in rural areas. Per capita consumption pattern of rice in both rural and urban household areas has reduced from 80 and 59.83 kg/year to 79.4 and 58.9 kg/year over the period 2010 to 2020. Per capita edible oil consumption has shown a steady upward trend in both rural and urban household areas by registering an increase from 4 to 8 kg/year in rural areas and from 6.6 to 10.2 kg/year in urban areas during 1987 to 2013. A significant increase in per capita milk consumption has taken place during the analysis period, both in rural and urban areas in response to increasing per capita income. From the forecasted value it is clear that food grains consumption pattern are declined over year to year and non-food grains consumption pattern are increased in Indian dietary system.

Keywords: Forecasting, shift in consumption pattern, trend models

Since independence in 1947, agricultural development policies in India have aimed at reducing hunger, food insecurity, malnourishment and poverty at a rapid rate. India, with a population of 1.25 million (2013) accounts for 17 per cent of world's population. Its size, in terms of consumers, is many-times larger than the average size of rest of the countries, except China. With regard to rice and wheat, while the compound annual rate of growth in area was marginal at 0.41 and 0.46 per cent, respectively during the 1980s, growth in both production and yield was above 3 per cent. During 1990-91 to 1999-2000,the same of area for rice and wheat improved to 0.68 and 1.72 per cent respectively, but it came down for both production and yield in the case of rice and yield in the case of wheat. The subsequent decade 2000-01 to 2011-12 experienced an improvement of area under wheat but the compound annual growth rate of production reduced for both rice and wheat although it is necessary to note that these two crops together constituted 78 per cent of total food grains production in 2009-2010 (Economic Survey, 2012-2013). There are the large differences in both production and consumption of pulses across regions, as well as the increase in imports in recent years. It argues that an improved package of practices, including technological interventions, and a region-specific approach are needed to alleviate the problem of short supply of pulses and chronic malnutrition among the people (Reddy, 2004).

Per capita consumption refers to the average consumption per person per year within a population. While this information can be useful for estimating how much a population consumes, it does not take into account the consumption disparities between individuals. In urban India, the analysis of food consumption is of greater interest as it permits not only to understand the food consumption pattern of an important and growing population, but also reveals the future trend of consumption habits in India. It is considered that the changes in consumption are more likely to happen in urban than in rural India. An understanding of the changing consumption pattern according to the extent of value addition would have implications not only for food grains demand projection but also for development policies. In the present context, an attempt is made to analyze the per capita consumption pattern for both rural and urban areas as well as to estimate the consumption trend for both the areas. The study of shift in food consumption pattern is also considered in this investigation.

MATERIALS AND METHODS

To study the per capita consumption of rice, wheat, coarse cereals and pulses and non-food grains items *i.e.* edible oils, milk, egg, meat, fish, onion, potato for both rural and urban areas for the period 1987 to 2013,necessary data are collected from the various

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issues of NSSO (National Sample Survey Organization) reports (38th, 43rd, 50th, 61st, 68th rounds).

Descriptive statistics

Descriptive statistics applied in the present analysis can broadly be categorized into measures of central tendency (CT), measures of dispersion and measures of associationship. Among these, the arithmetic mean, the standard deviation/error, skewness, kurtosis, maximum, minimum, SGAR percentage *etc*. are widely used to describe the given data for their obvious merits over other hosts of measures.

Jarque-Bera test: In statistics, the Jarque–Bera test is a goodness-of-fit test of whether sample data have the skewness and kurtosis matching a normal distribution. The test is named after Carlos Jarque and Anil K. Bera. The test statistic *JB* is defined as

$$JB = \frac{n-k+1}{6}\left(S^2 + \frac{(C-3)^2}{4}\right)$$

where *n* is the number of observations (or degrees of freedom in general); *S* is the sample skewness, *C* is the sample kurtosis, and k is the number of regressors.

The jarque-Bera test statistics has chi-square distribution $(JB \sim \chi^2)$ with two degrees of freedom for large sample and can be used to test the null hypothesis that the data is from normal distribution.

Parametric trend models

In statistics parametric models can be described using a finite number of parameters. These parameters are usually collected together to form a single *k*-dimensional *parameter vector* $\theta = (\theta_1, \theta_2, \ldots, \theta_k)$. Over the last several decades, regression and time-series models play a vital role for analyzing the dataset; as well as to develop the statistical models. Among the different class of statistical models (*viz*, parametric, non-parametric, semi-parametric) parametric models are known to be superior for their statistical properties. Many of cases it is very difficult to guess the most suitable functional form just from looking at the data and sometime the appropriate parametric form may not exist to express the functional form. In this study different parametric models are tried to explain and apply in several respective dataset under consideration.

Linear model: A linear model is one in which all the parameters appear linearly associated and it is formulated as $X_t = a + bt + e_t$.

Quadratic model: The quadratic model can be used to model a series which "takes off" or a series which "dampens". It is expressed as $X_t = a + bt + ct^2 + e_t$.

Cubic model: The equation of cubic model is a 3rd order of polynomial regression equation and it is represented as $X_t = a + bt + ct^2 + dt^3 + e_t$

Exponential model: The equation of exponential model is $X_t = a\left[Exp(bt)\right] + e_t$.

Logarithmic model: The equation of logarithmic model is given by $X_t = a + b\ln(t) + e_t$.

In order to apply these models, e_t is expressed as error term which is independently and identically normally distributed. In all the trend models, model significant was tested by F test and individual regression coefficient is tested using t test. The best fitted models are selected on the basis of maximum value of R^2 and minimum values of RMSE, MAPE, MAE, AIC and SBC. Standard statistical packages like SPSS and SAS are used for estimating the best fitted models through parameter estimation and goodness-of-fit.

Prediction and forecasting : In statistics, prediction is a one of the important part of statistical inference. On this particular approach, such inference is known as predictive inference, but the prediction can be undertaken within any of the several approaches to statistical inference. Indeed, one description of statistics is that it provides a means of transferring knowledge about a sample of a population to the whole population, and to other related populations, which is not necessarily the same as prediction over time. When information is transferred across time, often to specific points in time, the process is known as forecasting. In this study the Forecasting on time series is usually done using automated statistical software packages like SAS (Version 9.3), SPSS and XLSTAT.

RESULTS AND DISCUSSION

To examine the per capita food consumption data series, per se performance are presented in table-1 and 2 for both rural and urban areas respectively. In rural areas, the per capita consumption under rice has varied between 79.24 to 86.40 kg $year^{-1}$ with an average of 82.18 kg $year^{-1}$ registering a negative simple growth rate -0.27 per cent per annum. The negative growth rate confirms that per capita consumption of rice declines over the study period. The value of skewness (0.64) indicates that there has been shift of per capita consumption in favour of rice during the early phase

of study period. In case of wheat, the per capita consumption has varied between 49.21 to 58.80 kg year^{-1}with an average of 52.74 kg year^{-1} registering the negative simple growth rate -0.63 per cent per annum which indicates that per capita consumption of wheat is in decreasing order. The positive kurtosis (0.26) and skewness (0.72) indicates that there has been increase in per capita consumption of wheat during early half of the study period but could not be sustained for long period. The per capita consumption of coarse cereals has varied between 15.86 to 25.70 kg year^{-1} with an average of 20.67 kg year^{-1} registering negative simple growth rate -1.30 per cent per annum implying a deceleration in per capita consumption. The value of skewness (0.12) indicates that there has been shift of per capita consumption in favour of rice during the early phase of study period. In case of pulses, the positive kurtosis and skewness indicates that there has been increase in per capita consumption of pulses during early half of the study period but could not be sustained for long period. For testing of normality of all the series Jarque-Bera test is used, which is proves that all the data series are normally distributed.

Table 1: *Per se* performance of per capita consumption of food grains in rural area.

	rice	***wheat***	***Coarse Cereals***	***Pulses***
Mean	82.18	52.74	20.67	10.11
Standard Error	0.43	0.47	0.53	0.10
Kurtosis	-0.98	0.26	-0.94	2.82
Skewness	0.64	0.72	0.12	1.14
Jarque-Bera(p)	0.24	0.35	0.56	0.62
Minimum	79.24	49.21	15.86	9.30
Maximum	86.40	58.80	25.70	11.80
SGAR%	-0.27	-0.63	-1.30	-0.46

Note : SGAR=Simple growth rate, p=prob. Value kg year^{-1}

In urban areas, the per capita consumption of rice has ranged between 58.92 to 64.70 kg year^{-1} with an average of 61.88 kg year^{-1} registering a negative simple growth rate -0.28 per cent per annum. The negative growth rate confirms that per capita consumption of rice is in decreasing. The negative value of skewness (-0.14) and kurtosis (-1.36) indicates that there is marginal and consistent per capita consumption pattern of rice during the later phase of investigation. In case of wheat, the per capita consumption has varied from 56.40 to 58.70 kg year^{-1} with an average 57.23 kg year^{-1} registering the simple growth rate 0.04 per cent per annum which indicates that per capita consumption of wheat is in slightly increasing order. The positive kurtosis (2.05) and skewness (1.15) indicates that there is an increase in per capita consumption of wheat during early half of the study period but could not be sustained for long period. The per capita consumption of pulses in urban areas ranges from from10.32 to 12.34 kg year^{-1} with an average of 11.31 kg year^{-1}. The simple growth rate is -0.57 per cent per annum indicating an upward movement in per capita consumption of pulses. The negative value of skewness (-0.04) and kurtosis (-1.59) implies that there has been marginal and consistent per capita consumption pattern of pulses during the later phase of investigation. It is observed that per capita consumption of coarse cereals is registering negative simple growth rate -1.68 per cent per annum. To test the normality of all data set by using Jarque-Bera test, it is found that all the data series are normally distributed which are significant at 5 per cent level.

Different parametric models like polynomial, logarithmic and exponential models are used to estimate the best fitted trend. All estimated parameters and goodness of fit by those models are presented in table-3 for both the data series of rural and urban areas respectively. For testing parametric models, cubic model fits well for wheat, coarse cereals and pulses for both the data series of rural and urban areas. But in case of rice consumption data, quadratic model is selected for best fitted model for rural areas, whereas cubic model is fitted well for urban areas. The best fitted models are selected on the basis of maximum R^2 value, minimum value of RMSE, MAPE, MAE, AIC and SBC.

Per capita consumption trend of food grains in rural and urban areas are presented in fig. 1 and 2. Per capita rice consumption in rural households has declined from about 85 kg year^{-1} in 1987-88 to 81 kg year^{-1} in 1999-2000, but accelerated to 79 kg year^{-1} in 2012-13. A similar trend is noticed in the urban households in first period where per capita rice consumption declined from 64 kg year^{-1} in 1987-88 to 63 kg year^{-1} in 1999-2000 and further reduced to 58 kg year^{-1} in 2012-13. The trend in wheat consumption shows a similar pattern as that of rice but in less magnitude. Wheat consumption pattern in rural household areas has declined from 58 to 55 kg year^{-1} during the period 1987-88 to 1999-2000 and subsequently to 50 kg/year in the year 2012-2013. In urban household areas, wheat consumption shows a marginal increasing trend. Wheat consumption pattern in urban areas are increased during the period 1987-88 to 1996-97, after that the data series exhibits a decreasing order. From per se performance, it is also proved that as because of positive skewness and positive

kurtosis (Table 2). The wheat consumption in urban areas is slightly increased mainly because of increased consumption of wheat products such as bread, biscuits and noodles *etc*. In case of coarse cereals, the consumption pattern is in decreasing order during the period 1987-88 to 2012-13 and has registered a negative growth rate for both rural and urban areas. Coarse cereals consumption in rural household areas has declined from 24 to 16 kg year^{-1} whereas in case of urban households, it has come down from 7 to 5 kgv over the same period. Per capita coarse cereals consumption in rural households has decreased from about 11 to 10 kg year^{-1} during period 1987-2000 and further reduced to 9 kg year^{-1} in 2012-13. A similar trend was noticed in the urban households where per capita pulses consumption has dipped down from 12 to 11 kg year^{-1} over the period 1987-2000 and to 10 kg year^{-1} in 2012-13.Summarily, consumption pattern of coarse cereals, pulses in both rural and urban conglomerations shows similar trend over the entire study period. After selecting the best fitted trend models of per capita consumption pattern of food grains, all the data series are estimated and the projected value up to 2020 is depicted in table-4. Per capita rice consumption pattern in rural household areas are changed from 80 kg year^{-1} in 2010 to 79.4 kg year^{-1}in 2020, whereas in urban household areas it is changed from 59.83 kg year^{-1} to 58.9 kg year^{-1} at the same year. It is observed that per capita consumption of wheat is projected 47.80 kg year^{-1} in 2020 in case of rural household areas, whereas 57.30 kg year^{-1} in 2020 is projected in case of urban household areas. Per capita consumption of coarse cereals has shown much steeper decline than by rice and wheat. In rural areas consumption pattern of coarse cereals is forecasted 14.42 kg year^{-1} in 2016 and 14.90 kg year^{-1} in 2020. And in case of urban areas, per capita coarse cereals consumption is projected 4.53 kg year^{-1} in 2016 and 4.90 kg year^{-1} in 2020. Per capita pulses consumption is predicted to be 11.40 kg year^{-1} in 2020 in rural household areas and 12.90 kg year^{-1} in case of urban household areas. It is also found that the per capita consumption of total food grains are estimated to be 153.50 kg year^{-1} in rural areas and 134 kg year^{-1} in urban areas in the year 2020.

Shift in food consumption pattern

Per capita cereal consumption has exhibited a declining trend over years in both rural and urban India. Increase in per capita income and urbanization has led to changes in the composition of the food basket, with consumers moving from coarse cereals to superior cereals (rice and wheat). The allocation of monthly per capita expenditure on food items shows structural shift in dietary pattern in favour of non-cereal food items such as edible oils, vegetables, milk, meat, eggs and fish in both the areas. From fig. 3, it is confirmed that per capita consumption of food grains items is declined over the years. But per capita edible oil consumption has shown a steady upward trend by registering an increment from 4 to 8 kg year^{-1} in rural areas and from 6.6 to 10.2 kg year^{-1} in urban areas during 1987 to 2013 (Table 4). A significant increase in per capita milk, egg, meat, fish consumption has taken place during the analysis period, both in rural and urban areas in response to increasing per capita income. In rural households, per capita onion consumption has almost doubled from 4.6 to 9 kg year^{-1} and in urban households from 6.1 to 11 kg year^{-1} during the year 1987 to 2013. Being an essential ingredient in most non-vegetarian cooking, the increasing consumption of meat and poultry meat might have translated into increased onion consumption. The fluctuation in production and a steady growth in consumption have resulted in onion prices fluctuating widely from year to year. Potato per

Table 2: *Per se* performance of per capita consumption of food grains in urban area.

	Rice	***Wheat***	***Coarse cereals***	***Pulses***
Mean	61.88	57.23	5.75	11.31
Standard Error	0.35	0.10	0.23	0.13
Kurtosis	-1.36	2.05	-1.30	-1.59
Skewness	-0.14	1.15	0.39	-0.04
Jarque-Bera(p)	0.35	0.21	0.29	0.27
Minimum	58.92	56.40	4.06	10.32
Maximum	64.70	58.70	7.70	12.34
SGAR%	-0.28	0.04	-1.68	-0.57

Note : SGAR=Simple growth rate, p=prob. value *kg year^{-1}*

Table 3 : Best fitted trend models of per capita consumption of food grains in rural and urban area.

Rural											
Food grains	**Trend Model**	**Parameter Estimation**				**Goodness of Fit**					
		a	**b1**	**b2**	**b3**	**RMSE**	**MAPE**	**MAE**	**R^2**	**AIC**	**SBC**
Rice	Quadratic	86.49	-0.426	0.006		1.01	0.97	0.80	0.79	6.63	10.52
Wheat	Cubic	59.74	-1.512	0.104	-0.002	1.01	1.53	0.80	0.82	8.43	13.62
Coarse Cereals	Cubic	25.62	-0.451	0.011	-0.0003	0.76	2.63	0.56	0.92	6.74	7.73
Pulses	Cubic	10.72	-0.074	0.004	-0.0001	0.38	2.19	0.23	0.65	44.11	38.92

Urban											
Food grains	**Trend Model**	**Parameter Estimation**				**Goodness of Fit**					
		a	**b1**	**b2**	**b3**	**RMSE**	**MAPE**	**MAE**	**R^2**	**AIC**	**SBC**
Rice	Quadratic	63.12	0.353	-0.043	0.0009	0.62	0.81	0.50	0.88	17.62	12.44
Wheat	Cubic	55.70	0.485	-0.036	0.0007	0.38	0.49	0.28	0.70	30.07	27.48
Coarse Cereals	Cubic	7.65	-0.076	-0.009	0.0003	0.43	6.38	0.36	0.86	37.07	31.89
Pulses	Cubic	12.08	-0.067	0.003	-0.0001	0.41	2.58	0.29	0.60	39.75	34.56

Significant at 5% level

Table 4: Trend in per capita consumption in India both rural and urban areas.

Commodity	***Estimated based on NSS***							***Projected***		
Rural	**1987**	**1993**	**1995**	**1999**	**2004**	**2010**	**2013**	**2016**	**2018**	**2020**
Rice	85.20	84.00	84.00	81.36	79.70	80.09	79.24	78.39	77.83	79.4
Wheat	58.80	52.80	50.40	54.60	52.20	50.12	49.21	48.30	47.69	47.80
Coarse cereals	24.00	24.30	22.90	20.10	20.20	17.30	15.86	14.42	14.46	14.90
Pulses	10.70	9.30	10.00	10.70	9.90	10.62	10.41	10.19	11.05	11.40
Total food grains	178.70	170.40	167.30	166.76	162.00	158.14	154.73	151.31	151.03	153.50
Urban	***Estimated based on NSS***							***Projected***		
	1987	**1993**	**1995**	**1999**	**2004**	**2010**	**2013**	**2016**	**2018**	**2020**
Rice	63.60	64.20	64.20	62.64	59.00	59.83	58.92	58.01	57.40	58.9
Wheat	56.40	57.40	57.90	57.24	56.50	57.12	57.02	56.92	56.86	57.30
Coarse cereals	7.20	7.70	6.80	5.10	4.40	4.59	5.06	4.53	4.18	4.90
Pulses	12.10	10.50	11.70	12.00	10.40	10.59	10.32	10.05	12.87	12.90
Total food grains	139.30	139.80	140.60	136.98	130.30	132.14	131.33	129.52	131.31	134.00

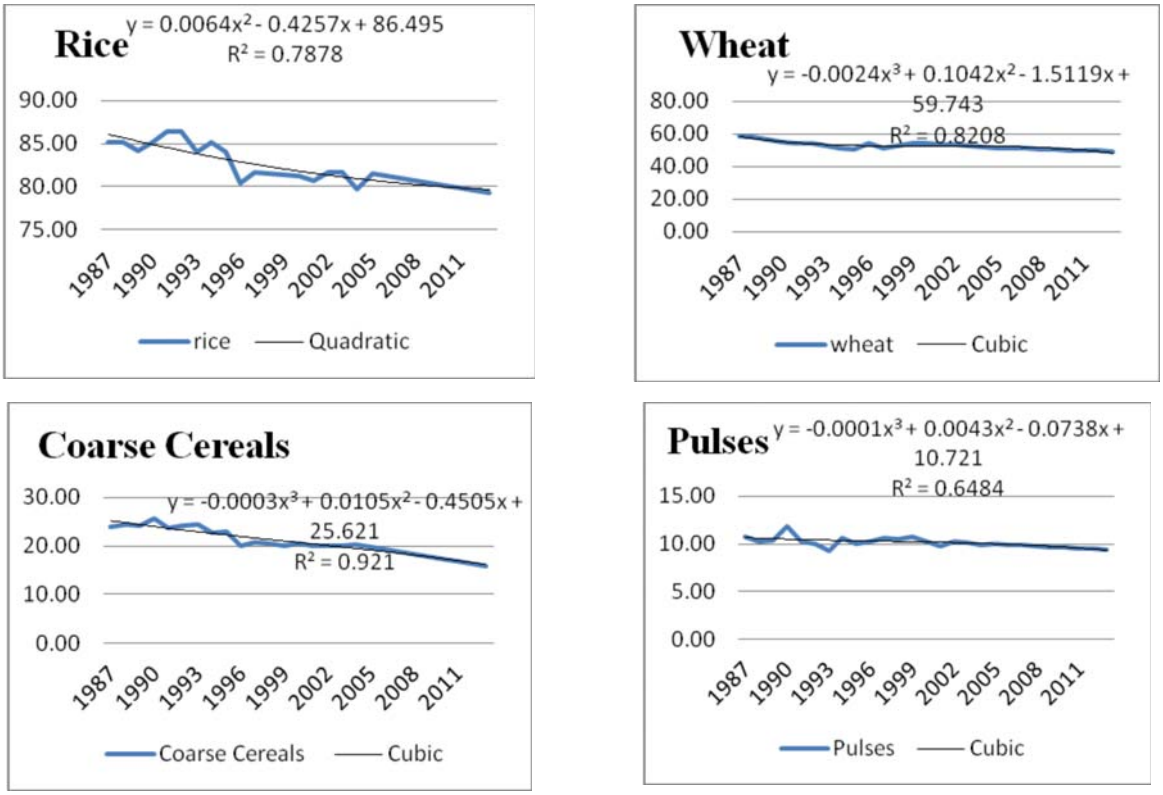


Fig. 1 : Trend in per capita consumption of food grains in rural area.

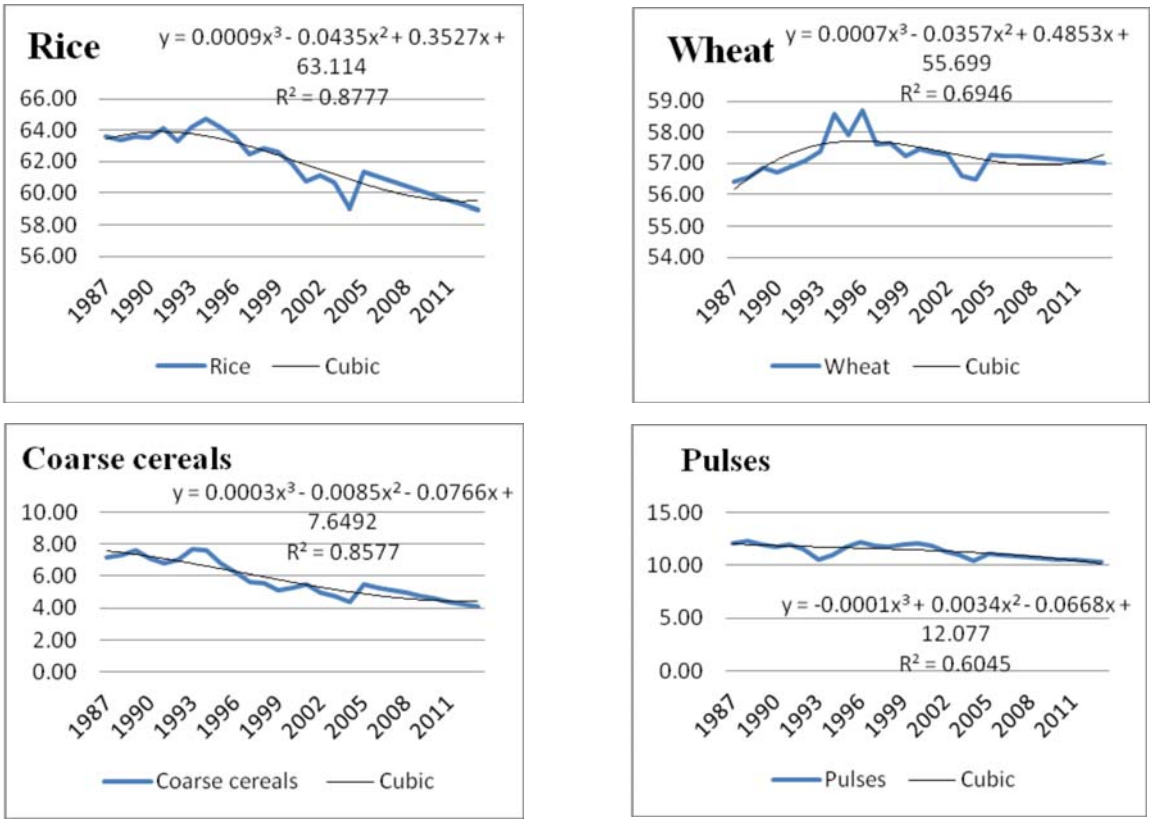
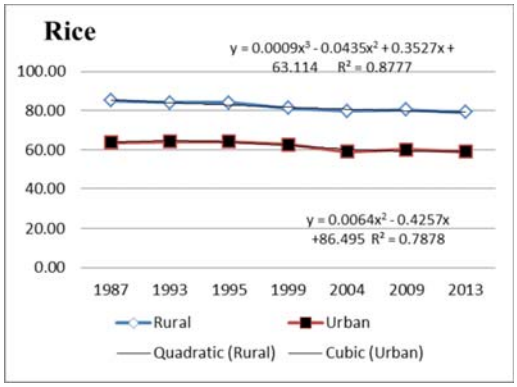
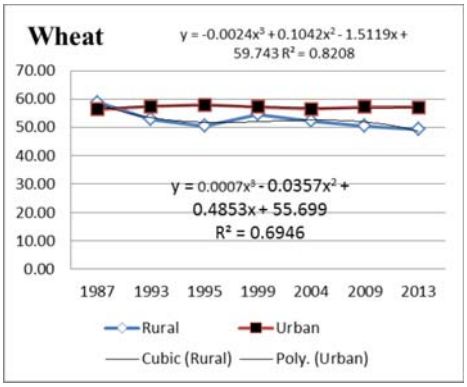
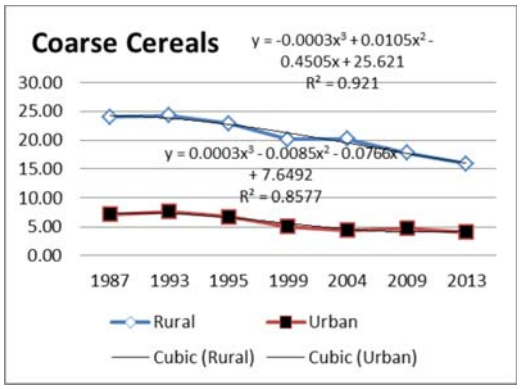


Fig. 2. Trend in per capita consumption of food grains in urban area.







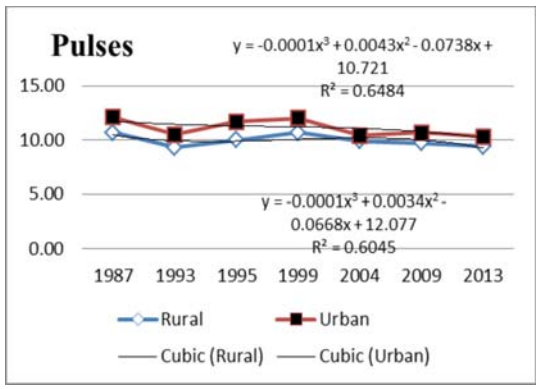
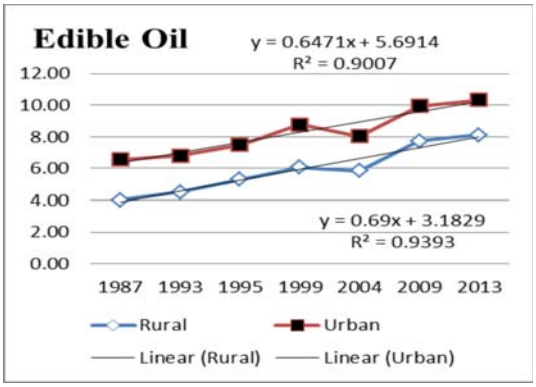
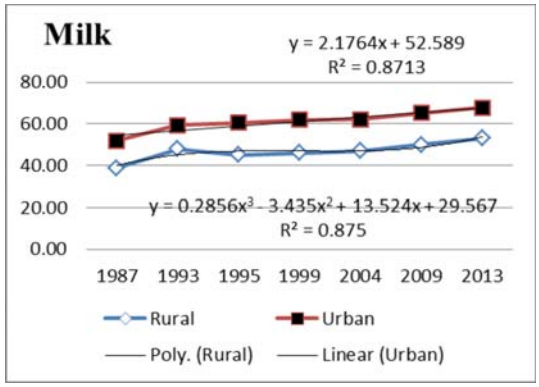
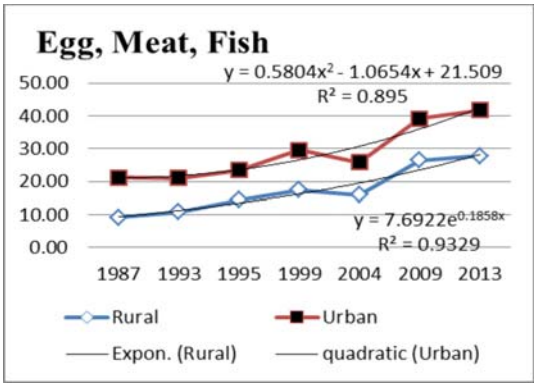


Fig. 3. Per capita consumption of food grains trend







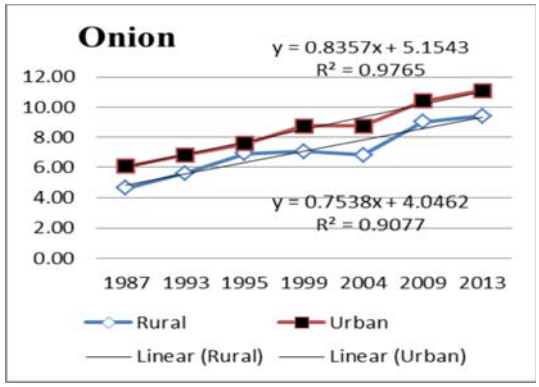
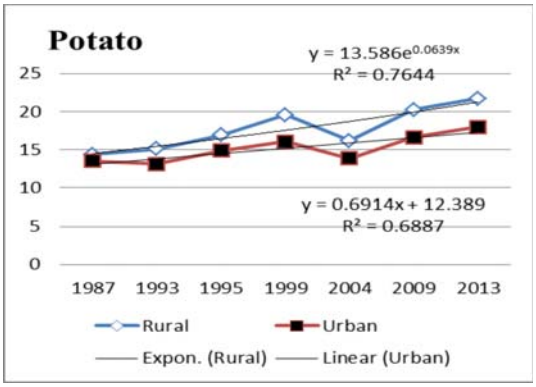


Fig. 4 . Per capita consumption of non-food grains trend.



capita consumption has shown a generally upward trend, more significantly in rural households where it has increased from about 14.36 in 1987 to 21.74 kg year^{-1} in 2013. In urban households the consumption has grown at a lower rate from about 13.51 to 17.97 kg year^{-1} during the same period. However the potato consumption in urban areas is an under estimate as it has not taken into consideration the increasing non-home consumption of French fries served by mushrooming fast food chains and processed potato chips manufactured and marketed by large companies.

From this study it can be concluded that per capita consumption of food grains has been decreased during the study period whereas the consumption pattern of non-food grains has been increased day by day. Indian diet is diversified with fruit/vegetables and animal-based food share makes increasing consumption pattern. The consumption pattern of food grains *i.e.* cereals and pulses are declined. The cereal-based food consumption will have only a limited impact in achieving the goal of providing food and nutritional security. Despite large imports, the overall decline in per capita pulse consumption is also of concern.

There is need to more concern about higher protein food such as pulses or protein enriched cereals production in the country. India is exporting a major share of its high protein soybean meal while the country is facing a protein-deficiency. Indian diet should be encouraged with higher protein pulses and cereals production improved technology.

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