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Relationship between Food Production and Consumption Diversity in India – Empirical Evidences from Cross Section Analysis

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Abstract

This study has examined (i) the food production and consumption diversity across the states, (ii) trends in food consumption and nutritional intake and changes in related socio-economic characteristics, and (iii) relationship between consumption diversity and production diversity along with other major determinants. The data on production, consumption, and other socio-economic factors have been collected from various government published sources for the past two decades (1990-2010). The study has revealed that per-capita consumption has decreased in cereals and is stagnant in pulses, and has doubled in edible oils, vegetables, eggs, fish and meat during 1993-94 to 2011-12. It has reflected the nutritional intake wherein calorie and protein intake has declined, fat intake has increased during this period. Simultaneously, a significant growth has been observed in per-capita income and availability of food commodities along with rapid urbanization. The multivariate regression analysis of 28 states has suggested that dietary diversity significantly increases with production diversity and per-capita income and is significantly higher in other states *vis-a-vis* north-eastern states. A significant non-linear relationship has been observed between dietary diversity and literacy. The study has highlighted a significant impact of local production diversity on consumption pattern and therefore, policies should target the diversification of agricultural production, particularly in the north-eastern states to bring out dietary diversity and desired nutritional outcome.

Key words: Dietary diversity, food consumption, production diversity, Simpson index, and north-eastern states

JEL Classification: I12, Q1, R12

Introduction

The economic growth in a country eventually leads to a shift in food preferences and consumption pattern and affects nutritional status of the people. For better health and elimination of malnutrition, a diversified and balanced food basket is required (Sangeetha *et al.*, 2013). During the past 50 years, agricultural production environment, practices and culture have changed and crop breeding programmes have made farmers less dependent on seasons (Kearney, 2010). Family farming played a key role in securing food and nutrition security in India (Singh *et al.,* 2014), however, in recent years market-driven agriculture has made a significant impact on food consumption pattern of rural households, and urbanization and rising income levels have changed consumption habits of urban households. The studies on agriculture focused on production pattern, crop diversification and their determinants (Chand, 1996; Joshi *et al.*, 2003; Kumar and Gupta, 2015) and nutrition have emphasized on the consumption of calories, micro and macro nutrients intake and importance of diversified food consumption for better health (Drescher *et al.,* 2007; Lumole, 2013; Viswanathan *et al.,* 2015). A recent study has identified various linkages and pathways between agriculture and

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nutritional outcome in South Asia (Pandey *et al.,* 2016). However, information on linkage between food production and consumption pattern seems lacking. Therefore, the present study attempts to bridge the information gap on connectivity of these variables to develop a holistic approach to address the malnutrition problems in India. Specifically, the study addresses the following questions: (i) What is the trend in food consumption and nutrient intake in India and its associated factors? (ii) What is the food production and consumption diversity across the states? and What are all major determinants of dietary diversity with special reference to production diversity?

Data and Methodology

The data on food production, per-capita availability and consumption of various food items and its expenditure share, per-capita income, population, urbanization, per-capita intake of calorie, protein and fats were collected for the past two decades, 1990-2010 from the government published reports like various rounds of National Sample Survey Organisation survey, National Family Health Survey (NFHS), and economic survey. State level information on production of crops, livestock products and fisheries was collected from various published sources such as *Horticulture at a Glance* (GoI, 2015) and *Agricultural Statistics at a Glance* (GoI, 2014) and government website (https://data.gov.in/). Data on other related factors like state-wise percentage of urban population, literacy rate, *etc.* were collected from the census data (http://censusindia.gov.in/). The data on gross state domestic product (GSDP) and poverty estimates were collected from Planning Commission, Government of India (http://planningcommission.gov.in/). All monetary values were converted into real terms by using GDP deflator.

In this study both production and consumption diversity have been estimated. The production diversification studies have mostly used Simpson (Kumar and Gupta, 2015), Herfindhal, Entrophy, Shannon and Margalef diversity index measures. We have adopted Simpson index of diversification for our analysis. The concept of dietary diversity is emerging one and there is a debate on classification on foods and food groups to better represent a healthy diet. The FAO (2013) has developed guidelines for measuring household dietary diversity scores (HDDS) based on twelve food groups. The HDDS method is mostly used to study diversity at individual consumer or household's level (Jones *et al.,* 2014; Sibhatu *et al.,* 2015). Some studies have used Simpson index (Thiele and Weiss, 2003; Parappurathu *et al.,* 2015) and modified Simpson index (Drescher *et al.,* 2007) also. However, for studying at aggregate level such as consumption at state level, index method is more suitable and we have used Simpson index (SID) for measuring dietary diversity.

$$SID = 1 - \sum_{i=1}^{n} Pi^2$$

where, Pi is the proportion of i^{th} food item consumed (or produced) in total consumption (or production).

Based on the NSSO survey on household consumption of food commodities, in total 19 commodities, viz. rice, wheat, arhar, moong, masur, urd, gram, milk, fish, mutton, chicken, groundnut oil, mustard oil, potato, onion, brinjal, cauliflower, cabbage and tomato were considered for analysing consumption diversity at state level and corresponding state's production was taken for assessing production diversity. There are many factors that influence food consumption diversity. Literature suggests that increased per capita income, level of poverty, urbanization, education and changing consumer behaviour are the major demand pull factors and agricultural production diversity is the major supply side factors. The multiple linear regression model was applied to study how various factors influence consumption diversity. The state level analysis was carried out with the cross-section data on these factors across the 28 states in India for the year 2011-12. The following model was used for the study:

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_3^2 + B_7X_4^2 + B_8X_5^2 + B_8X_4X_5X_5 + D1 + u$$

Simpson index of diet diversity (SIDD) was used as dependent variable and Simpson index of production diversity (SIPD) (X_1), per-capita gross state domestic product (GSDP) (X_2), literacy percentage (X_3), percentage of urban population (X_4) and percentage of population below poverty line (BPL) (X_5) were used as explanatory variables. To test the linear relationship between dependent variable and some of the explanatory variables such as urbanization, education level and poverty, the square terms of these variables

were taken. The interaction of these variables were also tested by taking multiplications of these variables. Dummy variable was introduced with two categories, as all the seven north-eastern states and Sikkim were designated as base category and other states as event category to eliminate the effect of variation due to geographical and cultural differences. The 'u' error-term represented the factors which were not taken into account explicitly in the model.

Results and Discussion

Food Production and Consumption Diversity across the States

Based on the selected 19 agricultural commodities, state-wise production and consumption diversities were worked out and are depicted in Figures 1 and 2, respectively. The maps were prepared by ArcGIS 10 software. The ArcGIS classified index value into four classes (high, medium, low and no data) by using Jenks natural breaks classification method. This method minimizes deviation within the classes and maximizes between the classes. The Figure 1 clearly depicts that north-eastern states, Kerala, Tamil Nadu, Rajasthan, Chhattisgarh, Punjab and Haryana belong to either low or medium production diversified states, while, other states have high production diversities. On the other hand, the eastern, and south-eastern and western states were found consuming less or medium diversified foods when compared to other states (Figure 2).

Food Consumption

Table 1 depicts crop group-wise food consumption trends in India during the period 1993-94 to 2011-12. The monthly per-capita consumption of cereals declined from 13 to 11 kg in the rural areas, whereas, decline in urban areas was marginal, from 10.6 to 9.2 kg/month during the study period. The pulses consumption wobbled around 0.8 kg/ month in rural and 0.9 kg/month in the urban areas. The notable changes were observed in consumption of edible oils (0.70 to 0.67 kg in rural and 0.56 to 0.85 kg in urban), vegetables (2.70 to 4.33 kg in rural and 2.9 to 4.3 kg in urban), eggs (0.6 to 1.9 in rural and 1.5 to 3.0 numbers in urban) and fish and meat (0.26 to 0.5 kg in rural and 0.34 to 0.57 kg in urban) during 1993-94 and 2011-12. In general, it was observed that monthly per-capita

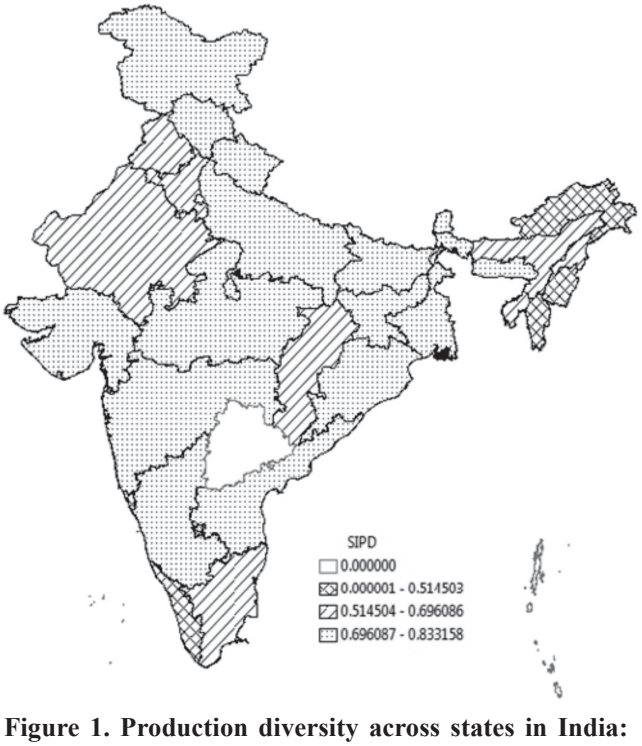

Figure 1. Production diversity across states in India: 2011-12

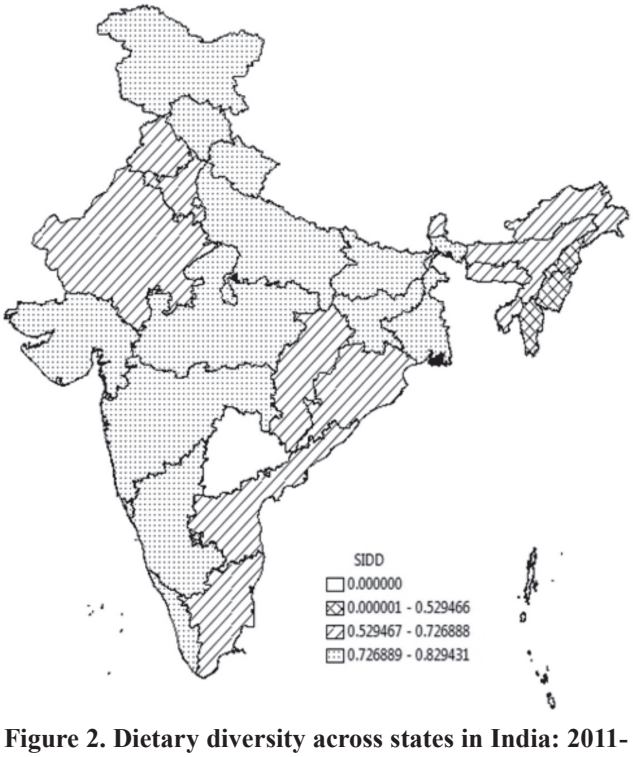

Figure 2. Dietary diversity across states in India: 2011-12

Source: Compiled and estimated by authors from GoI (2014) and GoI (2015) and map was prepared using ArcGIS10 software.

Table 1. Dynamics in monthly per capita consumption of food commodities in India: 1993-94 to 2011-12

(per capita/month)

Year	Cereals (kg)	Pulses (kg)	Edible oils (kg)	Vegetables (kg)	Banana (No.)	Milk (litre)	Egg (No.)	Fish & meat (kg)
				Rural areas				
1993-94	13.40	0.76	0.37	2.71	2.2	3.94	0.64	0.26
1999-00	12.72	0.84	0.50	3.30	2.48	3.79	1.09	0.32
2004-05	12.12	0.71	0.48	2.92	2.37	3.87	1.01	0.30
2011-12	11.22	0.78	0.67	4.33	4.18	4.33	1.94	0.50
				Urban areas				
1993-94	10.60	0.86	0.56	2.91	4.48	4.89	1.48	0.34
1999-00	10.42	1.00	0.72	3.49	5.00	5.10	2.06	0.38
2004-05	9.94	0.82	0.66	3.17	4.14	5.11	1.72	0.37
2011-12	9.28	0.90	0.85	4.32	6.69	5.42	3.18	0.57

Source: Compiled by authors from NSSO report on Household Consumption of Various Goods and Services in India

consumption of food commodities was higher in urban than rural areas for all the food groups, except cereals. Between 1993-94 to 2011-12, the consumption of all food commodities increased, except cereals. In particular, consumption of edible oils, vegetables, egg, fish and meat has more than doubled and was relatively stagnant for pulses. Among the cereals, consumers' preferences were more centred on rice and wheat and were drifting away from coarse cereals, whilst fish and meat consumption has increased about 2-times (0.26 to 0.50 kg/month in rural areas and 0.34 to 0.57 kg/ month in urban areas). It clearly indicates the changes in dietary pattern in India during the past two decades. It is to be noted that as compared to the recommended dietary allowance (kg/month/capita) (cereals: 13.8, pulses: 1.2, edible oils: 0.6, vegetables: 3.0, and milk: 4.5) as reported by NIN (2010), the consumption of cereals and pulses was low, and of edible oils, vegetables and milk was high in India in 2011-12.

Nutritional Intake Trends

If each individual in a country is able to consume a minimum quantum and quality of various ingredients such as energy, fat, protein and other vitamins and micronutrients on a regular basis, could then the country be said to have achieved food and nutrition security (Nawani, 1994). The nutritional outcomes of the population mainly depend on not only the quantity of food, but the quality of food also. The trends in intake of calorie, fat, and protein are presented in Figure 3 for the period 1973-74 to 2011-12. The data show that between 1973-74 to 2011-12, the per-capita intake of calorie had decreased from 2266 to 2099 kcal/ day in rural areas and from 2107 to 2058 kcal/ day in urban areas and of protein decreased in rural areas from 62 to 57 g/day, but it was contrastingly stagnant in urban areas (56 g/day). The fat intake has depicted an increasing trend (24 to 42 g/ day in rural and 36 to 53 g / day in urban) during 1973-74 to 2011-12. In general, calorie consumption was higher in rural than urban areas throughout the study period. It is mainly because people do more physical work in rural areas than in urban areas. The urbanization also leads to sedentary life-style, which results in relatively low energy requirement to maintain a given body weight than in the rural areas.

Trends in Major Socio-economic Characteristics

The food consumption is influenced by many factors such as locality, climate, food availability and accessibility, besides social factors like class, caste, religion, culture, individual preferences and attitudes etc. This section discusses trends at aggregate level in demand-driven factors like improved per-capita income, rapid urbanization, etc. and supply factors like growth in food production and accessibility facilitated through social welfare programmes.

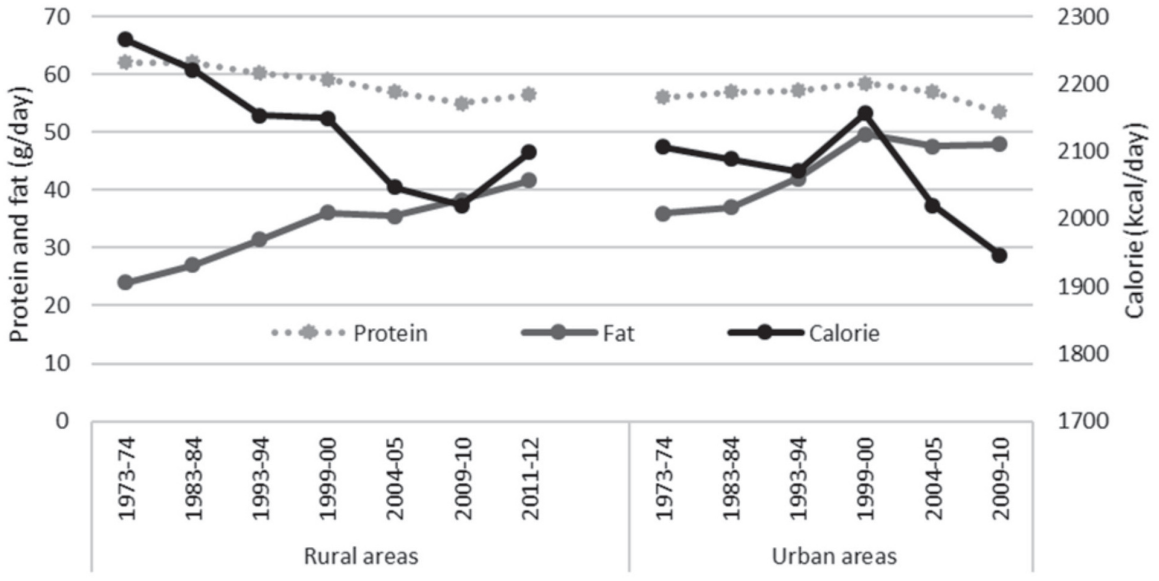

Figure 3. Trends in per capita intake of calorie, fat and protein in India: 1973-74 to 2011-12

Source: Compiled by authors from NSSO report on Nutritional Intake in India

Income and Expenditure Trends and Pattern

The monthly disposable income is one of the major factors that determine consumption behaviour of households. The income plays a critical role in reducing malnutrition and there is a strong negative relationship between income and malnutrition through enhanced access to food in both quantity and quality terms (Gulati *et al.,* 2012; Marmot, 2001). Therefore, the data on monthly per-capita expenditure given by NSSO were taken as a proxy for monthly per-capita income (MPCI) in this study. It was found that the real per-capita monthly income increased substantially from ₹ 1608 to ₹ 2477 in urban areas and from ₹ 943 to ₹ 1287 in rural areas during 1993-94 to 2011-12. The Figure 4 shows that MPCI in urban areas has always been higher than in rural areas the difference of about 70 per cent in 1993-94 widened to 92 per cent in 2011-12. The MPCI at constant (2011-12) prices increased gradually during 1993-94 to 2011-12, in both rural (36%) and urban (54%) areas. The studies have also highlighted that during the previous decade, the agricultural growth benefitted the agricultural labourers and increased their

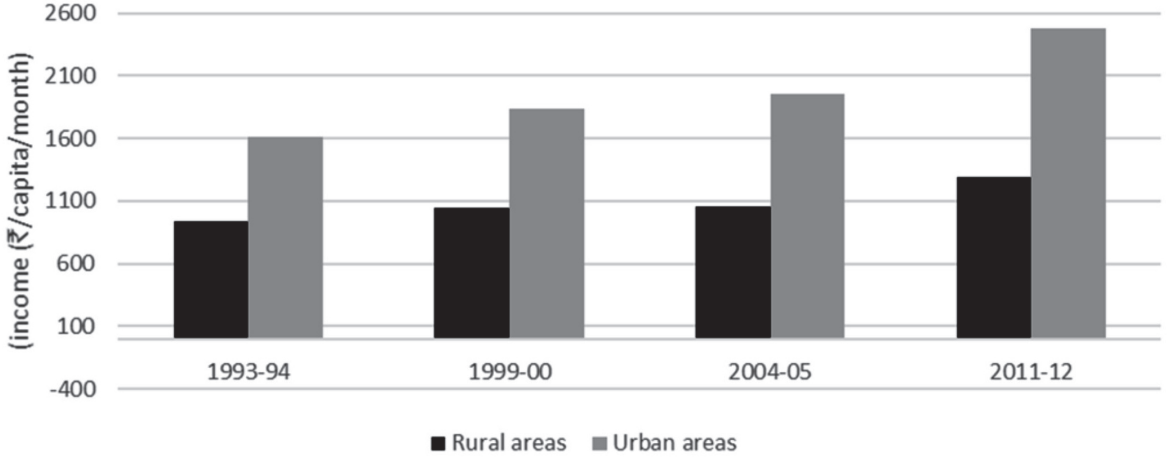

Figure 4. Trends in monthly per capita income during 1993-94 to 2011-12 at constant 2011-12 prices

Source: Compiled by authors from NSSO report on Household Consumer Expenditure across Socio-Economic Groups in India

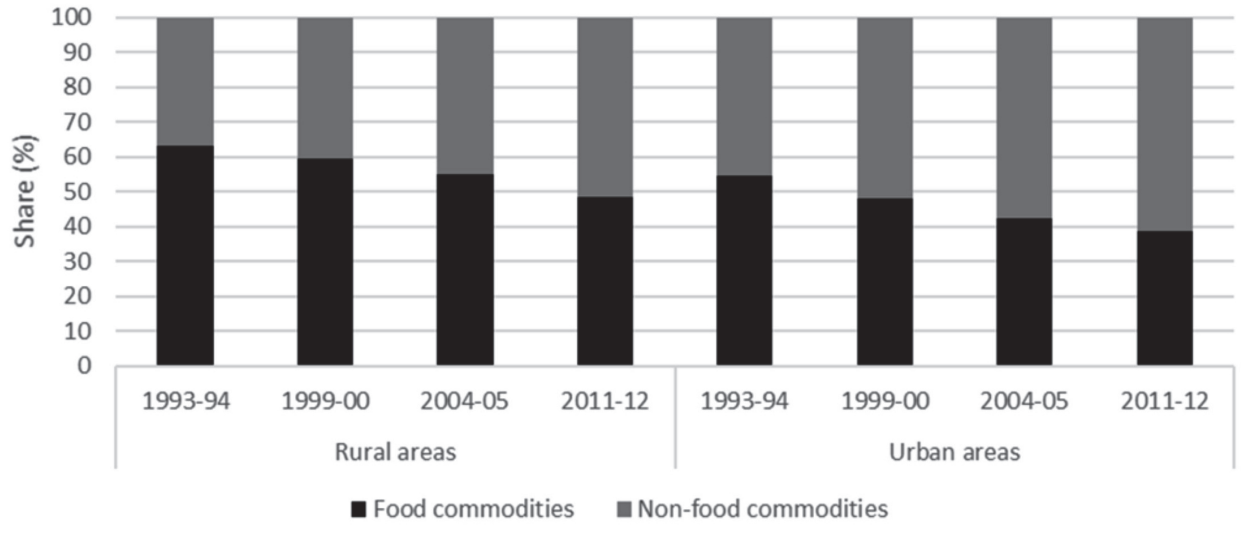

Figure 5. Trends in composition of consumer expenditure: 1993-94 to 2011-12

Source: Compiled by authors from NSSO report on Household Consumer Expenditure across Socio-Economic Groups in India

income (Venkatesh, 2013), and income disparity among the farm households in rural areas significantly declined (Nithyashree *et al.,* 2013). Consistent with economic theory, with increase in income level, the share of food expenditure declined in total consumption expenditure in both rural (from 63% to 49%) and urban (from 55% to 39%) areas during study period (Figure 5).

The share of some food groups in total food expenditure is depicted in Figure 6. Among food commodities, the share in food expenditure was highest for cereals, followed by milk and vegetables. The cereals' share dropped both in rural (38% to 25%) and urban (26% to 19%) areas, whereas, milk share increased from 15 to 19 per cent in rural and from 18 to 20 per cent in urban areas during the study period. The share of fish and meat and other food groups also witnessed an increasing trend, whereas the share of pulses, and edible oils registered a marginal declinine. However, vegetables recorded a mixed trend with a marginal increase in rural areas and slight decline in urban areas.

Urbanization

Urbanization is one of the other important factors that significantly influence the consumption behaviour by increasing the availability of food items through improved marketing infrastructure, transportation, modern retailing and linking global food market with domestic consumers (Hawkes, 2006). It has been reported that urbanization has a positive effect on consumption of animal based foods (Rae, 1998).The data clearly show that India has witnessed a significant growth in urbanization in recent periods (Table 2). The previous decade (2000's) had registered the highest growth in urbanization since 1950s, with addition of about 90 million people in the urban areas. In the past two decades, the share of urban population increased from 26 to 31 per cent and the number of towns and urban areas increased from 3768 to 7935 along with significant raise in single-earner households to double-earner households, which led to the change in food consumption pattern.

Determinants of Dietary Diversity

This section deals with empirical relationship between major factors (such as agricultural production diversity, education, income, poverty and urbanization) and dietary diversity. To estimate the effect of production diversity on consumption diversity, simple linear regression model was estimated with these variables. The results showed that model was significant and the value of R^2 also indicated that production diversity could explain about 30 per cent of the variation in diet diversity (Table 3). The regression coefficient revealed that a positive and significant association between production diversity and dietary diversity, on an average, 0.01 increase in SIPD value will increase SIDD by 0.047. A backward

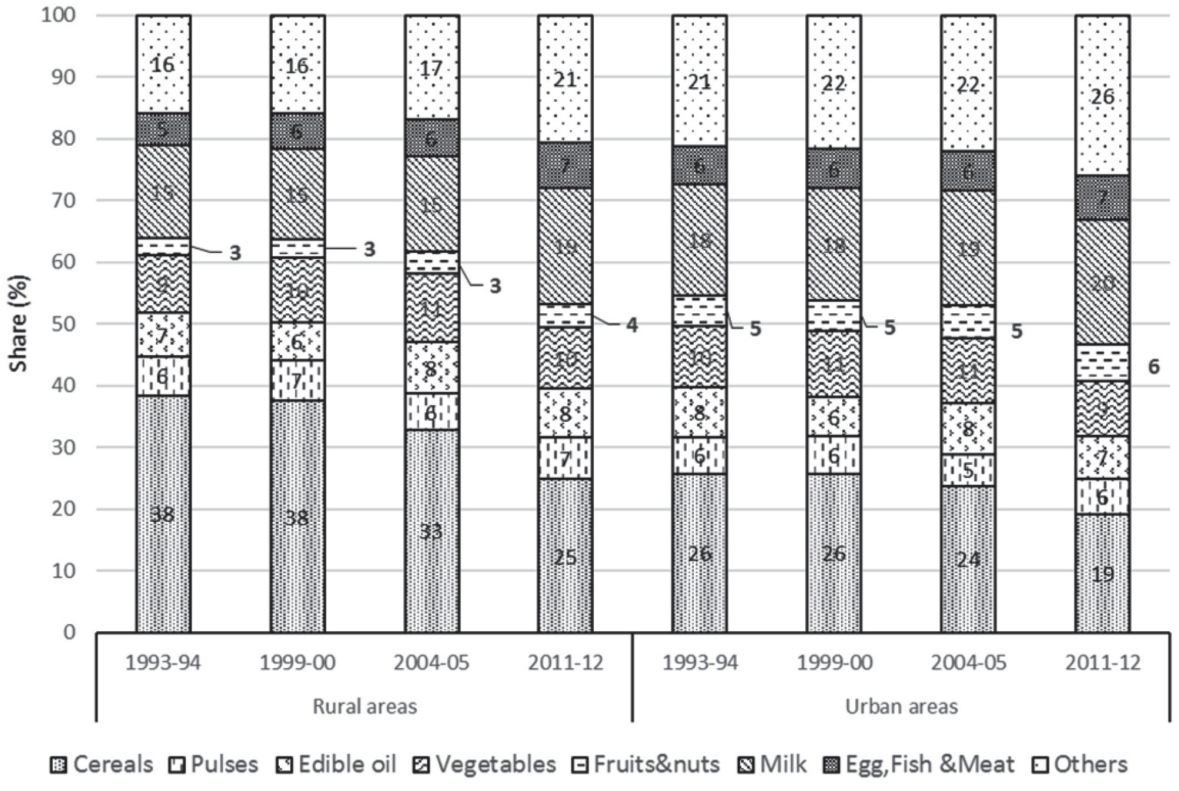

Figure 6. Trends in share of selected food groups in total food expnditure: 1993-94 to 2011-12

Source: Compiled by authors from NSSO report on Household Consumer Expenditure across Socio-Economic Groups in India

Table 2. Trends in urbanization and decadal growth in India: 1951-2011

Year	Total population (crore)	Towns and urban areas (No.)	Urban population (crore)	Share of urban population in total population (%)	Decadal growth in urban population (%)
1951	36.11	2843	6.24	17.3	41.4 (1941-1950)
1961	43.92	2365	7.89	18.0	26.4 (1951-1960)
1971	54.81	2590	10.91	19.9	38.2 (1961-1970)
1981	68.33	3378	15.95	23.3	46.1 (1971-1980)
1991	84.63	3768	21.76	25.7	36.4 (1981-1990)
2001	102.86	5161	28.61	27.8	31.3 (1991-2000)
2011	121.01	7935	37.7	31.2	32.7 (2001-2010)

Source: Compiled from Planning Commission (http://planningcommission.nic.in/aboutus/committee/ strgrp11/ str11_hud1.pdf) and Census reports (http://censusindia.gov.in/2011-prov-results/paper2/ data_files/ india/ Rural_Urban_2011.pdf)

multiple linear regression analysis was also estimated with all the selected variables using SPSS 21.0 software. The estimates for the model with significant variables and full model are presented in Table 3.

The results in Table 3 clearly display a strong and positive association of production diversity and dietary diversity across all the three models. This suggests that availability of a variety of food commodities

Table 3. Determinants of diet diversity at state level

Variable	B coefficients		
	Model 1	Model 2	Model 3
Y: Diet diversity Y (SIDD)			
Constant	0.383***	2.583***	2.56***
X_1 : Production diversity (SIPD))	0.467***	0.497***	0.465***
D_1 : Regional dummy (1=other states; 0=NE states)	-	0.001***	0.002**
X_2 : Per capita GSDP (in '000 ₹/year)	-	0.123***	0.136***
X_3: Literacy rate (%)	-	-0.63***	-0.061***
X_4: Literacy square	-	0.423***	0.401***
X_5: Urban population (%)	-	-	-0.004
X_6: Urban population square	-	-	0.041
X_7: Population under BPL (%)	-	-	0.003
X_8: Population under BPL square	-	-	-0.058
X_9: Interaction term (X_3 x X_5 x X_7)	-	-	2.56
No. of observations	28	28	28
R^2	0.308	0.852	0.868
Adjusted R^2	0.282	0.818	0.802

Note: ***, ** and * indicate significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

determines the consumption diversity and state with higher production diversity consumes more diversified foods than others. A farm level study on relationship between production diversity and dietary diversity in developing countries has found a positive relationship, however their relationship was not linear, when there was a high level of production diversity the relationship turned significant or negative due to income foregone from specialization (Sibhatu *et al.,* 2015).

Jones *et al*. (2014) in their study in Malawi have found a consistent and positive relationship between these variables. The study has also found significant differences among north-eastern states and other states. A positive and significant dummy variable on regional characteristics indicates that, households in other than north-eastern states consume more diversified foods than north-eastern states (base category states). It may be noted that geographical nature in north-eastern states limits production diversity and in turn, availability of diversified foods and cultural differences could also significantly influence the consumption behaviour.

The relationship between per-capita income and diet diversity was also found significant and positive. On an average if the per-capita income of a state increases by 1000 rupees, the consumption diversity will increase by 0.123. This result is in conformity with the past studies in developing countries including India (Thiele and Weiss, 2003; Jones *et al.,* 2014; Parappurathu *et al.,* 2015). They have also mentioned that increased diet diversity was mainly due to its palatability and pleasantness.

Further, the study has provided a non-linear significant relationship between the education level and dietary diversity. It indicates that the states with higher literacy rates fared well with a high dietary score. Many studies have established the positive influence of education on dietary diversity, as education improves the knowledge about health and importance of having diversified food in particular education level households- head (Parappurathu *et al.,* 2015) and mother (Beyene *et al.,* 2015). The study could not find any significant relationship between dietary diversity and rate of urbanization. Jones *et al.* (2014) have also found the inconsistent result with rural and urban areas and their dietary diversity in Malawi. A study on poverty and food security in Egypt has reported that poverty adversely affects the consumption of different food types. However, we find no significant association between poverty rate and diet diversity across the states in India.

Conclusions and Policy Implications

The food consumption pattern and nutritional intake have been studied over the past two decades (1993-2011) in India. The Simpson index of diversification for food production and consumption was computed across the states and its relationship was examined. The study has observed that food consumption has diversified with higher consumption of vegetables and meat and fish, there is slight decline in consumption of cereals and of pulses is stagnant over the past two decades. The consumption diversity has been found low in north-eastern states as compared to other states. The production diversity has been observed low and medium in north-eastern states and Punjab, Haryana, Tamil Nadu, Chhattisgarh and Rajasthan as compared to other states. Maharashtra has fared well in terms of both production diversity and consumption diversity.

The regression analysis has clearly revealed that dietary diversity and production diversity are positively and significantly associated. The study has established that local production diversity is one of the major determinants of dietary diversity. The per-capita income emerged as another important factor which positively influences dietary diversity, which indicates that consumption diversity moves along income.

Further, states with higher literacy rate fared well in terms of dietary diversity. The study also revealed that the north-eastern states consume less diversified foods as compared to other states. The study has concluded that production diversity combined with increased income and better education would result in better dietary diversity, which would improve nutritional status of the population. Policies should be targeted towards promotion of production diversification across the states to increase the availability of food commodities and improve the nutritional outcome.

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