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Household Dependence on the Public Distribution System in Bihar: A District-Level Analysis

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Abstract
One of India's most important welfare initiatives, the Public Distribution System (PDS), works to guarantee food security for households that are economically disadvantaged. Its efficacy differs greatly between areas and demographic groupings in spite of numerous revisions. With an emphasis on the percentage of necessary wheat and rice that is purchased from Fair Price Shops (FPS), this study investigates the factors that contribute to household-level reliance on the PDS in the state of Bihar. utilising primary data gathered from 384 homes in the Patna, Purnia, and Madhepura districts. The study investigates the ways in which location, socioeconomic status, and demographics affect the amount of food grain purchased from the PDS. While the average household's rice procurement from PDS represents 37% of its needs, descriptive statistics show that wheat procurement is far lower at 6%, suggesting a discrepancy in the efficiency of grain distribution. To take into consideration the censored nature of the dependent variable (proportions between 0 and 1), the study uses Tobit regression models. Age, household size, income, caste, education, occupation, and geography are all significant predictors of PDS dependency, according to the regression results. It is noteworthy that while educated and OBC households are less likely to purchase grains from FPS, especially wheat, larger, poorer, and older households are more likely to rely on PDS. The PDS is still an essential safety net, although its impact and reach vary by household and grain variety, according to the study's findings. Enhancing wheat supply chains, lowering obstacles to access, and making sure that worthy households are effectively targeted are some policy ideas. Maximising the advantages of PDS and attaining inclusive food security in Bihar will require improving grain quality, reducing caste and income-based exclusion, and fortifying distribution infrastructure.

Keywords: Public Distribution System, Food Security, Tobit Model, Household Dependence, Socio-economic Determinants

Introduction
One of the biggest food security initiatives in the world is India's Public Distribution System (PDS), which provides subsidised food grains to disadvantaged groups in society, especially those living below the poverty line. In food-insecure areas like Bihar, where poverty, undernutrition, and rural hardship are enduring issues, the PDS is especially important in reducing hunger and giving millions of people a social safety net. With a sizable rural population and a heavy reliance on agriculture, Bihar has long struggled with food insecurity, which is made worse by inadequate infrastructure, seasonal work, and socioeconomic marginalisation. Disparities in PDS access, adoption, and efficacy continue to exist despite the National Food Security Act's (NFSA) reforms and welfare program growth. Although the

PDS policy aims to provide universal access to eligible recipients, the actual situation frequently displays problems that differ by region and household, including leakage, exclusion errors, quantity deficiencies, low grain quality, and inadequate monitoring. A wide range of demographic, economic, social, and geographic factors influence household participation in PDS and more crucially, the degree to which households genuinely depend on it. There is still a study gap in understanding micro-level family behaviour regarding the procurement of food grains like rice and wheat, particularly in Bihar, despite the fact that existing literature has examined a number of PDS-related topics, such as targeting efficiency, leakages, and state-wise comparisons. Furthermore, while wheat and rice procurement patterns are frequently taken into account together, households may actually handle them differently depending on local dietary preferences, market availability, and Fair Price Shops' (FPS) perceived quality. By investigating the percentage of necessary wheat and rice that households buy from the PDS and analysing the variables that influence this procurement behaviour, this study seeks to close this crucial gap. The study's foundation is primary data gathered from a cross-section of rural and semi-urban households in three different districts of Bihar: Purnia, Madhepura, and Patna. These districts were chosen to represent regional differences in the PDS's administrative performance and socioeconomic circumstances. The study aims to offer a comprehensive knowledge of how household-level factors including age, gender, caste, religion, income, education, occupation, family size, and distance to the FPS affect reliance on subsidised food grains by examining rice and wheat independently. Furthermore, geographical differences can be examined within the same policy framework thanks to the inclusion of locational dummies. In light of this, the study's specific goals are fourfold: (1) to analyze the socio-economic and demographic characteristics of households utilizing the Public Distribution System (PDS) in selected districts of Bihar; (2) to estimate the proportion of required rice and wheat procured by households through Fair Price Shops (FPS);(3) to identify the key determinants influencing household-level dependence on PDS rice and wheat separately using Tobit regression models; and (4) to offer policy recommendations for enhancing the PDS's accessibility, targeting, and efficacy based on evidence from households. It is anticipated that these goals will produce empirical insights that will help implementers and policymakers understand the factors that influence the state's delivery of food security. Assessing whether the system is meeting its objective of providing equitable access to subsidised food grains or whether structural or operational reforms are necessary to more effectively reach the most vulnerable populations will be made easier with a better understanding of the factors influencing household reliance on the PDS. Furthermore, in intricate, multi-layered socioeconomic contexts like Bihar, this research adds to larger discussions on welfare delivery, targeting efficiency, and the function of local governance in putting national food security policies into practice making sure that programs like the PDS operate effectively and fairly is more crucial than ever since food security remains a top priority during the post-pandemic recovery phase and in the face of growing unemployment and inflation. Hence, this study aims to contribute meaningfully to the discourse on inclusive food governance by grounding its analysis in field-level evidence and a robust econometric framework tailored to the behavioral patterns of actual grain procurement. The study will also be of interest to development practitioners, economists, and government agencies aiming to reform or strengthen social safety nets in similar low-income and high-population contexts.

1. Review of Literature

Given its position as the foundation of India's framework for food security, the Public Distribution System (PDS) has been the focus of intense scholarly examination. Its targeting effectiveness, leakages, and performance across states have all been evaluated in a number of studies. Despite extensive leaks, PDS reforms after NFSA improved coverage and delivery, particularly in states that implemented end-to-end computerisation and grievance redressal procedures, according to Dreze and Khera (2013). Similar to this, Khera (2011) pointed out that the PDS continued to perform poorly in states like Bihar and Uttar Pradesh because of a lack of institutional accountability, but it was more successful in places like Tamil Nadu and Chhattisgarh because of proactive governance. In order to improve PDS performance, Himanshu and Sen (2013) highlighted the importance of administrative dedication and political will. Khandker's (2012) research provided additional evidence of how geographical and infrastructure limitations influence access to food grains that are subsidised. According to research by Vanneman and Dubey (2011), locality, caste, and religion all have a big impact on how much a person benefits from social safety net programs like PDS. Numerous academics have highlighted systemic issues in Bihar; Bhatia and Srivastava (2008) and Kumar and Mishra (2018) discovered that PDS running is significantly hampered by logistical inadequacies, dealer-level corruption, and beneficiary ignorance. Mukherjee (2012) discovered that because of mobility problems and knowledge asymmetries, marginalised castes and households headed by women experience higher levels of exclusion. In terms of methodology, a lot of research has analysed access and targeting using logistic regression or descriptive statistics (Khandker, 2012, for example). However, comparatively few studies have used Tobit models, which can handle censored dependent variables like proportions, particularly when discussing actual grain procurement quantities. Furthermore, it has frequently been forgotten that rice and wheat are two distinct commodities with distinct purchasing and consuming habits. Without measuring the degree of reliance on particular commodities, the majority of studies tend to aggregate food grains or analyse PDS access in binary terms, regardless of whether the household uses the system or not. Although Basu and Das's (2015) research makes an effort to differentiate regional food preferences, it does not connect those choices to PDS procurement behaviour. Furthermore, there is a dearth of empirical research examining intra-state differences in PDS access in Bihar. Although studies like Sharma and Sinha (2020) acknowledge the importance of geography, they only look at averages at the district level rather than examining variability at the household level. Furthermore, nothing is known about how household attributes like occupation, education, income level, and the number of earning members affect the amount of food purchased from PDS. Additionally, there aren't many recent data-driven studies that use strong econometric techniques to include modern variables such locational dummy variables, joint family configurations, or the distance to Fair Price Shops. Although recent efforts by institutions like NITI Aayog and the Ministry of Consumer Affairs have emphasized the need to reform and digitize the PDS, academic research has yet to catch up in terms of evaluating how these changes impact household-level procurement behavior. Furthermore, literature on food security in Bihar remains outdated in light of the post-pandemic economic context, which has changed household dynamics, employment patterns, and dependency on welfare programs. Hence, the present study fills this significant gap by employing a Tobit regression framework to analyze the determinants of the proportion of required rice and wheat procured through the PDS among households in three districts of Bihar; Patna, Madhepura, and Purnia. This approach allows for a more nuanced understanding of procurement behavior rather than a simplistic binary assessment of access. By disaggregating rice and wheat consumption and

correlating them with a wide set of socio-economic, demographic, and spatial variables, the study adds to the literature in several meaningful ways. It provides insights into how reliance on subsidised food grains is shaped by various social groupings (based on caste, religion, and family type), economic status (income, occupation, and education), and geographic factors (district, distance from FPS). Therefore, by fusing methodological rigour with policy relevance, the study fills a significant gap in the literature and offers current empirical data that might guide specific reforms in Bihar's PDS mechanism.

2. Methodology

In order to investigate the factors influencing the percentage of necessary rice and wheat that households in Bihar purchase through the Public Distribution System (PDS), the current study uses a quantitative research approach. Primary data from 384 households in three districts: Patna, Purnia, and Madhepura were specifically chosen to reflect regional variations in socioeconomic circumstances and PDS performance served as the basis for the research. Using questionnaires, a structured household survey was carried out to collect comprehensive data on demographics, education, occupation, household size, number of earning members, monthly income, consumption patterns, and distance from the closest Fair Price Shop (FPS). In order to guarantee representation from rural, semi-urban, and urban clusters within each district, the study employed stratified random sampling. The percentage of needed wheat and rice that was purchased from FPS, as determined by dividing the amount from PDS by the total amount consumed in a month, was one of the main dependent variables. Tobit regression models, which provide robust estimate in situations where the dependent variable is continuous but has a limited range, were used for analysis because of the censored character of these proportions (bounded between 0 and 1). Age, sex, married status, caste, religion, income, education, occupation, family structure, and locational dummies were all considered independent variables. STATA 15 was used for all statistical analyses, with the proper multicollinearity and heteroscedasticity checks applied. Confidentiality and informed consent were two ethical principles that were closely followed when gathering data. This methodology facilitates an in-depth understanding of the socio-economic and locational determinants that influence the extent of household reliance on the PDS, providing strong empirical grounding for policy recommendations aimed at improving the inclusivity and efficiency of food distribution in Bihar.

Model Specification

By employing the censored Tobit regression model, this study aims to elucidate the socio-economic and demographic factors influencing the reliance on the PDS for rice and wheat in Bihar. The findings will contribute to understanding the effectiveness of the PDS in meeting the food security needs of vulnerable populations and provide a basis for potential policy improvements.

The Tobit model assumes that there is an underlying continuous latent variable, Y*, representing the unobserved propensity to purchase food from the FPS. This latent variable is modeled as:

$$Y_i^* = \Omega_0 + \Omega_1 X_{1i} + \Omega_2 X_{2i} + \ldots + \Omega_k X_{ki} + \omega_i$$

Where, Y_i^* is the latent variable, X_i are the independent variables, representing the proportion of required rice or wheat purchased from FPS; X_{1i}, X_{2i}, ..., X_{ki} are the independent variables (such as age, sex, marital status, caste, religion, education, occupation, family type, household size, income, distance to FPS, and location); Ω_0 is the intercept Ω_1, Ω_2, ..., Ω_k

are the coefficients of the independent variables; and ωi is the error term, assumed to be normally distributed with mean zero and constant variance. i take 1 for the proportion of required rice purchased from FPS and 2 for the proportion of required wheat purchased from FPS estimated separately in the model.

The observed dependent variable Y_i is defined as:

$$Y_i = \begin{cases} 0 & if\ Y_i^* < 0 \\ Y_i^* & if\ 0 < Y_i^* < 1 \\ 1 & if\ Y_i^* > 1 \end{cases}$$

This approach, which records households that buy zero rice or wheat from FPS and those that buy the full amount they need as a cap of one, encapsulates the essence of censorship in the data b ecause the data is censored, the Tobit model can use maximum likelihood estimation (MLE) to estimate the parameters. Several diagnostic tests are performed to verify the Tobit model results: likelihood ratio test was estimated to determine the model's overall significance. Pseudo R-squared was used to determine the percentage of variation that the model explained, which gave information about how well the model fit the data.

3. Results and Discussion

Using a sample of 384 households, the Tobit regression results in Table 1 determine the socioeconomic and demographic parameters impacting the percentage of necessary rice purchased from Fair Price Shops (FPS). With a Pseudo R^2 of 0.14 and LR $Chi^2 = 70.92$, $p = 0.000$, the model is statistically significant and suggests a modest level of explanatory power. The positive and significant effect of age suggests that older people are more dependent on subsidized rice, most likely as a result of their limited access to alternate food sources or economic weakness. Additionally, education has a favourable impact, suggesting that people with higher levels of education may be better able to use FPS because they are more aware of their rights under the Public Distribution System (PDS). Religion and caste are important social determinants: individuals from General castes purchase more rice from FPS than Scheduled Castes, while OBC households purchase slightly less, pointing toward social disparities in access and usage. The negative impact of income suggests that wealthier households rely less on subsidized rice, opting instead for market alternatives possibly due to quality considerations. Self-employed and private sector workers buy more from FPS than those in agriculture, suggesting that inconsistent income or a lack of food security may cause them to turn to subsidised sources. Because larger families have higher food needs and subsidised sources are more appealing, household size dramatically increases FPS dependency. However, usage is lower in nuclear families and those that live farther away from FPS outlets, indicating that household structure and accessibility are important obstacles. The fact that gender, marital status, and the number of earning members do not significantly affect the results suggests that locational and structural factors may be more important than individual-level demographic characteristics. Regional variations are pronounced, with households in Patna and Purnia significantly more likely to purchase rice from FPS than those in Madhepura, likely due to better PDS implementation, infrastructure, or higher poverty levels in those districts. The negative impact of distance to FPS points to logistical challenges and suggests the need for improved physical access. The findings taken together show that a number of factors, including age, household size, wealth, education, social identity, and geography, influence the purchase of rice from FPS. These results imply that although FPS is essential to food security, particularly for those from low-income backgrounds, specific reforms are required to lessen regional and caste-based inequalities,

increase outreach in remote areas, and improve accessibility and quality in order to guarantee fair and efficient PDS delivery.

Table 1: Result of Tobit Regression: Factor determining proportion of required rice purchased form Fair Price Shop[i]

Proportion of Required rice purchased form Fair Price Shop	Coef.	S. E.
Age	0.05**	0.02
Sex	-0.01	0.01
Marital Status	0.02	0.03
Caste (Reference : SC)		
General	0.02**	0.03
OBC	-0.01*	0.01
Religion	0.01**	0.01
Year of Schooling	0.01**	0.01
Occupation (Reference: Agriculture)		
Business	-0.01	0.02
Private Sector	0.02**	0.01
Self Employed	0.04***	0.02
Family Type	-0.02**	0.02
Household Size	0.13***	0.03
No. of Earning Members	-0.01	0.02
Income	-0.03**	0.03
Distance to Fair Price Shop	-0.02**	0.01
Location (Reference: Madhepura)		
Patna	0.03**	0.01
Purnia	0.05***	0.01
Constant	0.27	0.22
LR Chi ^{2}		70.92 (0.000)
Pseudo R^2		0.14
Log Likelihood		287.06
N		384

Source: Author's Calculation

Insights into how demographic, socioeconomic, and geographic factors impact wheat uptake under the Public Distribution System (PDS) are provided by the Tobit regression results in Table 2, which examine the factors determining the percentage of necessary wheat purchased from Fair Price Shops (FPS). With an LR Chi2 value of 235.47 (p = 0.000) and a pseudo R2 of 0.13, the model is statistically significant and the independent variables account for 13% of the variation. The positive and substantial effect of age indicates that older household heads are somewhat more likely to purchase wheat from FPS, possibly as a result of their increased dependence on subsidised food grains as they age. Marital status has a weak but negative influence, possibly indicating that unmarried or widowed individuals may have lesser household food needs or access constraints. Among social groups, OBC households purchase a significantly lower share of wheat compared to SCs, implying possible exclusion or differing preferences within caste groups. Interestingly, educational attainment negatively influences wheat procurement, pointing to a possible substitution effect where more educated households opt for higher-quality or market-based alternatives. Income shows a strong and

negative relationship, reinforcing that economically better-off families rely less on FPS wheat, consistent with market preference or food diversity.

Table 2: Result of Tobit Regression: Factor determining proportion of Required Wheat purchased form Fair Price Shop

Proportion of Required Wheat purchased form Fair Price Shop	Coef.	S. E.
Age	0.002**	0.027
Sex	-0.001	0.018
Marital Status	-0.002*	0.037
Caste (Reference : SC)		
General	-0.002	0.035
OBC	-0.001**	0.018
Religion	0.001	0.02
Year of Schooling	-0.006**	0.019
Occupation (Reference: Agriculture)		
Business	0.006	0.27
Private Sector	0.004	0.21
Self Employed	0.005	0.22
Family Type	-0.009	0.23
Household Size	0.041***	0.43
No. of Earning Members	0.004	0.3
Income	-0.23**	0.36
Distance to Fair Price Shop	0.0005	0.21
Location (Reference: Madhepura)		
Patna	0.002	0.201
Purnia	0.001	0.210
Constant	-0.023	0.032
LR Chi ^{2}	235.47 (0.000)	
Pseudo R^2		0.13
Log Likelihood		994.6
N		384

Source: Author's Calculation

The largest positive impact is household size, which reflects the reality that larger households are more reliant on government-subsidized wheat because of their larger consumption needs. In contrast, location variables such as Patna and Purnia and distance to FPS are statistically insignificant, suggesting that regional variation and accessibility may not be significant barriers to purchasing wheat as opposed to rice, perhaps as a result of household preferences or varying state-level PDS effectiveness. Wheat uptake is not considerably impacted by the number of earning members or the sorts of occupations, indicating that decisions are driven more by income level than by employment structure. The non-significance of religion hints at a uniform distribution of wheat benefits across religious groups, while the negative but insignificant effect of caste General category suggests social equity in access for wheat may be relatively better compared to rice. The results overall point to a consumption pattern where household size, income, education, and marginal caste identity are the primary determinants

of wheat procurement through FPS, possibly shaped by both economic necessity and quality preferences, highlighting the need to strengthen outreach and quality assurance to sustain PDS usage among all sections, especially those who are gradually opting out.

4. Conclusion

The findings of this study highlight how household-level participation in the Public Distribution System (PDS) in Bihar is complex and stratified, with notable differences in the percentage of necessary wheat and rice purchased from fair price stores across demographic, social, economic, and geographic dimensions. Age, caste, religion, education, occupation, household size, income, and location to the fair pricing store are among the factors that have a substantial impact on procurement levels, according to the findings of Tobit regression analysis. Households in Purnia and Patna, with larger family sizes and higher levels of education, shown greater reliance on PDS for rice procurement, while being in a nuclear family, living far from stores, and having a higher income had a negative impact on participation. In contrast, wheat procurement was more sensitive to education (negatively associated), caste, household size, and income, while location and distance showed minimal effects. These findings reflect both structural inequalities and logistical constraints that continue to shape access and utilization of the PDS. Therefore, a number of policy recommendations emerge from this study. First, there is a need to improve the spatial accessibility of fair price shops by either increasing their density in remote and rural areas or by introducing mobile ration units, especially in districts like Madhepura. Second, targeted awareness campaigns must be conducted among socially and economically disadvantaged groups, especially among the OBC and SC populations, to enhance their knowledge about PDS entitlements and procedures. Third, digitization of ration distribution and biometric authentication should be complemented with grievance redressal mechanisms to reduce exclusion errors and mitigate the inconvenience caused by technological or infrastructural failure. Fourth, policymakers must recognize the dietary preferences and consumption patterns specific to regions and communities, while rice is a staple for many, wheat consumption varies and policy provisioning should be responsive to such preferences. Fifth, the negative association between higher education or income and wheat procurement suggests possible quality concerns; hence, improving the nutritional and grain quality standards at FPS outlets can boost uptake among more informed or aspirational households. Sixth, special attention should be paid to households with fewer earning members or female-headed households, which are often more dependent on subsidized food due to economic vulnerability. Further, district administrations should conduct periodic household-level needs assessments to adjust allocations dynamically, based on family size and local conditions. Lastly, by guaranteeing both food and income security, combining social welfare programs like the PDS with more comprehensive livelihood and job initiatives like MGNREGA may have synergistic effects. In conclusion, our analysis shows that structural disparities and logistical inefficiencies still influence the extent of benefit that households receive, even though Bihar's PDS has made notable progress in coverage. A one-size-fits-all strategy is insufficient. The PDS can only reach its full potential as a distributive justice instrument and a pillar of food security in Bihar by implementing region-specific, data-driven, and socially inclusive changes.

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