

Analysis of Nutrient Security Prospects in Rural Tamil Nadu: Nutrient Availability, Nutrient Consumption Status and Way to Attain Nutrient Security

Appasmandri S.^{1*}, Chandra Sen², Saket Kushwaha³, Umanath Malaiarasan⁴ and Kamalvanshi V.⁵

¹Research Scholar, Department of Agricultural Economics, I.A.S., Banaras Hindu University, Varanasi, India

²Former Professor, Department of Agricultural Economics, I.A.S., Banaras Hindu University, Varanasi, India

³Vice Chancellor, Rajiv Gandhi University, Itanagar, Arunachal Pradesh

⁴Assistant Professor, Madras Institute of Development Studies, Chennai, Tamil Nadu, India. 600020

⁵Associate Professor, Department of Agricultural Economics, I.A.S., Banaras Hindu University, Varanasi, India

*Corresponding Author E-mail: appasmandri.s4@bhu.ac.in

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ABSTRACT

Among the basic needs of life, food possesses ahead of everyone else as it nourishes us and able to stand which leads further activity. Tamil Nadu state is self-sufficient in food production and Nutrient availability assessment also shows the same but the consumption pattern shows inverse pattern to availability because consumption is directly related with income, education, taste and preference, cultural, ethical and etc. Food consumption patterns of rural Tamil Nadu shows that high demand of Public Distribution System (PDS) observed in earlier and gradually decreased over year. Vitamin Thiamine is coming under severe inequality category in rural areas of Tamil Nadu for both 61st and 68 rounds. Goal programming was effectively optimised the nutrient requirement with least cost and optimised to higher level of nutrient status.

Keywords: Nutrient Security, Nutrient Transition, Nutrient Availability, Inequality in Consumption, Food Optimization

INTRODUCTION

Among the basic needs of life, food possesses ahead of everyone else as it nourishes us and able to stand which leads further activity. For a proper functioning of our body ensuring the Proper nutrition which means provision of all the essential nutrients required have to supply

through diet (Ronto, Wu, & Singh, 2018). Imbalance of essential nutrient make the situation worse like obesity, heart diseases, wasted, stunted, weak immune system, marasmus, kwashiorkor, cancer (Medeiros, 2007).

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As the fore most goal of UNDP Sustainable Development Goal “No Poverty- End poverty in all its forms everywhere” targeted to achieve by 2030 (United Nation, 2020). India is in the stage of developmental transition as a character of developing countries, it faces the twin burden of pre-transition diseases like undernutrition and infectious diseases as well as post-transition, lifestyle-related degenerative diseases such as obesity, diabetes, hypertension, cardiovascular diseases and cancers due to improper allocation of food with in the nation, even with in the urban and rural region of state (National Institute of Nutrition, 2009).

India attained self-sufficiency in cereals such as rice and wheat at the national level way back in the 1980s. Though, national food security did not translate into nutrition security due to lack of effective research on nutritional security or on availability of a balanced diet (encompassing cereals and millets, pulses, vegetables and fruits, and animal products) tools that makes the people to choose among best alternative at least cost. With this situation the present study focused to study the current nutrient availability of rural Tamil Nadu (Gopalan, Sastri, & Balasubramanian, 2018), analyse the trends in nutritional transition in rural Tamil Nadu (Lipoeto, Wattanapenpaiboon, Malik, & Wahlqvist, 2004), examine the nutritional inequality among different socio-economic

groups (Kalmijn, 2014), in rural Tamil Nadu and optimize the cost of nutrient uptake with budget constraints to attain the nutrient security.

MATERIALS AND METHODS

Sampling and Source of Data

The National Sample Survey Office (NSSO), was the largest organisation in India for conducting periodic surveys. Survey collected household consumption on various good and services in India, 2011- 12. In Tamil Nadu, for 61st round 8298 sample (of which 4160 rural) were surveyed, 68th 9203 household was allotted for survey of which 4928 respondents.

Selected most commonly available and consumed food crop in TN and India then converted into nutrient wise per capita availability of Tamil Nadu. By using Stata Analytical software data were extracted and analysed the Nutrient transition and consumption pattern of rural Tamil Nadu of NSSO C. Nutrient consumption inequality was analysed by using Gini coefficient for different socio-economic groups. The formula for analysing the inequality in the form of

$$G = 1 - 2 \int_0^1 L(X). dX$$

Nutrient intake is optimised with least cost for standard men (Weigh 60 Kg) for 68th round NSSO consumer expenditure survey data (Price and quantity) with the help of Goal Programming. Goal Programming given as,

Objective function in the model is defined as:

$$\text{Minimize } Z = \sum_{k=0}^n (d_i^- + d_i^+)$$

Where:

$d_i^- + d_i^+$ are positive and negative deviational variables representing deviations from the i th goal.

For the RNI constraints positive deviation $d_i^+ = 0$,

While for the UL constraints negative deviation $d_i^- = 0$.

In the case of **micronutrients** and **macronutrients** requirements the objective function is subject to the following constraints:

$$\sum_{j=1}^m a_{ij} \cdot x_j + (d_i^- + d_i^+) = g_i$$

Where:

$i = 1$ to ‘n’, number of constraints

$m =$ number of food commodities

x_j = decision variables representing mass of the selected food commodities expressed in grams

a_{ij} = content of the i th nutrient in the j th food commodity

g_i = RNI or UL

The objective function is subject to the following

Constraint with respect to the energy value, e

$$\sum_{j=1}^m b_{ij} \cdot x_j + (d_e^- + d_e^+) = e$$

Where:

b_j = energy quantity per grams for the j th food commodity

$d_e^- + d_e^+$ = positive and negative deviations from the recommended energy value

The objective function is also subject to the following constraint with respect to the food cost:

$$\sum_{j=1}^m c_{ij} \cdot x_j + (d_c^- + d_c^+) = C$$

Where:

c_j = cost per gram of j th food commodity

$d_c^- + d_c^+$ = positive and negative deviations from the food cost

C = household food budget constraint

At least 400 grams of raw vegetable and fruit daily is taken into the model as per the WHO recommended level (Pasic, Catovic, Bijelonja, & Bahtanovic, 2012).

RESULT AND DISCUSSION

Availability of Nutrients

It is evident from the table 1. that as for concern major nutrient Protein is 5.99 kg/ day/ per person is available for the residents of Tamil Nadu (2011 Population Census), Let's assume that even if the 99 per cent production of major crops is shared with neighbour state and exported to overseas still, we can meet the dietary requirements of protein i.e. 1 gram per

body mass. The availability of fat is 1.11 kg/ day/ per person, we can feed with less than 1 per cent of total availability. The major things after Protein and Fat, 41 Kilocalories of Energy were available for resident of Tamil Nadu it is also much higher with respect to recommended dietary allowances prescribed by National Institute of Nutrition (Indian Council of Medical Research), Hyderabad.

Table 1: Per capita Nutrient Availability of Tamil Nadu in 2011-12

Nutrients	Tamil Nadu per capita Availability*
Protein (kg/day)	5.99
Fat (kg/day)	1.11
Minerals (kg/day)	0.27
Crude Fibre (kg/day)	0.0229
Carbohydrates (kg/day)	1.68
Energy (Kcal /day)	40.64
Calcium (g/day)	10.10
Phosphorus (g/day)	49.49
Iron (g/day)	0.6565
Carotene (g/day)	16.91
Thiamine (g/day)	0.0089
Riboflavin (g/day)	0.0297
Niacin (g/day)	0.2721
Total B6 (g/day)	0.0010
Folic acid (g/day)	2.96
Vitamin C (g/day)	0.1037
Choline (g/day)	0.1566

*According to the 2011 population census

Food Consumption Pattern

The Food consumption patterns of rural Tamil Nadu indicate 1993 and that demand of Public Distribution System (PDS) is more and gradually decreased over year, in 1993 10 kg (58 per cent) of rice purchased and in 2011-12 it was 4.5 kg (17 per cent) from PDS while rice from other source is increased gradually it indicate increased welfare of the people both in economically and socially because the quality of rice provided by PDS is very poor. Wheat from PDS is increasing trend in 93-94 it was 0.21 kg per person its increased 0.43 kg in

2011-12 while wheat from other source increased from 0 to 0.1 kg other cereals and is decreasing over the year because in 1993 the consumption of millet was more but food item was not included in the interview schedule by NSSO. Consumption of Milk and Milk products have increased from 2.12 kilogram to 3.75 kilogram. Consumption of salt and sugar is also increased from 0.48 kilogram to 0.95 kilogram. Likewise, consumption of edible oils increased from 0.26 kilogram to 0.62 kilogram per capita for the month.

Table 2: Percentage Share of Consumption Pattern by Food Group Wise in Tamil Nadu (Rural) over the Year from 1993-94 to 2011-12

Particulars	Round 68	Round 61	Round 55	Round 50
	2011-12	2004-05	1999-00	1993-94
Rice (P.D.S.)	17.64	18.91	15.18	58.04
Rice (Other Sources)	15.85	27.94	31.95	0.00
Wheat/Atta (P.D.S.)	1.70	0.3651	0.6727	1.1834
Wheat/Atta (Other Sources)	0.3660	0.5408	0.2883	0.0000
Other Cereal and Millets	1.46	2.54	2.69	0.00
Cereal Substitutes	0.0662	0.0508	0.00	0.00
Pulses and Pulse Products	3.87	3.58	3.99	3.38
Milk and Milk Products	14.59	11.57	11.48	11.95
Salt and Sugar	3.71	3.95	5.77	2.70
Edible Oil	2.43	1.90	2.07	1.47
Egg, Fish and Meat	3.92	1.99	2.71	2.11
Vegetables	18.95	16.15	17.58	12.99
Fresh Fruits	5.30	5.95	3.18	3.24
Dry Fruits	0.2025	0.0462	0.0000	0.5635
Spices	2.70	0.26	2.21	2.20
Tea and Coffee Powder	0.2451	0.1568	0.1956	0.1593
Served Processed Food	6.90	4.07	0.00	0.00
Packaged Processed Food	0.1195	0.0140	0.0327	0.0098
Total Food	100.00	100.00	100.00	100.00

Table 3: Percentage Share of Protein consumption by Food group wise from 1993-94 to 2011-12 in Tamil Nadu

Item Name	1993-94 Rural	1993-94 Tamil Nadu	1999-00 Rural	1999-00 Tamil Nadu	2004-05 Rural	2004-05 Tamil Nadu	2011-12 Rural	2011-12 Tamil Nadu
Rice and its Products	63.92	59.77	56.48	50.42	58.68	52.94	41.81	37.98
Wheat and its Products	2.10	3.70	3.00	5.05	2.98	4.81	5.41	6.31
Other Cereals and Millets	0.00	0.00	2.35	1.12	2.27	1.28	0.75	0.55
Pulses	11.34	12.89	13.91	14.85	13.09	14.38	14.16	14.38
Milk Products	7.02	9.53	7.34	10.53	7.70	11.09	9.77	11.20
Sugar and Salt	0.05	0.05	0.04	0.05	0.04	0.05	0.05	0.05
Edible Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Egg, Fish and Meat	5.01	5.63	7.21	8.31	5.82	6.72	12.38	12.79
Vegetables	2.78	2.88	3.69	4.04	3.14	3.71	4.14	4.27
Fruits (Fresh)	0.90	1.01	0.79	0.69	1.34	1.26	1.50	1.63
Fruits (Dry)	2.09	1.12	0.00	0.00	0.11	0.14	0.59	0.55
Spices	2.81	2.32	3.24	3.16	2.84	2.21	4.40	4.31
Beverages	0.23	0.25	0.29	0.34	0.20	0.14	0.15	0.15
Served Proces. Food*	0.00	0.00	1.19	0.56	1.70	1.15	4.76	5.68
Packaged Proces. Food**	1.74	0.85	0.47	0.88	0.10	0.10	0.13	0.15
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Served Processed Food, ** Packaged Processed Food

Protein Transition

From the monthly food consumption, the share of protein from food group wise is presented in the table 3. In 1993-94, 64 per cent of total

protein consumption is met with Rice and Rice Products alone. Then this proportion is gradually decreased to 50 per cent in 1999-00, 53 per cent in 2004-04 and 38 per cent in

2011-12, due to increased consumption of pulses, milk product along with higher consumption of egg, fish and meat.

Fat Transition

Consumption of fat and its sources is presented in the table 4, in 1993-94, the invisible fat from rice and rice product was 7 per cent and due to decreasing conception of rice compared to other food this proportion is decreased to 2 per cent in 2011-12. The major proportion of fat come from edible oils and this was 42 per cent in 1993 and it is gradually increased to 68 per cent in 2011 - 12.

Even though the consumption of milk and milk products has increased, the share of fat has decreased to 16 per cent from 30 per

cent due to processing of milk, Invisible fat from fruits is also decreased from 10 per cent to 6 per cent.

Energy Transition

Major sources of energy are presented in the table 5. Major proportion of energy in 1993-94 comes from rice and rice products (68 per cent) and it is gradually decreased to 42 per cent in 2011-12, consumption of wheat product has contributed around 5 per cent of energy in 2011-12. Consumption of pulses is increased along with increasing energy proportion. The energy from milk i.e. lactose was increased to 7 per cent in 2011-12 from 4 per cent.

Table 4: Percentage Share of Fat consumption by Food group wise from 1993-94 to 2011-12 in Tamil Nadu

Item Name	1993-94 Rural	1993-94 Tamil Nadu	1999-00 Rural	1999-00 Tamil Nadu	2004-05 Rural	2004-05 Tamil Nadu	2011-12 Rural	2011-12 Tamil Nadu
Rice and its Products	8.42	7.02	4.18	3.22	4.05	3.19	2.28	1.98
Wheat and its Products	0.58	0.92	0.39	0.58	0.36	0.52	0.56	0.62
Other Cereals and Millets	0.00	0.00	0.46	0.19	0.46	0.23	0.13	0.09
Pulses	1.92	1.96	1.33	1.25	1.23	1.18	1.10	1.08
Milk Products	24.25	30.08	14.25	18.89	13.96	17.89	13.87	15.49
Sugar and Salt	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Edible Oil	42.49	41.82	72.39	69.80	67.82	66.47	65.70	64.38
Egg, Fish and Meat	2.60	3.18	2.30	2.38	1.55	1.68	2.14	2.31
Vegetables	0.76	0.69	0.68	0.65	0.60	0.55	0.54	0.52
Fruits (Fresh)	10.30	9.68	0.15	0.17	7.12	6.13	6.69	6.44
Fruits (Dry)	6.55	3.13	0.00	0.00	0.17	0.20	0.75	0.67
Spices	1.83	1.31	2.64	2.20	2.52	1.63	2.89	2.71
Beverages	0.14	0.14	0.14	0.18	0.03	0.02	0.03	0.03
Served Proces. Food*	0.00	0.00	1.06	0.43	0.14	0.30	2.94	3.25
Packaged Proces. Food**	0.14	0.06	0.04	0.05	0.00	0.00	0.40	0.42
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Served Processed Food, ** Packaged Processed Food

Table 5: Percentage Share of Energy consumption by Food group wise from 1993-94 to 2011-12 in Tamil Nadu

Item Name	1993-94 Rural	1993-94 Tamil Nadu	1999-00 Rural	1999-00 Tamil Nadu	2004-05 Rural	2004-05 Tamil Nadu	2011-12 Rural	2011-12 Tamil Nadu
Rice and its Products	72.65	68.34	60.46	54.96	60.83	55.81	46.09	42.14
Wheat and its Products	1.46	2.59	2.08	3.55	2.02	3.28	3.79	4.47
Other Cereals and Millets	0.00	0.00	2.45	1.18	2.23	1.28	0.78	0.56
Pulses	4.20	4.80	4.90	5.33	4.53	5.05	5.27	5.39
Milk Products	4.32	6.00	4.26	6.49	4.33	6.41	5.81	6.79
Sugar and Salt	3.88	4.52	3.69	4.24	3.34	4.00	3.92	4.07
Edible Oil	4.77	5.30	13.63	15.47	13.26	15.12	17.30	17.86
Egg, Fish and Meat	0.89	1.06	1.20	1.40	0.89	1.06	1.82	1.94
Vegetables	1.89	1.97	2.24	2.51	1.68	2.07	2.61	2.75
Fruits (Fresh)	2.20	2.47	0.99	1.25	3.04	2.89	3.48	3.81
Fruits (Dry)	1.16	0.62	0.00	0.00	0.08	0.12	0.39	0.40
Spices	2.01	1.77	2.13	2.11	1.54	1.25	2.73	2.66
Beverages	0.46	0.51	0.53	0.69	0.39	0.31	0.33	0.32
Served Proces. Food	0.00	0.00	1.33	0.64	1.83	1.27	5.46	6.56
Packaged Proces. Food	0.10	0.05	0.13	0.17	0.02	0.06	0.23	0.27
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Served Processed Food, ** Packaged Processed Food

Inequality in Nutrient Consumption

Gini index ranges from 0 to 1, in that zero represent hypothetical equal state of parameter and 1 represent complete inequality of parameter and if the Gini index ranges less than 0.2 indicates more equality in nutrient consumption, 0.2-0.3 relative equality in nutrient consumption, 0.3-0.4 adequate equality in nutrient consumption, 0.4-0.5 represent big inequality in nutrient consumption, and above 0.5 represents severe nutrient consumption inequality. Inequality of nutrients consumption for rural Tamil Nadu is presented in the table 6. Protein, energy is

coming under the category of more equality in rural areas of Tamil Nadu and This is a good sign because these are the most important nutrients for life. Crude fibre, Carbohydrate Calcium, Phosphorus, Iron, vitamins like Riboflavin, Niacin, Vitamin B6, Folic Acid, Vitamin C are coming under the category of relative equality and nutrient like fat, vitamins like carotene and Choline are coming under the category of adequate equality and vitamin Thiamine is coming under severe inequality category in rural areas of Tamil Nadu for both 61st and 68 rounds.

Table 6: Inequality in Nutritional Intake of 61st Round and 68th Round of Consumer Expenditure Survey

Nutrients	61 st Round Nutritional Inequality Gini coefficient	68 th Round Nutritional Inequality Gini coefficient
Protein	0.15	0.16
Fat	0.34	0.37
Crude Fibre	0.24	0.29
Carbohydrates	0.19	0.22
Energy	0.17	0.20
Calcium	0.27	0.26
Phosphorus	0.23	0.24
Iron	0.24	0.26
Carotin	0.37	0.35
Thiamine	0.54	0.51
Riboflavin	0.28	0.26
Niacin	0.20	0.24
Vitamin B6	0.23	0.26
Folic acid	0.23	0.23
Vitamin C	0.24	0.29
Choline	0.36	0.36

From table 7. it is clear that 65 per cent of the rural population ate 58 per cent of protein from the total with Gini Index 0.13 in Fractile 1 and 29 per cent of rural population have consumed 33 per cent of protein with Gini index of 0.12. Among the Fractile, Fractile 4 is having more inequality with 0.24 in rural and for Fat 65 per cent of rural population consumed 50 per cent of fat and 29 per cent of rural population consumed 38 per cent of total fat. In rural Fractile 6 is in severe inequality with Gini

Index of 0.46 followed by Fractile 4 is with the Gini Index of 0.40. inequality analysis for energy is presented in the table in rural 65 per cent of the population consumed 37 per cent of the total energy, 29 per cent of the population consumed 34 per cent of the energy and 4 per cent of the population consumed 27 per cent of the total energy. Fractile 4 having higher inequality with Gini index of 0.27 followed by Fractile 6 with Gini index of 0.24.

Table 7: Inequality in Protein Intake in 61st Round for Rural Tamil Nadu

Fractile	Population Share	Relative mean	Protein share	Gini Coefficient
1	0.6514	0.90	0.5832	0.13
2	0.2933	1.15	0.3361	0.12
3	0.0485	1.41	0.0681	0.15
4	0.0044	1.94	0.0085	0.24
5	0.0015	1.59	0.0024	0.23
6	0.0003	1.67	0.0005	0.18
7	0.0002	2.63	0.0006	0.05
8	...	...	...	...
9	0.0005	1.26	0.0006	0.00
10	...	...	...	...
11	...	...	...	...
12	0.0001	1.03	0.0001	0.02

Table 8: Inequality in Fat Intake in 61st Round for Rural Tamil Nadu

Fractile	Population Share	Relative mean	Fat share	Gini Coefficient
1	0.65137	0.77	0.5006	0.30
2	0.29327	1.30	0.3820	0.28
3	0.04845	2.05	0.0991	0.28
4	0.00439	2.88	0.0127	0.40
5	0.00153	2.02	0.0031	0.27
6	0.00027	2.36	0.0006	0.46
7	0.00023	4.07	0.0009	0.01
8	...	...	...	...
9	0.00045	1.94	0.0009	0.00
10	...	...	...	...
11	...	...	...	...
12	0.00005	2.16	0.0001	0.02

Table 9: Inequality in Energy Intake in 61st Round for Rural Tamil Nadu

Fractile	Population Share	Relative mean	Energy share	Gini Coefficient
1	0.6514	0.880	0.5730	0.14
2	0.2933	1.165	0.3418	0.15
3	0.0485	1.486	0.0720	0.17
4	0.0044	2.053	0.0090	0.27
5	0.0015	1.559	0.0024	0.19
6	0.0003	1.791	0.0005	0.24
7	0.0002	2.914	0.0007	0.05
8	...	...	...	...
9	0.0005	1.424	0.0006	0.00
10	...	...	...	...
11	...	...	...	...
12	0.0001	1.253	0.0001	0.03

In 2011-12, protein consumption inequality is assessed with the data of NSSO consumer expenditure survey from the table 7 it is clear that in rural 48 per cent of the population have consumed 40 per cent of protein, 41 per cent of the population have taken 46 per cent of total protein and 8 per cent of population with 11 per cent of total protein consumed. Likewise, in urban 65 per cent of the population have consumed 60 per cent of the protein, 27 per cent of the population

consumed 31 per cent after total protein available and six per cent of population consumed 7 per cent of the total Protein available. Among the rural Fractile class, Fractile 5 is having high inequality in protein consumption with Gini Index of 0.43 followed by Fractile 6 with Gini Index of 0.36. In urban Fractile 4 is having higher inequality with Gini Index of 0.27 and Fractile 3 with Gini Index of 0.23.

Table 10: Inequality in Protein Intake in 68th Round for Rural Tamil Nadu

Fractile	Population Share	Relative mean	Protein share	Gini Coefficient
1	0.48396	0.84	0.4049	0.12
2	0.41820	1.10	0.4611	0.12
3	0.08893	1.33	0.1185	0.18
4	0.00694	1.82	0.0127	0.21
5	0.00167	1.21	0.0020	0.42
6	0.00003	0.78	0.0000	0.36
7	0.00018	2.10	0.0004	0.19
8	...	...	...	...
9	0.00004	1.35	0.0001	0.00
10	0.00004	1.74	0.0001	0.00
11	...	...	...	...
12	0.00002	16.79	0.0003	0.00

Inequality analysis of fat show that 48 percentage of the population have consumed 37 percentage of total fat, 41 percentage of the population have consumed 48 per cent of the total fat and 8 per cent of population have ate 12 per cent of the fat in rural Tamil Nadu. Likewise, in urban 65 per cent of the population shared 59 per cent of the fat, 27

percentage of the population have eaten 32 per cent of the fat. among the rural Fractile, Fractile 5 is having higher inequality with Gini Index of 0.52 and Fractile 5 with Gini Index of 0.40. in urban Fractile class, Fractile 4 is with higher inequality with Gini Index of 0.42 and followed by Fractile 3 with Gini Index of 0.40.

Table 11: Inequality in Fat Intake in 68th Round for Rural Tamil Nadu

Fractile	Population Share	Relative mean	Fat share	Gini Coefficient
1	0.48396	0.76795	0.37165	0.3652
2	0.41820	1.15401	0.48260	0.32661
3	0.08893	1.40861	0.12527	0.3771
4	0.00694	2.47568	0.01718	0.26788
5	0.00167	1.48323	0.00247	0.52102
6	0.00003	0.49378	0.00001	0.40318
7	0.00018	3.67204	0.00068	0.33928
8	...	...	...	...
9	0.00004	0.89079	0.00003	0
10	0.00004	1.51925	0.00006	0
11	...	...	...	...
12	0.00002	1.98743	0.00004	0

Table 12: Inequality in Energy Intake in 68th Round for Rural Tamil Nadu

Fractile	Population Share	Relative mean	Energy share	Gini Coefficient
1	0.48396	0.82	0.39703	0.17
2	0.41820	1.10	0.46110	0.16
3	0.08893	1.41	0.12499	0.20
4	0.00694	1.86	0.01294	0.16
5	0.00167	1.89	0.00315	0.18
6	0.00003	1.34	0.00004	0.10
7	0.00018	2.98	0.00055	0.16
8	...	...	...	...
9	0.00004	1.11	0.00004	0.00
10	0.00004	1.52	0.00006	0.00
11	...	...	...	...
12	0.00002	5.13	0.00010	0.00

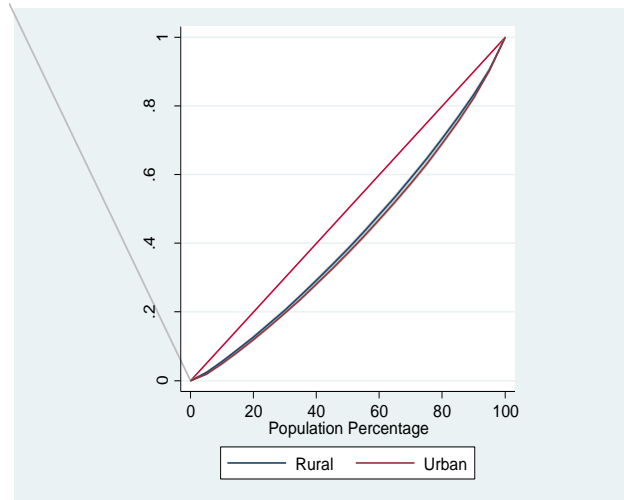
From the table 11 We can distinguish that in rural 48 per cent of the population have consumed 39 per cent of the energy and 41 per cent of the population Have consumed 46 per cent of energy. Among the rural Fractile, **Copyright © May-June, 2021; IJPAB**

Fractile 5 is having higher inequality with Gini Index 0.18 and followed by Fractile 4 and 7 with Gini Index of 0.16.

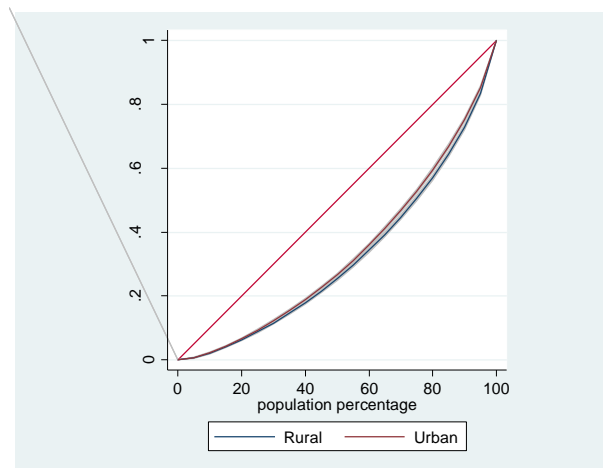
Lorenz curve explaining inequality that exists in consumption of nutrients for 61st and

68th round of Consumer Expenditure Survey of National Sample Survey Organization for Tamil Nadu. In the graphs the blue line indicates rural and the red line indicates urban. The diagonal Red Line represents hypothetical

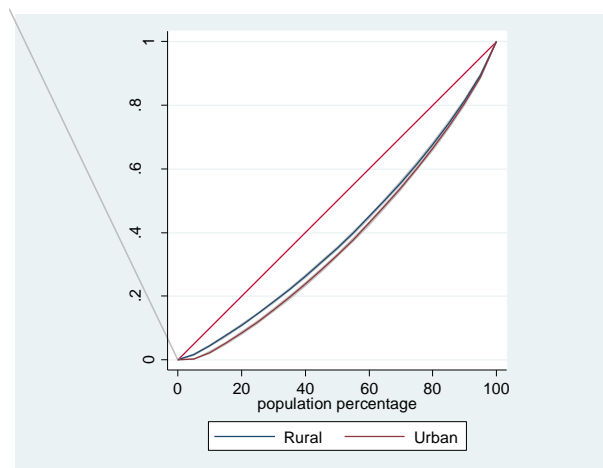
equality of parameters, the curve away from the diagonal line more is the inequality, vice versa. The X axis indicates population percentage and Y axis indicates cumulative proportion of respective parameters.



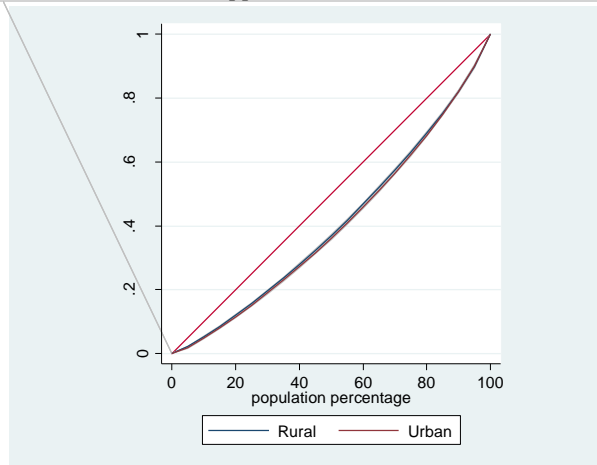
Graph 1. Inequality in Protein Intake in 61st Round for Rural Tamil Nadu



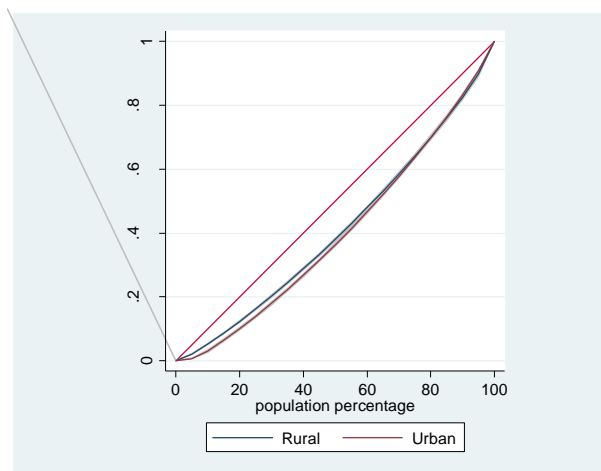
Graph 2. Inequality in Fat Intake in 61st Round for Rural Tamil Nadu



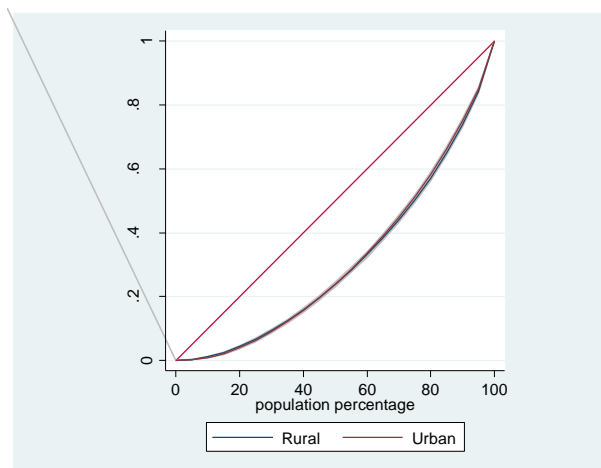
Graph 3. Inequality in Carbohydrate Intake in 61st Round for Rural Tamil Nadu



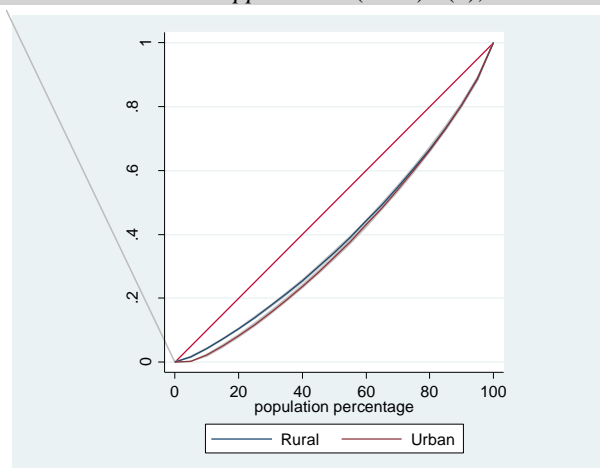
Graph 4. Inequality in Energy Intake in 61st Round for Rural Tamil Nadu



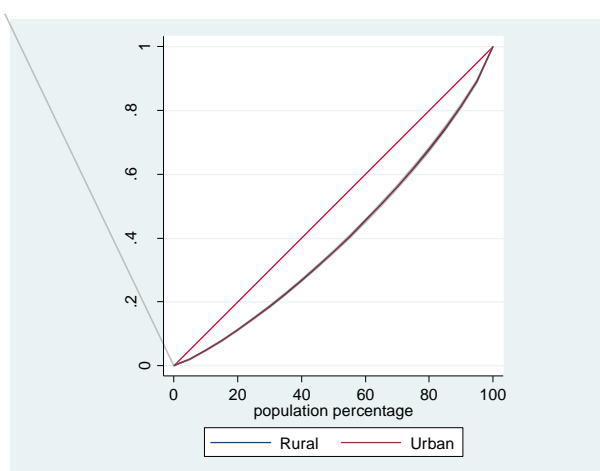
Graph 5. Inequality in Protein Intake in 68th Round for Rural Tamil Nadu



Graph 6. Inequality in Fat Intake in 68th Round for Rural Tamil Nadu



Graph 7. Inequality in Carbohydrate Intake in 68th Round for Rural Tamil Nadu



Graph 8. Inequality in Energy Intake in 68th Round for Rural Tamil Nadu

Optimization of food cost

Optimization of food cost for rural and presented for 68th round of NSSO in table 13 Here optimization was made only for two Fractile of rural because the monthly per capita expenditure was less it will not cover the minimum dietary allowance recommended by ICMR. Elite population consumption is very often for passion and hygienic food practice rather than survival.

In Fractile one, the actual consumption of protein was 1290 grams against RDA of 1,800 grams for normal adults weighing 60 kilograms and irrespective of gender but it's optimised to 1788 grams of Protein. Actual consumption of Carbohydrate, Energy, Fat and Crude Fibre was 8684 grams, 50248 Kcal, 995 grams and 177 grams respectively and this have optimised to 10218 grams of carbohydrate, 70264 kilocalories of energy, 1121 grams of fat and 1793 grams of crude
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fibre. Minerals have optimised from 37849 mg of calcium to 34583 mg and 856 mg of iron to 615 mg. Vitamins have optimized from 33214 Mg of Carotin to 44436 Mg, 517 Mg of Thiamine to 48 Mg, 47 Mg of Riboflavin to 31 Mg, 405 Mg of Niacin to 549, 28 Mg of Vitamin B6 to 48 Mg, 2234 mg of Folic acid to 1241 mg of Vitamin C to 874 with budget cost of Rs. 597.30 against actual Rs. 602.

Likewise, for Fractile two, the actual consumption of Protein was 1703 grams and this is optimised to 1974 grams, 10643 grams of carbohydrate to 10215 grams and its converged to recommended level. Fat consumption was decreased to target level from 1444 grams to 952 grams and optimised value for Energy, Crude fibre, Minerals like Calcium, and Iron have converged to recommended dietary allowances from actual consumption from 64327 Kcal to 70264 Kcal of energy, 253 grams to 2980 grams of Crude

fibre, 47194 mg to 34698 of calcium, 1262 mg to 766 mg of Iron with budget of Rs. 1008 to Rs.1012, this optimised budget is above the actual level. While the actual consumption of

Riboflavin was reduced from 63 mg to 39 mg against the target level of 48 Mg, because satisfying all constraints at the same time is not possible.

Table 13: Optimizations of Nutrient Intake for Rural Tamil Nadu by using Goal Programming

Nutrients	Actual Consumption		Optimised Consumption		Target
	F1	F2	F1	F2	
Protein (g)	1290	1703	1788	1974	1800
Carbohydrates (g)	8684	10643	10218	10215	9480
Energy (Kcal)	50248	64327	62406	70264	72000
Fat (g)	995	1444	1121	952	900
Crude Fibre (g)	177	253	1793	2980	810
Calcium (Mg)	37849	47194	31583	34698	18000
Iron (Mg)	856	1262	651	766	510
Carotene (Mg)	33214	53132	44436	70551	144000
Thiamine (Mg)	517	676	48	474	51
Riboflavin (Mg)	47	63	31	39	48
Niacin (Mg)	405	492	549	547	540
Total B6 (Mg)	28	34	48	51	60
Folic acid (Mg)	2234	2969	9207	9058	6000.0
Vitamin C (Mg)	1241	1927	874	2399	1200.0
Cost in Rupees	602	1008.76	597.30	1012.4	

CONCLUSION

Though the state Tamil Nadu is blessed with limited natural resources, hardworking human capitals made this state somehow prosperous in social, political and economic ways. Production of agricultural commodities in the state is self sufficient and major share of produce is shared with rest of states of India. Nutrient availability assessment shows the same that all essential nutrients, minerals and vitamins are 99 times higher than the recommended level but the consumption pattern shows inverse pattern of availability because consumption is directly related with income, education, taste and preference, cultural, ethical and etc. Food consumption patterns of rural Tamil Nadu shows that high demand of Public Distribution System (PDS) observed in earlier and gradually decreased over year. Vitamin Thiamine is coming under severe inequality category in rural areas of Tamil Nadu for both 61st and 68 rounds. Goal programming was effectively optimised the nutrient requirement with least cost and optimised to higher level of nutrient status.

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