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Food and nutrition security under the public distribution system in Odisha

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Abstract Odisha has been a frontrunner in overhauling its public distribution system (PDS), but its PDS has not contributed much to nutritional security. Over 60% of the state's population is undernourished and malnourished, and the poor are more calorie-deficient despite having greater access to subsidized grain, although there has been an upturn in both the coverage and the outreach of PDS, devoid of rural–urban bias. It is recommended that the Government of Odisha improves coverage by instituting a state-wide, universal system and widening the food basket to include high-protein pulses, coarse cereals, and biofortified food.

Keywords Public distribution system (PDS), utilization, food security, nutritional intake

JEL classification H31, H53, Q18

In India, the public distribution system (PDS) provides subsidized food to millions of poor people through a large network of Fair Price Shops. The PDS has raised the level of food security and eliminated hunger, but it is still criticized because it does not identify the poor correctly, and there are many errors in excluding and including the poor and incessant leakages in the distribution of food (Mooij 1994). To mitigate these problems, a shift was made during the late 1990s from a universal PDS to a targeted population below the poverty line (BPL), but it failed (Planning Commission 2005; Himanshu and Sen 2011; Nair 2011; Khera 2008, 2011; Puri 2012). From the early 2000s, some states—Odisha, Tamil Nadu, Rajasthan, Chhattisgarh, Madhya Pradesh, Telangana, and Gujarat—initiated an array of reform measures. Backed by strong political will and good governance, these reforms created aspirations that the system can be made efficient, and these reforms intensified following the enactment of the National Food Security Act (NFSA), 2013 (also Right to Food Act)[1] (Ministry of Law and Justice 2013) and its roll-out during 2016. The major concern of each state has been to steadily raise the nutritional standards[2] of people, while aiming to achieve food security, as directed in the NFSA 2013.

Several important challenges remain, however. The magnitude of malnutrition and undernutrition remains high, and ways need to be found urgently to improve access to sufficient amounts of protein, vitamins, and other nutrients. The difference in food prices in the PDS vis-à-vis the open market is sizeable; therefore, the impact of an increase in the transfer of implicit

[1] The pivot of the Act is the distribution of subsidized food to almost two-thirds of the country's population. It entails a rights-based approach and entitles priority households to 5 kg of rice, wheat, and millets per person per month at an issue price of, respectively, INR 3, INR 2, and INR 1 (Bathla, Bhattacharya, and D'Souza 2015).

[2] The two concepts are interlinked, but nutrition security has a much broader connotation than food security. It encompasses a biological approach—adequate and safe intake of protein, energy, vitamin and minerals and proper health, sanitation and social environment.

income on dietary diversification needs to be understood. And a policy mandate needs to be developed for distributing subsidized pulses, millets, and micronutrients through Fair Price Shops towards improving nutritional intake. These issues have not been researched well, and there is little consensus in the extant literature.

Kochar (2005) and Kaushal and Muchomba (2015) find that the impact of subsidized food on the total calorie intake of households is negligible despite an increase in their consumption of rice and wheat. While Kochar's analysis is restricted to wheat-consuming states, Kaushal and Muchomba extend it to rice-consuming states as well. Their findings are in sharp contrast to that of Krishnamurthy, Pathania, and Tandon (2014) for Chhattisgarh; Kishore and Chakrabarti (2015) for Andhra Pradesh, Chhattisgarh, Tamil Nadu, Odisha, and West Bengal; and Kaul (2018) for the entire country. These authors confirm greater inclusivity in the PDS along with a positive effect of implicit income transfer on energy intake and diet quality. They also report an increase in the consumption of pulses and edible oils, vegetables, sugar, and non-food items and, hence, improved energy intake.

In the case of Odisha, the state chosen for analysis, Kumar et al. (2017) reiterate the success of the PDS in ensuring food security: its share in total cereal consumption was much higher for Scheduled Caste (SC; 34%), Scheduled Tribe (ST; 32%), and Other Backward Class (OBC; 26%) households compared to General Caste households (19%) during 2011–12. Rahman (2016) compares the nutritional intake of beneficiaries under the universal and targeted PDS being followed across different regions and finds that in Kalahandi, Balangir, and Koraput (the KBK region), where the universal PDS is implemented, the macronutrient (calorie, protein, and fat) intake increased compared to that in the non-KBK region, which continues with a targeted system.

During 2014–15, Krishan (2017) conducted a primary survey of households in Nayagarh, Balangir, and Koraput districts; the contribution of PDS grain to calorie and protein intake for Antyodaya Anna Yojana (AAY) cardholders was highest (more than 40%) compared to BPL and Above Poverty Line (APL) cardholders. Kohli et al. (2017) also report improvements in health and nutrition outcomes over the period owing to coverage in the PDS, drinking water supply, and literacy. But much remains to be done through better infrastructure, women's secondary education, sanitation, access to land for food and livelihood, and mitigation of poverty and social disparities.

We aim to quantify the nutritional intake and deficiency of households as per the type of card possessed and income quantiles in rural and urban areas. We empirically estimate the effect on nutrition (calorie intake) of rice purchased from the PDS and the open market and of other factors. We extract the unit-level data from the 61st (2004–05) and 68th (2011–12) rounds on consumption expenditure of the National Sample Survey (NSS), and we take the year 2004–05, when Odisha began alterations in the structure and functioning of its PDS, as the starting point.

Odisha has contained leakages and brought in transparency by involving local people to monitor every stage regularly; installing electronic point-of-sale machines at Fair Price Shops; and by digitizing offtake and keeping records of procurement, storage, and distribution up to date. The NSS 2011–12 consumer expenditure survey is deemed to exhibit transformations in the broader context of reforms initiated in the state and the resultant food and nutritional standards. Aggarwal (2011), Chatterjee (2014), and Kumar et al. (2017) validate that these measures, backed by strong political will and good governance, have been effectual in ensuring food security to people at large. The present analysis will help to identify the role of the PDS in achieving nutrition security and draw policy implications.

Database and methodology

The 61st round of the NSS covered 3,836 households in rural areas in Odisha and 1,187 households in urban areas, whereas the 68th round covered 2,973 in rural areas and 1,053 households in urban areas. The sample constituted close to 4% of the total national sample. The bifurcation of households into poor and non-poor is done based on the recommendation of the Tendulkar Committee (Planning Commission 2014).

Accordingly, during 2004–05, households having a monthly per capita expenditure (MPCE) lower than INR 408 in rural areas and INR 497 in urban areas were considered poor; in the subsequent round these

limits increased to, respectively, INR 694, and INR 861. The inclusion and exclusion errors are estimated as Type 1 error (TR1) and Type 2 error (TR2). TR1 indicates the number of non-poor households included in the PDS (inclusion error) whereas TR2 indicates the number of poor households excluded from the PDS (exclusion error).

Inclusion error =

$$\frac{\text{Total number of poor households possessing ration cards}}{\text{Total number of households possessing ration cards}} \times 100$$

If all households accessing the PDS are poor, then the targeted ratio is 100, and the scheme is considered good. If the ratio is less than 100, it indicates the possibility of better targeting, maybe through a reduction in facilities to non-poor households.

Exclusion error =

$$\frac{\text{Total number of poor households possessing ration cards}}{\text{Total number of poor households}} \times 100$$

If TR2=100, the PDS scheme covers all the poor households. TR2 gives an idea of the poor households left out of the scheme as a proportion of the total poor households. The extent of coverage is followed by the estimation of implicit income transfer (Y) or savings owing to purchases made from PDS (Q), that is, $Y = Q(Pm - Ps)$, where Pm=market price and Ps=PDS price for commodities. The prevalence of undernourishment (POU) is measured as

$$\text{POU} = \frac{1}{N}\sum_{h=1}^{n} I_h w_h$$

where I_h= 1 if $C_h < Z$ and zero otherwise; h indexes households; C_h is per capita intake of hth HH, Z is the pre-specified norm as per the recommendation of the Indian Council of Medical Research-National Institute of Nutrition (ICMR-NIN), n is the number of households sampled, $N = \sum_{h=1}^{n} w_h$ is the estimated population; w_h is the sampling weight associated with the household.

In the case of unit-level data, W_h is given as a product of household-level multiplier and size. The extent of undernourishment is calculated on the basis of the norms set by the Food and Agriculture Organization (FAO) and the ICMR-NIN. The FAO uses a uniform norm of 1,800 kcal for both rural and urban areas for reporting undernutrition across countries, which is a minimum dietary requirement for sedentary activity (Chand and Jumrani 2013), but the norm does not reflect individual requirement, as each individual has a different adaptation level. Therefore, using the demographic information given in the NSS, an alternate method (Meenakshi and Vishwanathan 2006; Jumrani 2017) is used. The household-specific norm (Z_h) is calculated, instead of a pre-specified norm, and it is compared with household-level intake (C_h) instead of per capita norm. The age- and sex-adjusted norms used are taken from the Nutrient Requirements and Recommended Dietary Allowance for Indians (Rao and Sivakumar 2010) as follows:

Calorie (Rural) Z_h=

$N_{0h}\times 593+N_{1h}\times 1060+N_{2h}\times 1350+N_{3h}\times 1690+N_{4h}\times 2190+N_{5h}\times 2750+N_{6h}\times 3020+N_{7h}\times 2010+N_{8h}\times 2330+N_{9h}\times 2440+N_{10h}\times 2730+N_{11h}\times 2230$

Calorie (Urban) Z_h=

$N_{0h}\times 593+N_{1h}\times 1060+N_{2h}\times 1350+N_{3h}\times 1690+N_{4h}\times 2190+N_{5h}\times 2750+N_{6h}\times 3020+N_{7h}\times 2010+N_{8h}\times 2330+N_{9h}\times 2440+N_{10h}\times 2320+N_{11h}\times 1900$

Protein (Rural/Urban) Z_h =

$N_{0h}\times 10+N_{1h}\times 16.7+N_{2h}\times 20.1+N_{3h}\times 29.5+N_{4h}\times 39.9+N_{5h}\times 54.3+N_{6h}\times 61.5+N_{7h}\times 40.4+N_{8h}\times 51.9+N_{9h}\times 55.5+N_{10h}\times 60+N_{11h}*55$

These variables represent the number of individuals in different sex and age groups for a given household h; N_0 represents number of children below 1 year (infant); N_1 between 1 and 3 years; N_2 between 4 and 6 years; N_3 between 7 and 9 years; N_4 represents the number of boys between 10 and 12 years; N_5 between 13 and 15 years; N_6 between 16 and 17 years; N_7 represents the number of girls between 10 and 12 years; N_8 between 13 and 15 years; N_9 between 16 and 17 years; N_{10} represents number of adult males above 17 years and N_{11} represents number of adult females above 17 years.

The recommended dietary intake level represents moderate and sedentary activity in, respectively, rural and urban areas. The nutrient intake of an individual is calculated by using the quantity of each food item consumed and the nutrient chart prescribed by the NSS. It is also estimated by the type of ration card owned

and the contribution of different consumption items to nutritional intake. This quantification is followed by an empirical analysis of key factors that determine households' nutritional intake based on the equation

$$Y=\beta_{0+}\beta_1 X_{1+}... +\beta_n X_n+ \varepsilon$$

where Y is the dependent variable—per capita monthly calorie intake; $X_1 ... X_n$ are the independent variables MPCE, household size, educational level, per capita cereal consumption from open market and PDS, age of household head, and land owned. The latter two variables are taken to represent experience and status. Three dummy variables—social groups, rural–urban regions, and poor and non-poor households—are also included to capture the differences. The $\beta_0, \beta_1, \beta_n$ are fixed (but unknown) parameters and ε is a random variable representing an error or residuals. The equation is run using ordinary least squares in double log functional form.[3]

Results and discussion

Inclusion and exclusion errors

The efficacy of the targeting of the PDS is indicated by Type 1 (TR1) and Type 2 (TR2) errors; TR1 indicates the proportion of the non-poor included in the system, and TR2 indicates the percentage of the poor excluded from the system. The inclusion of non-poor households is desirable, but not at the cost of poor households. A high exclusion rate indicates that most of the eligible households are omitted from the system. It may imply that a smaller proportion of households than the actual proportion of deserving households obtain benefits from the welfare scheme. If the ratio is close to 100%, it means there exist inclusion and exclusion errors, that is, all the eligible poor are included in the PDS.

In 2004–05, 38.43% of the rural non-poor were included in the PDS and 29.65% of the actual poor were excluded (Figure 1a). In the subsequent NSS round, the proportion of inclusion errors increased and that of exclusion errors decreased. In 2004–05, 68.58% of the urban non-poor were included and 43.28% of the poor were excluded (Figure 1b). In 2011–12, the proportion of inclusion rose to 74.42% and that of exclusion dropped to 32.20%. It suggests the system performed better than before as most of the poor were included. The inclusion of the non-poor increased over time, indicating that increasing quantities of food grains will be diverted to them if the state government does not control the inclusion problem.

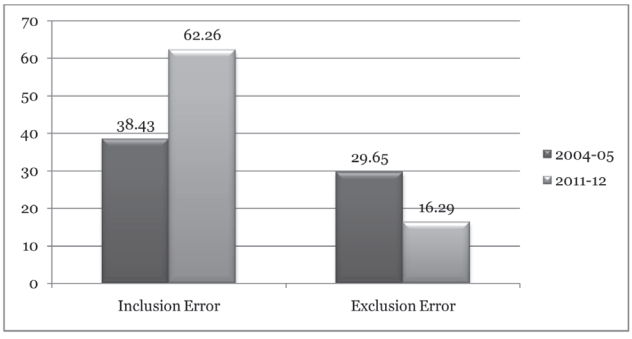

Figure 1a Inclusion and exclusion errors among rural households in Odisha

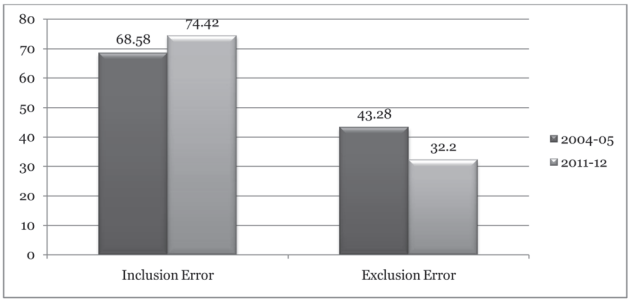

Figure 1b Inclusion and exclusion errors among urban households in Odisha

Table 1 provides statistics on the possession of ration cards by the poor and non-poor. It shows that 66.88% of rural households were covered, 1.98% were categorized as AAY, 42.44% BPL and 22.45% Other cardholders. The Tendulkar Committee recommended a way to measure the poverty line, and it is used to estimate the poor; it appears that in 2004–05, AAY and BPL cardholders (categorized mainly as poor) made up a smaller number than that of the poor. The proportion of AAY and BPL cardholders increased from, respectively, 1.98% and 42.44% in 2004–05 to, respectively, 5.49% and 47.86% in 2011–12. On ownership of ration cards, compared to rural areas, urban areas show 1.39% had an AAY card, 13.61% had a BPL card and 33.91% possessed an Other

[3] Due to household-specific unobserved heterogeneity, the ordinary least squares may lead to biased estimates. The Hausman test results were found to be insignificant when some explanatory variables were checked for endogeneity.

Table 1 Distribution of households by ration card type in Odisha and India (%)

Card type	AAY (1)	BPL (2)	Others	Total cardholders	Total poor household cover (1+2)	No card	Incidence of poverty
			Rural (2004–05)				
Odisha	1.98	42.44	22.45	66.88	44.42	33.12	58.64
All India	2.94	26.53	51.80	81.27	29.47	18.73	36.78
			Urban				
Odisha	1.39	13.61	33.91	48.91	15.00	66.09	27.10
All India	0.94	11.58	61.35	73.87	12.53	26.13	30.12
			Rural (2011–12)				
Odisha	5.49	47.86	18.22	71.57	53.35	28.43	32.27
All India	5.67	37.92	42.34	85.93	43.59	14.07	21.48
			Urban				
Odisha	2.19	18.27	25.37	45.83	20.46	54.17	17.29
All India	1.80	17.11	56.03	74.95	18.92	25.05	13.69

Source NSSO Unit Level Data 61st and 68th Rounds (NSSO 2006, 2014)

category card. The data show that 66.09% households did not have a card, and this proportion was much higher than in rural areas in 2004–05. In 2011–12, the proportion of households with AAY and BPL cards increased, respectively, to 2.19% and 18.27%.

Remarkably, the number of households without cards dropped over the years. Also, the ratio of the poor in both urban and rural locations was higher than the total poor with BPL and AAY cards in 2004–05. The situation reversed in 2011–12; the poor covered under the BPL and AAY card numbered more than the poor covered under the scheme. One may infer that the coverage of poor households in the PDS increased manifold over the period in both rural and urban areas, which could also be explained by the adoption of universal PDS in some regions and hence entitlement to APL cardholders. The growing price advantage might have also pushed households to claim eligibility and create demand-side pressures on the system to function better.

Per capita consumption from PDS and accrual of savings

The monthly per capita consumption of PDS rice, wheat, kerosene, and sugar increased considerably in 2011–12, especially in rural areas (Table 2). Rice consumption in rural areas increased from 0.94 kg to 3.82 kg, but the consumption of other items increased only marginally—of wheat from 0.001 kg to 0.19 kg, sugar from 0.01 kg to 0.10 kg, and of kerosene from 0.39 litres to 0.50 litres. In urban areas, consumption was substantially low, and it increased eventually. Apparently, the consumption of commodities from the open market and other sources was much higher (except of kerosene) perhaps because grains or the preferred quality of rice were not available in the PDS.

Table 2 Per capita consumption from PDS and other sources (kg per month)

Commodities	Consumption from PDS			
	Rural		Urban	
	2004–05	2011–12	2004–05	2011–12
Rice	0.94	3.82	0.31	1.34
Wheat	0.001	0.19	0.02	0.30
Sugar	0.01	0.10	0.004	0.05
Kerosene (litre)	0.39	0.50	0.23	0.30
Consumption from open market and other sources				
Rice	11.90	8.39	10.23	7.51
Wheat	0.45	0.47	1.73	1.54
Sugar	0.31	0.30	0.50	0.46
Kerosene (Litre)	0.14	0.11	0.29	0.23

Source NSSO Unit Level Data from 61st and 68th Rounds (NSSO 2006, 2014)

Table 3 provides estimates of items consumed by AAY and BPL ration card holders. In rural areas, rice consumption by AAY and BPL cardholders was, respectively, 5.98 kg and 1.63 kg in 2004–05, which increased to, respectively, 7.34 kg and 6.54 kg in 2011–12. Rice consumption by other cardholders increased marginally from 0.18 kg to 0.79 kg. The monthly per capita consumption of rice increased in urban areas but not as much as reported by rural households. For all commodities, the consumption by AAY and BPL cardholders was the most. The consumption of all PDS commodities except sugar increased; the sugar consumption of other cardholders declined. Notably, per capita consumption of grain by other cardholders increased over time, which is congruent with the finding of Rahman (2016) on the impact of the universal PDS introduced in the KBK region from 2008. The outreach and allocation of rice and other commodities benefited the rural poor more and raised consumption.

The per capita consumption of commodities from other sources was much higher for holders of cards other than AAY and BPL cards (Table 4). Concomitantly, AAY and BPL cardholders consumed more rice per capita from the PDS than from any other source. Variations are visible in the case of sugar and wheat. In urban areas, rice consumption from other sources was high, but it decreased in due course for all cardholders. The consumption of sugar from other

Table 3 PDS consumption per capita by card type (kg per month)

Commodities	2004–05			2011–12		
	AAY	BPL	Other	AAY	BPL	Other
Rural						
Rice	5.98	1.63	0.18	7.34	6.54	0.79
Wheat	0.11	0.01	0.00	0.02	0.02	0.78
Sugar	0.003	0.01	0.01	0.12	0.18	0.03
Kerosene	0.52	0.46	0.44	0.61	0.62	0.53
Urban						
Rice	0.94	0.27	0.01	1.96	1.03	0.11
Wheat	0.001	0.09	0.04	0.19	0.02	0.19
Sugar	0.001	0.01	0.01	0.04	0.04	0.00
Kerosene	0.10	0.08	0.06	0.20	0.12	0.09

Source NSSO Unit Level Data from 61st and 68th Rounds (NSSO 2006, 2014)

Table 4 Per capita consumption from other sources by card type (kg/month)

Commodities	2004–05			2011–12		
	AAY	BPL	Other	AAY	BPL	Other
Rural						
Rice	7.08	11.39	13.03	5.76	6.12	10.74
Wheat	0.17	0.26	0.76	0.40	0.37	0.55
Sugar	0.21	0.24	0.41	0.23	0.21	0.44
Kerosene	0.08	0.09	0.09	0.06	0.03	0.06
Urban						
Rice	1.90	1.81	1.63	0.73	1.05	1.48
Wheat	0.13	0.18	0.31	0.07	0.15	0.18
Sugar	0.05	0.06	0.08	0.10	0.05	0.09
Kerosene	0.06	0.03	0.02	0.03	0.01	0.02

Source NSSO Unit Level Data from 61st and 68th Round

sources increased for holders of cards other than AAY and BPL cards, but their consumption of PDS sugar declined.

Income transfer due to subsidized food grains

Grains are priced lower under the PDS vis-à-vis the open market; since the coverage and outreach of PDS improved in both rural and urban areas, households incurred savings, and they may utilize it to purchase commodities other than cereals and sugar. Households that made purchases from the PDS as well as the open market were delineated. The amount of saving equals the price difference of a commodity in PDS and open market multiplied by the quantity of that commodity from the PDS. The market (retail) price of selected commodities is extracted from the survey.

Table 5 shows rice to be the main staple food in Odisha, though in 2011–12 the NSS reported it to be wheat. The average monthly saving per household in 2004–05 was INR 86 and INR 36, respectively, in rural and urban areas, which increased substantially to, respectively, INR 535 and INR 618 in the subsequent round. The same holds true across the type of card possessed. During 2011–12, AAY and BPL cardholders in rural areas could save, respectively, INR 531 and INR 528 and in urban areas, respectively, INR 647 and INR 628. An increase in the savings of the poor shows their dependency on the system; the percentage change in the amount can be attributed to variations in grain entitlement across the type of card and the differences in commodity prices in rural and urban markets. As commodity prices are higher in urban locations, the estimates show 15–28 times higher savings; in rural areas the saving is only 3.5–7 times.

Nutritional (calorie and protein) intake of households

We turn to providing estimates of the nutritional requirements and actual intake of households on the basis of the ICMR-NIN–recommended dietary allowance in 2010. The energy intake is estimated in terms of calories and proteins separately for various categories of cardholders and income groups in rural

Table 5 Average household saving due to PDS purchases (INR per household per month in nominal price)

Type of Card	Rice	Wheat	Sugar	Kerosene	All Commodities
			Rural (2004–05)		
AAY	135	0.0	0.0	22	157
BPL	55	0.0	6.38	20	82
Others	50	0.0	0.0	18	69
All Households	61	0.0	6.19	18	86
			Urban (2004–05)		
AAY	18	0.0	0.0	5	23
BPL	19	0.0	0.0	13	31
Others	20	0.0	0.0	19	39
All Household	18	0.0	0.0	17	36
			Rural (2011–12)		
AAY	479	-	24	27	531
BPL	404	66	26	30	528
Others	356	72	32	30	491
All Household	410	71	26	26	535
			Urban (2011–12)		
AAY	547	25	35	39	647
BPL	427	125	29	46	628
Others	407	104	26	46	585
All Household	439	104	29	45	618

Source NSS Unit Level data 61st and 68th Rounds (NSSO 2006, 2014)

and urban areas. A simple average per capita intake would not be able to capture the demographic features as each individual requires different levels of calorie and protein intake according to age, sex, and nature of work. The energy requirement is calculated assuming that people are engaged in sedentary work.

The estimates indicate that per capita calorie intake was less than the requirement in rural areas for both years (Table 6). In urban areas, the actual intake of AAY and other cardholders in 2004–05 exceeded their requirement; for other cardholders, the intake declined subsequently. The average actual per capita protein intake exceeded the requirement of other cardholders in rural and urban areas. Clearly, there was an increase over time in the average per capita requirement of all cardholders and their actual intake of proteins and calories. Urban households were slightly better off; the gap between their per capita requirement of protein and actual intake of protein was smaller. Calorie intake increased, but the gap between the norm and the actual consumption was wide, and it was wider in rural areas. In view of the uneven coverage and outreach of the PDS, a similar exercise is done per income group. The households are divided into five categories by their MPCE, which is taken as a proxy for income. The results are consistent with those obtained as per the type of card (Table 7).

During 2004–05, in rural areas, the average per capita actual intake of calories and proteins for all income groups was lower than the requirement; in urban areas, except for the bottom MPCE group, it was somewhat higher. The actual intake of households (1,679 kcal) was much lower than the requirement (2,157 kcal). In 2004–05, in both rural and urban areas, the actual intake of upper MPCE groups seemed to exceed their requirement by, respectively, 386 kcal and 659 kcal. This trend continued in 2011–12, but in rural areas the actual average intake of protein of all income groups increased and levelled with the requirement. Perceptible differences between the norm and actual intake of calorie and protein persist for all MPCE groups except the high-income group; their intake, in both rural and urban areas, tends to exceed their requirement.

Cereals and cereal substitutes are major sources of calories and proteins (more than 60%) for all income groups in both rural and urban areas. The share of cereals and cereal substitutes in the total declines as one moves up the MPCE groups from the bottom (Tables A1 and A3). In other words, the poorest of the

Table 6 Calorie and protein requirement and actual intake by MPCE group

Rural (per capita/day)					Urban (per capita/day)				
MPCE Class (INR)	Calorie (Kcal)		Protein (gm)		MPCE Class	Calorie (Kcal)		Protein (gm)	
	ICMR-NIN Norm	Actual Intake	ICMR-NIN Norm	Actual Intake		ICMR-NIN Norm	Actual Intake	ICMR-NIN Norm	Actual Intake
2004–05									
10–342	2157	1679	47	39	99–341	1960	1656	47	39
343–447	2248	2077	49	49	342–447	2011	1936	49	48
448–581	2278	2270	50	54	448–581	2093	2148	52	56
582–848	2300	2479	51	61	582–848	2067	2250	51	58
849–16082	2333	2719	52	71	849–13886	2051	2710	51	75
All	2224	2023	49	48	All	2036	2139	50	55
2011–12									
167–813	2338	1902	49	44	332–808	1990	1796	48	43
814–1065	2295	2180	51	52	809–1062	2023	1956	49	49
1067–1404	2300	2243	51	55	1068–1404	2069	2155	51	54
1407–2050	2345	2400	52	59	1415–2050	2074	2158	53	56
2053–11446	2403	2658	54	68	2054–22440	2105	2405	54	65
All	2282	2116	50	50	All	2052	2094	51	53

Source GOI NSS unit level data 61st and 68th Rounds (NSSO 2006, 2014)

Table 7 Calorie and protein requirements and actual intake by card type

Card Type	Rural (per capita per day)				Urban (per capita per day)			
	Calorie (Kcal)		Protein (gm)		Calorie (Kcal)		Protein (gm)	
	ICMR-NIN Norm	Actual Intake	ICMR-NIN Norm	Actual Intake	ICMR-NIN Norm	Actual Intake	ICMR-NIN Norm	Actual Intake
2004–05								
AAY	2168	1891	47	43	2135	2212	54	53
BPL	2210	1939	48	46	2022	1973	49	48
Others	2272	2226	50	54	2079	2294	51	60
All	2231	2039	49	48	2065	2202	51	56
2011–12								
AAY	2276	2116	50	49	2012	2134	49	49
BPL	2295	2088	51	49	2028	2009	50	49
Others	2311	2117	51	53	2091	2059	53	53
All	2298	2114	51	50	2062	2043	51	51

Source NSS unit level data 61st and 68th rounds (NSSO 2006, 2014)

poor in the bottom-most MPCE group consume a higher share of cereals than other income groups. The contribution of PDS cereal to nutrition has increased from 12% to 37% over the selected seven-year period; the share was the maximum for the poor in both urban and rural areas (Tables A1- A4).

The share of cereals and cereal substitutes in total consumption declined among all income groups in the state, and the share of non-staple items did not increase significantly. An implication may be that the pace of diversification towards nutrient-rich food items such as vegetables and fruits is slow. Another may be that the savings owing to purchases from the PDS is not being used to purchase non-staples and, hence, diet quality is not improving. In developing countries, the disconnect between contemporary nutritional challenges (micronutrient malnutrition and overweight/obesity) and agricultural policy is growing, and this is a major issue that needs to be addressed (Pingali 2015). Households draw protein mainly from cereals and cereal substitutes (73% in rural areas and 61% in urban areas) and calories (73% in rural areas and 65% in urban areas), of which rice is the main constituent. Since AAY households have higher access to rice and a larger quota, the contribution of the PDS to their energy intake in 2011–12 was double (53%) than to that of other beneficiaries.

Prevalence of undernutrition (POU), malnutrition, and nutritional intake

We quantify the POU and malnourishment among rural and urban populations by type of card owned and MPCE group. We estimate the extent of undernourishment using the ICMR-NIN and FAO norms. The ICMR calorie requirement is based on demographic features such as work, age, and sex, whereas the FAO recommends intake of 1,800 kcal on average (Chand and Jumrani 2013). The percentage of the population that was undernourished and malnourished in 2004 and 2011 was estimated on the basis of calorie and protein intake.

In rural areas, the proportion of the undernourished was higher among AAY cardholders than among BPL and Other cardholders (Table 8). In both rural and urban areas, the proportion of the undernourished as per the ICMR-NIN norms declined among AAY cardholders but increased in the case of BPL and Other cardholders. By the FAO norms, in contrast, a decline is clearly visible across all cardholders in rural areas and an increase in urban areas. The proportion of malnourished people among AAY cardholders was the highest, followed by BPL and other cardholders. In the case of rural AAY cardholders, the proportion of undernourished persons declined but was slightly

Table 8 Undernutrition and malnutrition by card type (%)

Card type	Rural			Urban		
	Undernutrition		Malnutrition	Undernutrition		Malnutrition
	FAO Norms	ICMR-NIN Norms	ICMR-NIN Norms	FAO Norms	ICMR-NIN Norms	ICMR-NIN Norms
			2004–05			
AAY	58.76	67.43	60.80	15.59	50.90	56.91
BPL	45.29	66.90	59.24	33.50	54.55	62.43
Others	23.26	56.82	48.02	26.11	43.76	43.64
			2011–12			
AAY	15.16	66.98	64.61	22.21	46.26	67.10
BPL	28.21	68.07	62.64	34.89	57.11	58.43
Others	19.68	65.74	57.93	31.10	59.21	66.06

Source NSS Unit Level Data 61st and 68th rounds (NSSO 2006, 2014)

higher compared to 'other' cardholders; for other cardholders, it increased over the period.

The findings are similar across income groups. By both FAO and ICMR-NIN norms, undernutrition and malnutrition tend to be much higher among the poor than among the rich (Table 9); it is the highest for the bottom-most MPCE group and declines as one goes up, and the extent of the decline was greater by FAO norms. In the subsequent period, there are some changes, albeit mild. By ICMR norms, in rural areas, deficiency increased for all MPCE groups from 64 to 65 (undernutrition) and 56 to 59 (malnutrition); in urban areas deficiency increased from 48 to 54 (undernutrition) and 47 to 56 (malnutrition). In rural areas, the deficiency increased significantly for the

Table 9 Undernutrition and malnutrition by MPCE group (%)

	Rural				Urban		
MPCE Group (INR)	Undernutrition		Malnutrition	MPCE Group (INR)	Undernutrition		Malnutrition
	FAO Norms	ICMR-NIN Norms	ICMR-NIN Norms		FAO Norms	ICMR-NIN Norms	ICMR-NIN Norms
			2004–05				
10–342	86	82	71	99–341	66	71	69
343–447	55	76	70	342–447	40	58	61
448–581	29	70	65	448–581	29	49	48
582–848	16	55	49	582–848	11	45	43
849–16082	5	39	26	849–13886	7	18	17
All	38	64	56		31	48	47
			2011–12				
167–813	52	76	70	332–808	54	68	70
814–1065	29	73	69	809–1062	39	63	67
1067–1404	18	65	64	1068–1404	19	52	57
1407–2050	14	62	51	1415–2050	21	50	54
2053–11446	8	51	38	2054–22440	7	36	30
All	24	65	59	All	28	54	56

Source GOI NSS unit level data 61st and 68th Rounds (NSSO 2006, 2014). MPCE group is divided into quintile from lowest to upper.

bottom-most MPCE group and increased for the uppermost MPCE group; in urban areas, it increased across all MPCE groups. If FAO norms are used, the picture changes. Between 2004–05 and 2011–12, in rural areas, undernutrition declined from 38% to 24%; in urban areas it declined from 31% to 28% in urban areas. However, according to the ICMR norms, it increased by 1 percentage point in rural areas and 6 percentage points in urban areas.

Alarmingly, however, by the ICMR norms, over 60% of the rural population of Odisha and over 50% of its urban population were calorie- and protein-deficient in 2011–12, and these proportions were much higher among the low-income population. In rural areas, the percentage of the undernourished and malnourished in lower MPCE groups declined more than in the top MPCE groups. In a slight variation of this trend, the undernourished population in urban areas declined, but the population of the malnourished increased.

Determinants of nutritional intake of households and contribution of PDS

To what extent does PDS grain impact the nutritional intake of households in Odisha? This question is addressed by employing a multiple regression approach in a double log functional form. The dependent variable taken is per capita calorie intake; the independent variables are total MPCE; monthly per capita consumption of cereal from the PDS and from the open market; household size; land owned by households and the household head's education. The model also includes regional dummies along with a location dummy (rural–urban) and a dummy to represent the social and economic status of households. The results presented in Table 10 refer to 9,534 observations, based on the number given in the NSS 68th round for Odisha.

Per capita calorie intake is significantly explained by the selected explanatory variables, as indicated by the high value of R^2 (0.65). The coefficient of household

Table 10 Determinants of household nutritional intake (2011–12)

Dependent variable per capita calorie intake of households in log		
Independent variables (in log)	β Coefficient	Sig. level
Log MPCE (INR)	0.170	0.000
Household size	-0.161	0.000
Education of household head	0.009	0.001
Age of household head	0.0002	0.870
Log total land owned	0.012	0.000
Log monthly per capita cereal consumption—PDS (kg)	0.108	0.000
Log monthly per capita cereal consumption—open market and other sources (kg)	0.211	0.000
Social groups (®Others)		
Scheduled Tribe (ST)	0.001	0.332
Scheduled Caste (SC)	0.009	0.023
Other Backward Class (OBC)	0.004	0.036
Poor and non-poor dummy (®Poor)	-0.028	0.000
Regional dummy (®Coastal region)		
Southern region	-0.0008	0.354
Northern region	0.002	0.249
Rural and urban dummy (® Urban)	0.040	0.000
Constant	6.145	0.000
R^2	0.65	
Number of observations	9534	
Test of endogeneity (H0: Variables are exogenous)		
Wu-Hausman	0.16	

Source Computed from GOI NSS unit level data 68th Round (NSSO 2014) ® Indicates a reference variable

size bears a negative sign, indicating that nutritional intake falls if the number of household members increases. The household head's level of education has a bearing on the energy intake. The economic variables MPCE (income) and land owned are positively related to per capita calorie intake.

The estimated elasticity of purchase of PDS cereal implies that a 10% increase in consumption of cereals procured from PDS and open market results in a 1.08% and 2.11% increase in calorie intake, respectively. The coefficient of the per capita calorie intake of non-poor households (based on the dummy) is 0.028, which is more than that of poor households at 1% level of significance, and it validates the finding of the descriptive statistics that the deficiency of macronutrients (fats, proteins, and calories) is higher among the poor than among the rich.

The estimated value of the coefficient of location, 0.04, indicates that calorie intake was better among rural households than among urban households. The calorie intake of households in southern Odisha was lower than among those in the relatively developed coastal regions. In the north, however, the calorie intake, though better than in the coastal region, was found to be statistically insignificant both in south and north region. The nutrition intake is higher among ST, SC and OBC (mostly poor having AAY and BPL cards) than among other, mainly upper-caste, cardholders at 5% level of significance. However, in the case of STs, it is statistically insignificant. These results align with Kumar et al. (2017) that nearly 14 million people could escape the curse of hunger due to revamped PDS. It translated to a 31.7% reduction in calorie-deficient population in the state.

Conclusions

By improving its governance and institutional arrangements, Odisha revamped its PDS almost a decade before the National Food Security Act, 2013 was implemented. This paper examines the effectiveness of the state's reform measures in achieving nutrition security among its rural and urban populations. The analysis is based on the quantification of calorie and protein intake, and of the deficiency among households, by the type of ration card possessed and income quantiles; it is based also on unit-level data on consumption expenditure from the 61st round of the NSS (2004–05) and the 68th round (2011–12).

The analysis reveals a significant upturn in the coverage, and fewer errors in inclusion and exclusion, which may also be attributed to the implementation of the universal system in some regions from 2008. The per capita consumption of rice, a key staple grain, increased as fewer of the AAY and BPL cardholders and other poor were excluded. The poor consumed more rice from the PDS than from the open market. Between 2004–05 and 2011–12, the monthly consumption of rice by AAY beneficiaries increased—from 5.98 kg to 7.34 kg in rural areas and from 0.94 kg to 1.96 kg in urban areas. Accordingly, the monthly savings on account of purchase of rice, wheat, sugar, and kerosene increased—in urban areas from INR 23 to INR 647 and in rural areas from INR 157 to INR 531. But this income transfer does not seem to have been utilized for non-staples; the consumption of cereal, a primary source of calories and proteins, also declined, and the consumption of other items did not increase much.

More than 60% of Odisha's population is estimated to be undernourished and malnourished. Based on the official poverty line, 16.29% of the rural poor and 32.2% of the urban poor were excluded from the PDS. The availability of rice from the PDS increased over the decade, but its contribution to nutritional intake was barely 30% in rural areas and 14% in urban areas. The econometric analysis verified that PDS cereal influenced calorie intake, with an elasticity of 0.108, compared to the higher elasticity of open market purchase at 0.211. The AAY cardholders had relatively greater access to PDS, but suffered more from calorie and protein deficiency.

The government must hasten to implement a universal PDS across the state to increase coverage. It must address the incidence of anaemia and recalcitrant deficiencies of micronutrients such as vitamin A. Adding high-protein pulses, coarse cereals, and biofortified food to the food basket, depending upon people's tastes and preferences, may encourage crop diversification, due to assured state-led procurement. But it may also necessitate changes in the agriculture policy, which is highly biased towards paddy/rice and wheat.

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Table A1 Share of different items in calorie intake (2004–05, %)

MPCE Group	Cereals and substitutes	Pulses and pulse products	Milk and milk products	Edible oil	Meat and fish	Fruits and vegetables	Sugar and spices	Others
				Rural				
1	82 (12)	6	1	0	1	7	1	1
2	76 (4)	9	2	0	1	8	1	2
3	73 (4)	9	3	0	2	8	1	1
4	71 (2)	9	4	0	2	9	1	2
5	64 (1)	11	7	0	3	9	1	4
All	76 (7)	8	2	0	2	8	1	2
				Urban				
1	80 (7)	7	1	0	1	7	1	2
2	73 (3)	8	3	0	3	7	1	2
3	69 (1)	10	7	0	3	7	1	2
4	64 (0)	11	8	0	3	8	1	4
5	54 (0)	12	12	0	6	8	1	6
All	68 (2)	9	6	0	3	7	1	3

Source NSS Unit-Level Data 61st Round (NSSO 2006). Figures in parentheses percentage share of PDS cereal in total consumption.

Table A2 Share of different items in protein intake (2004–05, %)

MPCE Group	Cereals and substitutes	Pulses and pulse products	Milk and milk products	Edible oil	Meat and fish	Fruits and vegetables	Sugar and spices	Others
				Rural				
1	85 (12)	2	0	4	0	5	2	1
2	80 (4)	3	1	4	0	6	3	2
3	78 (4)	3	2	5	0	7	3	2
4	74 (3)	3	3	5	0	7	4	3
5	68 (1)	4	4	6	1	8	4	4
All	80 (7)	3	1	4	0	6	3	2
				Urban				
1	83 (7)	2	1	4	0	5	3	1
2	78 (3)	3	2	5	0	6	3	2
3	73 (1)	4	4	6	0	6	4	3
4	67 (0)	4	5	7	1	7	5	5
5	58 (0)	5	8	8	1	8	5	7
All	71 (2)	4	4	6	1	7	4	3

Source NSS Unit-Level Data 61st Round (NSSO 2006). Figures in parentheses percentage share of PDS cereal in total consumption)

Table A3 Share of different items in calorie intake (2011–12, %)

MPCE Group	Cereals and substitutes	Pulses and pulse products	Milk and milk products	Edible oil	Meat and fish	Fruits and vegetables	Sugar and spices	Others
				Rural				
1	73 (37)	8	1	0	4	6	1	6
2	68 (30)	8	4	0	5	7	1	5
3	66 (24)	11	5	0	5	8	1	4
4	64 (18)	11	6	0	5	8	1	4
5	60 (12)	12	8	0	6	8	1	5
All	70 (30)	9	3	0	4	7	1	5
				Urban				
1	69 (25)	9	1	0	5	10	1	6
2	64 (18)	9	3	0	6	11	1	6
3	62 (15)	10	4	0	7	10	1	6
4	55 (9)	11	8	0	6	12	1	7
5	50 (5)	12	13	0	6	11	1	7
All	61 (15)	11	6	0	6	11	1	7

Source NSS Unit-Level Data 68th Round (NSSO 2014). Figures in parentheses percentage share of PDS cereal in total consumption.

Table A4 Share of different items in protein intake (2011–12, %)

MPCE Group	Cereals and substitutes	Pulses and pulse products	Milk and milk products	Edible oil	Meat and fish	Fruits and vegetables	Sugar and spices	Others
				Rural				
1	76 (37)	3	1	5	1	5	3	6
2	73 (30)	3	2	6	1	6	3	6
3	71 (24)	4	3	6	1	6	4	5
4	69 (17)	4	4	7	1	6	4	5
5	65 (11)	4	5	7	1	7	4	6
All	73 (30)	3	2	6	1	5	3	6
				Urban				
1	73 (25)	3	1	6	1	5	4	7
2	68 (18)	3	3	7	1	6	4	7
3	67 (14)	4	3	8	1	6	4	7
4	60 (7)	5	5	9	1	7	5	8
5	53 (4)	5	9	8	1	7	5	8
All	65 (14)	4	4	8	1	6	4	8

Source NSS Unit-Level Data 68th Round (NSSO 2014). Figures in parentheses percentage share of PDS cereal in total consumption.