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Multidimensional assessment of nutrition insecurity among tribal households in forest fringe villages: A study on Manbazar II block, Purulia district, West Bengal

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Abstract
Adequate nutrition remains elusive for tribal populations living in forest-fringe areas, constrained by poor socio-economic conditions and limited public health access. This study examines nutrition insecurity among 220 tribal households in Manbazar II Block, Purulia, West Bengal, through structured questionnaires, anthropometric assessments, and focus group discussions. Descriptive statistics measured dietary diversity, food access, and nutritional status, while Chi-square tests and logistic regression analysed socio-demographic associations. Results reveal that 64.5% of households face moderate to severe food insecurity (HFIAS). Among children under five, 41.3% are stunted, 28.7% underweight, and 17.5% wasted, reflecting high chronic and acute malnutrition. Mothers' education levels, income, and use of nutrition programs were found to be associated ($p<0.05$).Dietary diversity was low, with 73% consuming fewer than four food groups daily. Heavy dependence on forest produce, poor agricultural output, and weak ICDS/PDS coverage emerge as major causes. The study recommends integrated, location-specific interventions emphasizing nutrition education, livelihood diversification, and improved welfare access.

Keywords: Nutrition insecurity, tribal communities, forest fringe, dietary diversity

1. Introduction
The country of India is now facing a serious nutrition crisis, one of the worst of which is in tribal-dominated regions. There, economic neglect, difficult to access terrain, and severely weak public service delivery combine to create intense food and nutrition insecurity. Advanced welfare programmes China has managed to achieve, and India has made fascinating leaps in agricultural output, and yet there is still an under nutrition crisis. The Global Hunger Index (2023) placing India at 111th out of 125 countries shows the persistent concern regarding stunting, wasting and nutrition of children. The Scheduled Tribes (STs) of India, who represent 8.6% of the country's population (Census of India, 2011), become the most undernourished people due to their prolonged marginalization, reliance on volatile forest sources, and their isolation. National Family Health Survey-5 (2019-21) data reveals concerning issues in the nutrition of tribal children, especially those less than 5 years of age. The data shows stunting exceeding 35.6%, wasting over 19.4%, and underweight children surpassing 38.2%. There is a long list of reasons: insufficient dietary diversity, poverty, seasonal hunger, improper nutrition during life's critical stages, and inconsistent implementation of government nutrition programmes such as the Integrated Child Development Services (ICDS) and the Public Distribution System (PDS).The challenges posed by logistical issues and administrative inefficiencies stands out in their impact on the tribal regions, as Dreze and Deaton (2009) [9] alongside Saxena (2011) [31] point out. The nutrition challenges in the tribal regions of Jharkhand, West Bengal, and Odisha are further deepened by interruptions in the supply chain and by supplements that do not meet the locals' food preferences (Basu, 2013) [1]. For tribal families living in forest peripheries, the presence of food is equally dependent on the availability of forest produce, including tubers, fruits, mushrooms, and minor forest produce, which helps in enhancing their diet. A combination of deforestation, restrictive forest rules, and unsteady monsoon seasons has led to the diminish of these resources (Sundriyal *et al.*, 2005) [35]. During the lean agricultural months, seasonal hunger is a concern that is faced repeatedly.

The crisis is worsened by the inequities in gender: tribal women have more food gathering responsibilities and are the primary caregivers, and as such, they have more vulnerabilities. Vepa (2004) [40] and Mehrotra (2006)'s [26] research highlights the unique food scarcity challenges that women face compared to other members of their household, as well as intra-household food discrimination and healthcare access, and the resulting negative impact on themselves and on the next generation. The nutrition outcomes that the National Nutrition Mission (POSHAN Abhiyaan) has set out to address, has also run into tribal blocks, where monitoring is weak, food kits are culturally inappropriate, and community participation is lacking (Ministry of Women and Child Development, 2020) [27]. As such, the persistent, tribal-specific issues of nutrition insecurity continue to be neglected, even in the face of comprehensive, nutrition policy frameworks. The tribal population of Purulia, Bankura, and Jhargram districts exceeds 5.8 million, making these districts prime areas of nutritional concern in West Bengal. Economically, Purulia District is drought-stricken with seasonal migration and low agricultural output compounded by an overreliance on minor forest produce. Manbazar II Block embodies these problems, especially with its high number of tribal villages located on the edges of the forest. Still, the local nuances of forest reliance combined with seasonal hunger and insecure livelihoods see very little focus. The aim of this paper is to zero in on and address the lack of data concerning nutrition security of tribal families in Manbazar II Block. In this way, the paper takes a step toward building a richer picture of the complex relationships between a region's ecology, its poverty, and food security. In line with that, the objectives of the study are to estimate the tribal nutrition insecurity in Manbazar II Block and adjoining forest fringe villages; study the socio-economic and demographic relations, and their seasonal and dietary changes; study the government food and nutrition scheme coverage; and give workable solutions to tackle food and nutrition insecurity specific to forest-dependent tribal communities.

2. Materials and Methods

FGDs and KIIs are qualitative techniques that complement the tribal nutritional insecurity status assessment, and their use alongside quantitative tribal household surveys completes this study's research methodology (Krueger & Casey, 2015) [25]. To represent distinct tribal communities and ecological regions, 220 households were chosen across five forest fringe villages in Manbazar II Block using a stratified random sampling technique (Cochran, 1977) [6]. A structured questionnaire was used to collect quantitative data, which included socio-economic profile, food consumption patterns, dietary diversity, seasonal food availability, and access to government food and nutrition schemes (FAO, 2011; Swindale & Bilinsky, 2006) [12, 38]. Children's nutritional status, specifically those under the age of five, and women of reproductive age were assessed using anthropometric measurements (height for age, weight for age, and BMI), following the WHO anthropometric assessment guidelines (WHO, 2006; de Onis *et al*., 2007) [41, 42].

In order to complement the quantitative data, focus group discussions were held involving women collectors, community health workers (ASHAs), Anganwadi workers, and Panchayat members. These discussions focused on their views on hunger, seasonal food shortfalls, and difficulties in accessing nutrition programs such as ICDS, PDS, and POSHAN Abhiyaan (MoWCD, 2020; Kabeer *et al*., 2020) [27, 23]. Next, descriptive statistics, Chi square tests, and binary logistic regression (Hosmer, Lemeshow, & Sturdivant, 2013) [18] were used to complete the analysis and identify significant factors impacting household food insecurity and malnutrition. The Household Food Insecurity Access Scale (HFIAS) and the Minimum Dietary Diversity Score (MDDS) were used to assess the degree of food access and dietary quality (Swindale & Bilinsky, 2006; FAO, 2011) [12, 38]. Ethical clearance was obtained from the relevant institutional review board, and informed consent was issued to every participant prior to data collection (Israel & Hay, 2006) [20].

2.1 Statistical Techniques

2.1.1. Household Food Insecurity Access Scale Score (HFIAS)

The HFIAS is computed by summing up the frequency-of-occurrence scores for each of the nine standardized food insecurity questions.

$$\text{HFIAS Score} = \sum_{i=1}^{9} F_i$$

F_i = Frequency score for each food insecurity condition (0 = never, 1 = rarely, 2 = sometimes, 3 = often)

- Total HFIAS Score range = 0 (no insecurity) to 27 (severe insecurity)

2.1.2. Minimum Dietary Diversity Score (MDDS)

$$\text{MDDS} = \sum_{j=1}^{n} C_j$$

Where

- C_j = 1 if a food group was consumed in the past 24 hours, otherwise 00
- n = Number of food groups considered (usually 8-10 depending on FAO/WHO guidelines)
- A score <4 typically indicates low dietary diversity.

2.1.3. Body Mass Index (BMI) - For Women (and Adults)

$$\text{BMI} = \text{Weight (kg)}[\text{Height (m)}]2$$

- BMI < 18.5 = Underweight
- BMI 18.5 - 24.9 = Normal
- BMI ≥ 25 = Overweight/Obese

2.1.4. Anthropometric Indices - Children

a) Height-Age Z-score (HAZ)

$$\text{HAZ} = \frac{\text{Observed Height} - \text{Median Reference Height}}{\text{Standard Deviation}}$$

b) Weight-Age Z-score (WAZ)

$$\text{WAZ} = \frac{\text{Observed Weight} - \text{Median Reference Weight}}{\text{Standard Deviation}}$$

c) Weight-Height Z-score (WHZ)

$$\text{WHZ} = \frac{\text{Observed Weight} - \text{Median Weight for Height}}{\text{Standard Deviation}}$$

These are calculated using WHO Anthro software or equivalent tools.

2.1.5. Chi-Square Test

$$\chi 2 = \sum (Oi - Ei)\ 2$$

Where

O_i = Observed frequency

E_i = Expected frequency

Used to assess the relationship between categorical variables (e.g., maternal education vs. child malnutrition status).

2.1.6. Binary Logistic Regression Equation

$\log_{f0}(p1-p) = \beta0+\beta1X1+\beta2X2+\ldots+\beta k$

Where:

- p = Probability of the outcome (e.g., being food insecure)
- β0 = Intercept
- β1, β2..., βk = Coefficients for independent variables X1, X2,...

3. Results and Discussion

This research enriches previous studies on nutrition insecurity by adding information about the tribal households of the forest fringe villages of Manbazar II Block, Purulia. Food insecurity undermines nutrition security particularly for tribal communities that depend on forests and marginal agriculture because it imposes multiple, interlinked deprivations related to food availability, accessibility, and utilization (Swaminathan, 2019) [37]. The integrated tribal nutritional studies in this area allowed a household level survey and analysis of food consumption, which brought to light the height of the tribal nutrition problems along with the inadequacy and seasonal changes in their food consumption patterns. These findings are important because they describe in detail how competing socio-economic risks, cultural norms and reliance on ecological resources impact the nutrition of tribal families in the forest fringe (Patnaik & Nayak, 2020) [29]. The Household Food Insecurity Access Scale (HFIAS) indicates that most households are moderately to severely food insecure, a pattern that is consistent with other reported data on nutritional vulnerabilities of tribal populations in India (Bharati, Pal, & Bhattacharya, 2008; Patra, 2020) [2, 30].

The indicators of childhood malnutrition—stunting, wasting, and underweight in children under five years—show us a persistent and grave problem. The children are suffering from the dual burden of chronic and acute malnutrition. This persists not only in West Bengal but other tribal dominated regions as documented in earlier studies (Jana & Pal, 2017; Das, 2016) [21, 7]. Dietary variability was extremely poor, as the majority of families consumed boring and undiversified diets, primarily based on cereals. This is indicative of severe economic poverty as well as dependence on meagre forest resources (Basu, 2013) [1]. Statistical analysis shows strong correlations between nutritional outcomes and mother's education, family income, and welfare programs such as ICDS and PDS. Previous studies have also highlighted these issues of socio-economic deprivation and poor government schemes which have helped to maintain chronic malnutrition in tribal families (De & Chattopadhyay, 2010; Mishra & Singh, 2019) [8, 28]. Seasonal changes in food availability, dependence on wild foods, and low agricultural yield make matters worse, as noted in other tribal regions of eastern India (Singh & Mondal, 2021; Sundriyal *et al*., 2005) [34, 35].

3.1 Food and Nutrition Insecurity among tribal households in the forest fringe villages of Manbazar II Block

Manbazar II Block's tribal households face even more severe food and nutritional insecurity due to their remoteness, seasonal employment, and unstable forest yields. Their continued exclusion increases their risks, which include low dietary diversity, chronic undernutrition, and repeated bouts of food insecurity.

Table 1: Food and Nutrition Insecurity among Tribal Households in Forest Fringe Villages

Indicator	Category	Number of Households/Individuals	Percentage (%)
Household Food Insecurity Access Scale (HFIAS)	Food Secure	36	16.4
	Mild Food Insecurity	42	19.1
	Moderate Food Insecurity	88	40.0
	Severe Food Insecurity	54	24.5
Household Dietary Diversity Score (HDDS)	Low (≤ 3 food groups/day)	160	72.7
	Medium (4-5 food groups/day)	45	20.5
	High (≥ 6 food groups/day)	15	6.8
Nutritional Status of Children (n = 112)	Stunted (Height-Age < -2 SD)	46	41.1
	Underweight (Weight-Age < -2 SD)	32	28.6
	Wasted (Weight-Height < -2 SD)	20	17.9
	Normal Nutritional Status	14	12.5

***Source*:** Primary Survey, 2025

The analysis of food and nutrition insecurity (Table 1) among the tribal households in villages around Manbazar II block poses a serious concern. From the HFIAS evaluation, it is clear that a mere 16.4% of families are food secure. In contrast, a vast majority of 64.5% live under either moderate food insecurity (40%) or severe food insecurity (24.5%). These statistics demonstrate persistent exposure to hunger, diminished food consumption, and food scarcity-related worries, particularly evident during the lean or off agricultural seasons. Examining the Household Dietary Diversity Scores (HDDS), it is evident that 72.7% of the families eat fewer than three food groups per day, implying a strong possibility of micronutrient deficiencies as well as malnutrition. Cereals and wild tubers overwhelmingly dominate the daily diet; this signals an absence of access to animal proteins, dairy products, and fresh vegetables. Looking at the anthropometric data, it is evident that the under-five children face a high incidence of various forms of under nutrition: 41.1% are stunted, 28.6% are underweight, and 17.9% are wasted. It is remarkable that just 12.5% of children fall under the normal nutritional category. Such data conclusively confirms the presence of both long-standing and recent nutritional shortfall that is tied to insufficient caloric consumption, dull monotonous diet, and poor healthcare services.

3.2 Socio-Economic and Demographic Factors Influencing Nutrition Insecurity

Socio-economic and demographic variables, such as income, education, occupation, migration, household composition, and age-sex structure influence the nature of food insecurity in the region. Widespread poverty, the low level of female education, seasonal work, and inequitable distribution of food within families undermine the access to health and social services, deepening the chronic under nutrition and diminishing the capacity to bounce back in the long term.

Table 2: Association between Socio-Economic Factors and Food Insecurity

Variable	Category	% Food Insecure (HFIAS: Moderate-Severe)	Chi-Square (χ^2)	p-value	Significance
Monthly Income	< ₹5000	78.2	12.68	0.002	Significant (p<0.01)
	₹5000-₹10,000	62.1			
	> ₹10,000	36.4			
Maternal Education	Illiterate	75.4	14.23	0.001	Significant (p<0.01)
	Primary Level	59.8			
	Secondary & above	32.0			
Family Size	≤ 4 members	52.3	5.94	0.051	Marginally Significant
	> 4 members	67.8			
Landholding	Landless	70.5	1.86	0.172	Not Significant
	Marginal (≤ 1 acre)	61.7			
	Small (> 1 acre)	58.3			

***Source*:** Primary Survey, 2025

The socio-economic and demographic factors analysed indicate (Table 2) that it is low income and illiteracy, more so of mothers, that correlates with food insecurity. For households with low income the food insecurity rate is 78.2%, compared to 36.4% for households with higher income. Likewise, food-insecure households have a 75.4% prevalence of illiterate mothers, further demonstrating the importance of education in nutrition and awareness of food schemes. The size of the family has a very small significance—families with more than four members have a greater incidence of food insecurity, perhaps due to higher dependency burdens. Strikingly, food insecurity cannot be linked to land holding size, which perhaps shows that mere land ownership cannot guarantee food security in this rain-fed and ecologically fragile area.

Table 3: Minimum Dietary Diversity Score (MDDS)

Food Group (FAO/WHO guideline)	Consumed in last 24 hrs?	Indicator (Cj)
1. Cereals, roots, tubers	Yes	1
2. Pulses, legumes, nuts	Yes	1
3. Dairy products	No	0
4. Meat, poultry, fish	Yes	1
5. Eggs	No	0
6. Vegetables	Yes	1
7. Fruits	No	0
8. Oils/fats	Yes	1
Total MDDS = ∑Cj		5

***Source*:** Primary Survey, 2025

The MDDS (Table 3) is the total count of the different food groups consumed in the last 24 hours. The household has eaten foods from 5 different food groups (MDDS = 5). Since the adequacy cut-off is ≥4, the above household has met the minimum dietary diversity requirement, indicating relatively balanced dietary consumption. All households where MDDS <4 would be classified as having low dietary diversity, pointing to poor diet quality and higher nutrition insecurity risk.

Table 4: Body Mass Index (BMI) for Women (Adults)

Respondent	Weight (kg)	Height (m)	BMI Formula = Weight ÷ (Height²)	BMI Value	Nutritional Status
1	45	1.55	45 ÷ (1.55 × 1.55)	18.7	Normal
2	38	1.50	38 ÷ (1.50 × 1.50)	16.9	Underweight
3	62	1.58	62 ÷ (1.58 × 1.58)	24.8	Normal
4	72	1.60	72 ÷ (1.60 × 1.60)	28.1	Overweight/Obese

***Source*:** Primary Survey, 2025

The BMI results show (Table 4) variation in nutritional status among women respondents. For instance, women with BMI values below 18.5 are underweight**,** reflecting possible under nutrition and health risks. Those within the range of 18.5-24.9 are classified as normal**,** indicating adequate nutritional status. Women with BMI ≥25 fall under the overweight/obese category, suggesting excess weight and potential risk of non-communicable diseases. Thus, BMI provides a simple but powerful indicator of overall nutritional health among adult women.

Table 5: Anthropometric Indices of the study area

Child	Age (yrs)	Observed Height (cm)	Median Reference Height (cm)	Observed Weight (kg)	Median Reference Weight (kg)	SD (for reference)	HAZ	WAZ	WHZ	Nutritional Status
1	3	88	96	11.0	13.5	4.0	(88-96)/4 = -2.0	(11-13.5)/4 = -0.63	(11-12.8)/3 = -0.60	Stunted, Normal weight
2	4	100	104	12.5	15.0	4.0	(100-104)/4 = -1.0	(12.5-15.0)/4 = -0.63	(12.5-15.2)/3 = -0.90	Normal
3	2	78	89	8.5	11.5	3.5	(78-89)/3.5 = -3.1	(8.5-11.5)/3.0 = -1.0	(8.5-10.8)/2.5 = -0.92	Severely Stunted

***Source*:** Primary Survey, 2025

Different parts of child nutritional health are revealed by the anthropometric indices. HAZ shows (Table 5) an extended period of nutritional health (chronic malnutrition/stunting), WAZ shows overall underweight for the age, and WHZ shows acute malnutrition (wasting). For example, in the table above, Child 1 shows stunting (HAZ = -2.0) but weight-for-age and weight-for-height indices fall within the normal range as Child 1 has no wasting or underweight, which means long-term growth retardation. Child 3 with HAZ < -3 is severely stunted, which is a form of chronic under nutrition. As such, these indices measure child growth and malnutrition comprehensively.

3.3 Seasonal Variation in Food Availability and Dietary Patterns

Rural and tribal communities are especially vulnerable to the effects of seasonal shifts on the availability of food. The availability of cereals, fruits and vegetables, and even animal products depends on the harvest cycle, the weather, the markets, and even the transport infrastructure. These factors determine the composition of the family diet, which tends to be inadequate during the lean season, and improves only marginally during the harvest season.

Table 6: Seasonal Variation in Food Consumption and Nutritional Impact

Season	Common Foods Consumed	Average HDDS Score	% Households Reporting Food Shortage	Child Wasting Rate (%)
Summer (Apr-Jun)	Rice, wild tubers, mango kernel, limited vegetables	2.8	74.1	21.4
Monsoon (Jul-Sept)	Rice, leafy greens, seasonal vegetables	3.5	48.7	15.8
Post-Monsoon (Oct-Nov)	Rice, pulses (own-harvested), vegetables	4.3	32.3	11.2
Winter (Dec-Feb)	Rice, stored grains, pulses, meat/fish (occasional)	3.9	39.1	13.6

***Source*:** Primary Survey, 2025

The article exemplifies how the availability of food changes over the seasons (Table 6), which in turn affects the diet of the tribal households. Food stores are at their lowest in the summer, which is also the time when the average HDDS is 2.8 and as many as 74.1% of the households experience food shortages. As a consequence, incidences of child wasting soar to 21.4%, which is a clear indication of acute malnutrition brought on by an insufficient and low-quality diet. Food access is much better after the monsoon, which is also reflected in the HDDS (which climbs to 4.3) and only 32.3% of the households are affected by food shortages. This period aligns with the harvesting of minor crops as well as better access to fresh vegetables and pulses. This particular observation underscores the fact that seasonal food famine accounts for the malnourishment plaguing the study region. Employing MGNREGA-funded seasonal work, diversification of livelihood opportunities through the forests, and the safeguarding of wild edible foods may be certain to limit such extreme nutritional variations.

Table 7: Chi-Square Test Results — Factors Associated with Food Insecurity

Variable	Chi-square (χ^2)	df	p-value	Significance
Maternal Education	12.67	2	0.002	Significant
Household Monthly Income	10.32	2	0.006	Significant
Access to PDS	8.44	1	0.004	Significant
Land Ownership	1.92	1	0.165	Not Significant

***Source*:** Primary Survey, 2025

The Chi-square test (Table 7) indicates which socio-economic factors matter for food insecurity. For example, the levels of income households generate and their maternal education are effective indicators of food insecurity as compared to other factors with p-value < 0.01. Higher income and better maternal education lead to higher food access and better variety of food. Public Distribution System (PDS) access also has significant influence ($p<0.01$) on the food insecurity status of a household, stressing the need for proper subsidized food delivery. On the other hand, food insecurity does not bear any statistically significant relation with land ownership, which might be explained by the region's dependence on rain-based agriculture and the presence of poor soil quality.

Table 8: Results of Binary Logistic Regression Analysis of Factors Influencing Food Insecurity among Tribal Households

Predictor Variable	B (Coefficient)	S.E.	Wald χ^2	Odds Ratio (Exp(B))	p-value
Constant (β_0)	-1.215	0.482	6.36	-	0.012*
Household Income (X_1)	-0.845	0.295	8.20	0.43	0.004**
Education of Household Head (X_2)	-0.562	0.214	6.90	0.57	0.009**
Family Size (X_3)	0.624	0.189	10.90	1.87	0.001**
Landholding Size (X_4)	-0.411	0.176	5.46	0.66	0.019*
Seasonal Employment (X_5)	0.738	0.244	9.14	2.09	0.003**
Access to PDS/ICDS (X_6)	-0.932	0.301	9.58	0.39	0.002**

*Significant at 0.05 level, **Significant at 0.01 level

The resulting logistic regression model (Nagelkerke R^2 = 0.47) shows a strong association between food insecurity and a household's socio-economic and demographic characteristics (Table 8). Higher household income (OR = 0.43, $p<0.01$), higher education of the household head (OR = 0.57, $p<0.01$), larger landholdings (OR = 0.66, $p<0.05$), and access to government food schemes such as PDS/ICDS (OR = 0.39, $p<0.01$) emerge as significant protective factors that reduce the likelihood of food insecurity. In contrast, a larger family size (OR = 1.87, $p<0.01$) and dependence on seasonal work (OR = 2.09, $p<0.01$) considerably increase the risk of food insecurity. These observations highlight how structural and resource supports help improve a household's ability to withstand food insecurity, as do resource endowments;

however, demographic pressures and unstable livelihoods are still major contributors to ongoing food insecurity.

3.4 Evaluate the Accessibility, Coverage, and Effectiveness of Government Nutrition and Food Security Schemes (ICDS, PDS, and MGNREGA)

In India, issues like hunger, malnutrition, and farmer distress are tackled to an extent through the ICDS, PDS, and MGNREGA schemes in the red zones. The further these schemes extend to vulnerable populations, their equity in distributing benefits, and the overall contribution to achieving nutritional security can shed light on the programs' implementation, along with their accessibility, effective coverage, and impact.

Table 9: Accessibility, Coverage, and Perceived Effectiveness of Government Schemes

Scheme	Access (Registered Households)	Regular Service Delivery (% reporting timely benefits)	Perceived Usefulness (% rating as effective)	Common Issues Reported
ICDS (Anganwadi)	174 (79.1%)	102 (58.6%)	94 (44.0%)	Irregular supply of food, absentee staff, lack of medicines
PDS (Ration)	201 (91.4%)	141 (70.1%)	115 (57.2%)	Quantity less than quota, poor grain quality, irregularity
MGNREGA	133 (60.5%)	81 (60.9%)	72 (54.1%)	Delay in wage payment, limited work availability

***Source*:** Primary Survey, 2025

The nutrition and food security initiatives of safeguarding children are moderately covered but poorly effective in tribal villages of Manbazar II Block (Table 9). The Integrated Child Development Services (ICDS) has reached approximately 79.1% of eligible households, mainly those with young children and pregnant or lactating women. However, only 58.6% adhere to the services, and a mere 44% find the scheme beneficial. Irregular food distribution, absence of Anganwadi workers, and the absence of health supplements are angering beneficiaries more than the other two. Although the Public Distribution System (PDS) has the highest coverage at 91.4%, only 70.1% receive their rations punctually. Undoubtedly, many families claim to receive less than their entitled portions, and the quality of the grain is often subpar. Regardless of the problems, 57.2% of the populace still believes that the PDS is somewhat effective in continuing the provision of staple food. With a 60.5% coverage, MGNREGA, which is designed to provide employment and support income, has the poorest. For those registered, 60.9% claim that the allotment of work and the payment of wages are on schedule. The rest of the population experienced wage payment delays, a lack of work, and inefficiencies at the grass-roots level. Nonetheless, 54.1% still, viewed the program as helpful in supporting seasonal food access.

5. Conclusion

The data set offers clear evidence that food and nutrition insecurity are persistent problems in tribal households in the forest-fringe villages of the Purulia district's Manbazar II Block. Even though this ecological zone is well-endowed with resources, tribal communities are stuck in the cycle of poverty, inadequate dietary intake, and limited access to government welfare programs (Sen, 1981; Dreze & Sen, 2013) [33, 11]. The Household Food Insecurity Access Scale (HFIAS) data reveals that most households face moderate to severe food insecurity. The dietary diversity score corroborates the data, showing a diet that is monotonous and nutritionally insufficient (Coates *et al*., 2007; FAO, 2010) [5, 13]. The nutritional anthropometric data of children under five, marked by a high prevalence of stunting, underweight, and wasting, depicts the intergenerational consequences of malnutrition (Black *et al*., 2013; NFHS-5, 2021) [3, 19]. In addition, the study shows that socio-economic variables such as income level, education, landholding size, and family structure have a significant influence on household nutritional outcomes (Headey & Hoddinott, 2015) [17]. The problem becomes even worse in the summer and lean periods, when food becomes scarce and malnutrition, especially child malnutrition, becomes widespread (Devereux, 2001; Chambers & Conway, 1992) [10, 4]. The ICDS, PDS, and MGNREGA schemes* have a wide reach, but their effectiveness in combating food insecurity is diminished by inadequate implementation, low awareness, and irregular supply (Khera, 2011; Jha *et al*., 2013) [24, 22]. As explained, nutrition insecurity in this tribal area is not merely an issue of food access but a complicated socio-ecological and policy-related challenge (Scoones, 1998; Swaminathan, 2012) [32, 36]. A proper resolution of the matter entails a combination of locally specific nutrition-sensitive interventions, more effective implementation of government programmes, diversification of livelihood options, and increased community engagement (Ruel & Alderman, 2013; Haddad *et al*., 2015) [15, 16]. Guaranteeing food security to such marginalized areas is crucial not only for their health and development but also for social justice and inclusive development (UNDP, 2015; FAO, IFAD & WFP, 2020) [39, 14].

To Recommend Context-Specific Strategies and Policy Interventions for Improving Nutritional Outcomes and Ensuring Food Security among Forest-Dependent Tribal Populations

Taking into account the evidence from this research showing intense food and nutrition insecurity, gaps in seasonal diets, and ineffective public programs, the following targeted interventions and policies are recommended to address the nutritional issues faced by the farmers of Manbazar II Forest Block:

1. **Enhance Community Based Nutrition Frameworks**
   - Develop community-run dividers and kitchen gardens to community-run food grain banks and kitchen gardens to mitigate seasonal shortages.
   - Facilitate local campaigns and conservation efforts for the promotion of local and traditional forest foods such as tubers, mushrooms, and wild edibles.
   - Promote the cultivation of pulses, vegetables, and millets among small landholders, optimizing nutrition-sensitive agricultural practices.

2. **Revise and Localize ICDS and PDS Implementations**
   - Implement community-based monitoring systems to track and ensure consistent provision of supplementary nutrition at Anganwadi Centres.
   - Upgrade the nutritional content of ICDS take-home

rations by adding a variety of foods that are locally favoured.
- Move to a digital system for the Public Distribution System (PDS) incorporating biometric authentication and community-level reporting to decrease and manage

3. Targeted Livelihood and Income Support
- Increase MGNREGA employment opportunities during the off-peak agricultural seasons to mitigate income-related food insecurity.
- Encourage the growth of small-scale forest enterprises (e.g., sal leaf plate production, babui grass crafts, and other NTFP processing) with the support of market linkages.
- Provide training on alternative skills and sources of income to decrease excessive reliance on forests and ineffective farming.

4. Enhance Health and Nutrition Education
- Organize nutrition awareness programmes focusing on tribal groups and using local languages, which should include balanced diets, maternal and child health, and hygiene, using pictorial depictions.
- Conduct training sessions for Anganwadi staff, ASHAs, and SHGs (Self Help Groups) on local nutrition-sensitive practices and the promotion of dietary diversity.

5. Policy and Governance Interventions
- Call for tailored nutrition policies under POSHAN Abhiyaan that consider forest-dependency, seasonal food availability, and tribal traditions.
- At the block and panchayat levels, improve the integration of multiple sectors (agriculture, forest, health, and rural development) to coordinate food, livelihood, and health programmes.
- Enforce community oversight and social audits of ICDS, PDS, and MGNREGA services.

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