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Linking Agricultural Production Diversity with Household Dietary Diversity: A Panel Data Analysis from Rural Bangladesh

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Outline of the Presentation

- Background
- Methodology
- Major Findings
- Summary and Conclusions
- Implications

Background

Background

- In Bangladesh, where rural households largely rely on subsistence farming, the diversity of crops grown can significantly impact the variety of foods consumed within households.
- Dietary diversity is defined as the variety of foods across and within food groups consumed over a given reference period to ensure the required intake of essential nutrients for being in a state of good health (Parappurathu et al., 2015; Ruel, 2003).
- This study examines the pathways linking farm production diversity to household dietary diversity in rural Bangladesh, and to identify the key determinants of these linkages. We aim to understand how agricultural diversification contributes to nutrient-rich diets and how these relationships are influenced by various factors, including output market participation and climate challenges.

Methodology

Data

- The study uses data from three rounds of Bangladesh Integrated Household Survey (BIHS), were implemented by the International Food Policy Research Institute (IFPRI).
- BIHS samples are statistically representative of national rural Bangladesh, covers all seven administrative divisions of the country.
- Three round panel data
  - 1st Round: 2011-12
  - 2nd Round: 2015
  - 3rd Round: 2018-19
- BIHS survey contains detailed data on plot-level agricultural production and practices and dietary intake of household members.

Study Areas (Hotspot zones)

Location (Hotspot zone)	Number of District covered	Characteristics
Coastal Zone	08	Tidal fluctuation, accelerated sea level rise (ASLR), salinity intrusion with sea-level rise, cyclones, storm surges
Barind & Drought Prone Areas	09	Rising temperature, drought, reduced groundwater levels, reducing wetlands
Haor and Flash Flood Areas	07	Precipitation, subsidence and decreased sediment supply, land filling, encroachment, land use change
Chattogram Hill Tracts	03	Loss of forest and vegetation cover, flash floods in hilly terrain
River Systems & Estuaries	11	Riverine erosion and accretion, drought, river avulsion, sedimentation offtake, subsidence, tidal fluctuation, sea-level rise, flash floods in hilly terrain and dry periods
Coastal Plus River system & Estuaries	11	
Barind & Drought Prone Plus River system & Estuaries	07	
Relatively Less Hazard Prone (RLHP) Areas	08	Districts are relatively less hazard prone owing to their location away from sea and active rivers.

Source: Based on BDP 2100 Analysis, GED, 2015 and ICZM Policy, 2005.

Hotspot Zones in Bangladesh

Location (Hotspot zone)	No. of Household	% of Total sample
Coastal Zone	2447	13.20
Barind & Drought Prone Areas	1745	9.41
Haor and Flash Flood Areas	3323	17.94
Chattogram Hill Tracts	171	0.92
River Systems & Estuaries	3393	18.30
Coastal Plus River system & Estuaries	3300	17.80
Barind & Drought Prone Plus River system & Estuaries	1640	8.84
Relatively Less Hazard Prone (RLHP) Areas	2521	13.59
	18540	100

Variables: Dietary and agricultural production variables

Household Dietary Richness Score (HDRS),	Raw counts of number of food items consumed by anyone in a household over a seven day period.
Household Dietary Diversity Score (HDDS)	The number of food groups consumed by the household during a given reference period (Last 24 hours). Food items were categorized into 12 different food groups as proposed by the Food and Agriculture Organization of the United Nations (FAO, 2011). The 12 food groups are Cereals; White tubers and roots; Legumes, nuts and seeds; Vegetables; Meat; Eggs; Fish and other seafood; Fruits; Milk and milk products; Oils and fats; Sweets; and Spices, condiments and beverages. An HDDS ranges from 0 to 12. HDDS can only be calculated using data from BIHS round 2 and 3, because round 1 did not contain information on the frequency of consumption. Thus, an HDDS ranges from 0 to 12.
Aggregated Food Group Frequency (AFGF)	Aggregated number of days that specific food groups were consumed by any household member in the given seven days. This measure, which ranges between 0 and 84.
Agricultural Richness Score (ARS)	a count of the different food crops and animal products produced by a household
Simpson's Index of Diversity (SI).	The SI can also be used to measure Crop diversity: the number of crops and the distribution of area cultivated, taking into account the area of land allocated for each crops
Agricultural Diversity Score (ADS)	Counts the number of different food groups produced. ADS counts the number of different food groups (12 groups) produced

Empirical methodology

- Our outcome variables will be the different measures of dietary diversity as described above, ranging from 0 to the maximum value the relevant measure can take. We estimate a fixed-effects (FE) model with the generic form of
- $HDD_{it} = \alpha + \beta APD_{it} + \gamma X_{it} + T_t + \delta_i + \varepsilon_{it}$
- Where i is the index for the household and t is the time index; HDD_{it} is a measure of dietary diversity of the household i at time t; APD_{it} is the measure of agricultural production diversity of household i at time t; β is parameter of interest; X_{it} is a set of the individual and socio-economic characteristics associated with household i at time t; T_t are fixed effects related to time; δ_i are unobserved fixed effects related to the household; ε_{it} is the idiosyncratic error term.

Empirical methodology

- The empirical analysis employs fixed effects panel model that controls for household and time-fixed effects.
- We use an FE model with clustered standard errors which are heteroskedasticity- and autocorrelation consistent where the clusters are households.
- We examine the effect of the agricultural production of each individual food group on dietary diversity using a panel data model with dummies for each food group. A subsequent set of regressions studied the effects of production of an item in an individual food group on the number of days in a week that each individual food group was consumed by a household.

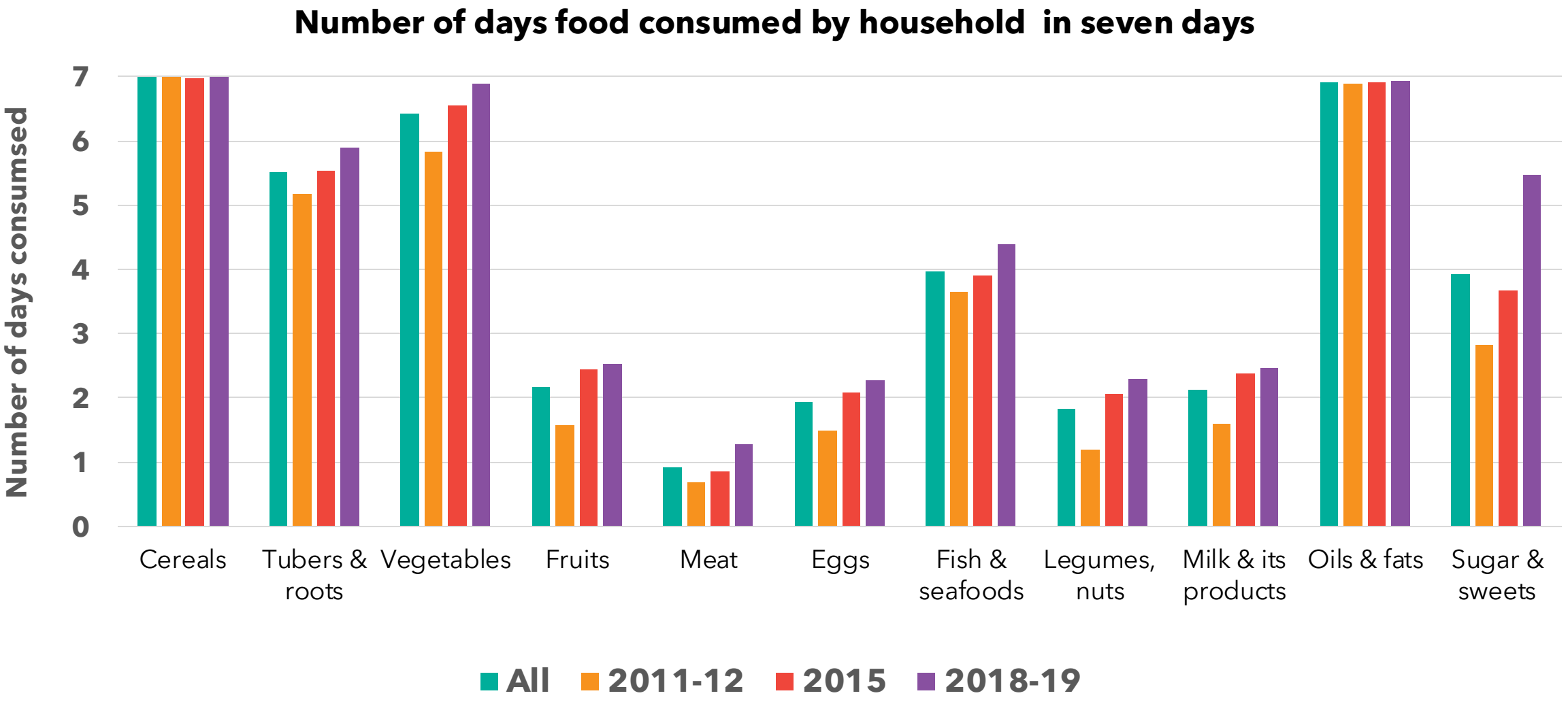
Major Findings

Summary Statistics

Variables	All sample			2012		2015		2018	
	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Outcome variables									
Household Dietary Richness Score (HDRS)	18540	26.53	7.96	24.18	7.21	26.89	7.89	28.84	8.12
Aggregated Food Goup Frequency (AFGF)	18540	44.90	10.97	38.06	9.05	43.64	8.88	54.29	8.25
Household Dietary Diversity Score (HDDS)	12037	7.04	1.62			6.44	1.56	7.74	1.40
Main explanatory variables									
Agricultural Richness Score (ARS)	18540	3.04	3.33	2.57	2.98	3.55	3.69	3.00	3.19
Simpson's Index of Diversity (SID)	18540	0.11	0.22	0.11	0.22	0.12	0.23	0.10	0.21
Agricultural Diversity Score (ADS)	18540	1.17	1.32	1.01	1.22	1.27	1.39	1.26	1.33
Output Market Participation (OMP)	18540	0.12	0.19	0.10	0.15	0.15	0.22	0.13	0.20
Climate shock experienced	18540	0.05	0.21	0.06	0.23	0.04	0.20	0.05	0.21

Summary Statistics

Variables	All sample			2012		2015		2018	
	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control variables									
Age of the hh head (years)	18540	45.45	13.91	44.17	13.98	45.76	13.84	46.59	13.79
Sex of the hh head (Male=1)	18540	0.81	0.38	0.82	0.38	0.81	0.39	0.79	0.41
Year of schooling of hh head	18540	4.05	4.38	3.84	4.35	4.07	4.36	4.28	4.43
Education of highest educated female member of hh	18540	6.24	4.04	5.68	3.96	6.38	3.99	6.75	4.11
Household size	18540	4.24	1.69	4.20	1.63	4.30	1.70	4.23	1.76
Share of children	18540	0.32	0.22	0.33	0.22	0.31	0.22	0.30	0.22
Share of elderly dependents	18540	0.07	0.17	0.06	0.16	0.06	0.16	0.08	0.19
Share of working age	18540	0.61	0.23	0.60	0.22	0.62	0.23	0.62	0.24
Cultivated area (acres)	18540	0.82	1.43	0.84	1.47	0.85	1.50	0.75	1.30
Housing walling (Brick or concrete=1)	18540	0.21	0.41	0.16	0.36	0.21	0.41	0.26	0.44


Number of days food consumed by household in seven days
Number of days consumsed
0
1
2
3
4
5
6
7
Cereals
Tubers & roots
Vegetables
Fruits
Meat
Eggs
Fish & seafoods
Legumes, nuts
Milk & its products
Oils & fats
Sugar & sweets
All
2011-12
2015
2018-19

Agricultural production diversity on household dietary diversity (HDRS)

Variables	Household Dietary Richness Score (HDRS)		
	[1]	[2]	[3]
Agricultural Richness Score (ARS)	0.861*** (0.024)		
Agricultural Diversity Score (ADS)		0.792*** (0.057)	
Simpson's Index of Diversity (SID)			0.638* (0.377)
Output Market Participation (OMP)	-0.082 (0.304)	0.212 (0.319)	0.388 (0.324)
Climate shock experienced	-0.288 (0.234)	-0.426* (0.250)	-0.433* (0.252)
Age of the household head (years)	-0.015 (0 .009)	-0.009 (0.010)	-0.008 (0.010)
Sex of the household head (Male=1)	0.714*** (0.255)	0.798*** (0.263)	0.904*** (0.263)
Year of schooling of household head	0 .011 (0 .039)	0.046 (0.041)	0.049 (0.041)
Edu of best-educated female member of hh	0.118*** (0.025)	0.133*** (0.027)	0.129*** (0.027)
Household size	0.666*** (0.072)	0.787*** (0.076)	0.820*** (0.077)
Share of children	0.657 (0.694)	0.514 (0.735)	0.581 (0.751)
Share of working age	1.106* (0.582)	1.340** (0.617)	1.514** (0.635)
Total own cultivable land (acres)	0.061 (0.116)	0.228* (0.140)	0.283* (0.152)
Housing walling (Brick or concrete=1)	0.489** (0.236)	0.494** (0.249)	0.476* (0.250)
Constant	17.812*** (0.834)	18.043*** (0.872)	18.337*** (0.883)
R-squared	0.255	0.200	0.183
No. of observations	18500	18500	18500
Number of households	7503	7503	7503
Month of interview	Yes	Yes	Yes
Household and Year Fixed effects	Yes	Yes	Yes

Agricultural production diversity on household dietary diversity (HDDS)

Variables	Household Dietary Diversity Score (HDDS)		
	[4]	[5]	[6]
Agricultural Richness Score (ARS)	0.052*** (0.008)		
Agricultural Diversity Score (ADS)		0.101*** (0.020)	
Simpson's Index of Diversity (SID)			0.081 (0.139)
Output Market Participation (OMP)	0.227** (0.108)	0.229** (0.108)	0.252** (0.108)
Climate shock experienced	-0.073 (0.088)	-0.062 (0.088)	-0.064 (0.089)
Age of the household head (years)	0.002 (0.004)	0.002 (0.003)	0.002 (0.004)
Sex of the household head (Male=1)	0.231*** (0.084)	0.226*** (0.084)	0.232*** (0.085)
Year of schooling of household head	-0.004 (0.016)	-0.002 (0.016)	-0.001 (0.016)
Edu of best-educated female member of hh	0.020** (0.009)	0.020** (0.009)	0.019** (0.009)
Household size	0.105*** (0.025)	0.111*** (0.025)	0.114*** (0.024)
Share of children	0.248 (0.233)	0.230 (0.232)	0.234 (0.233)
Share of working age	0.211 (0.188)	0.206 (0.188)	0.236 (0.188)
Total own cultivable land (acres)	0.051 (0.069)	0.058 (0.068)	0.067 (0.072)
Housing walling (Brick or concrete=1)	0.078 (0.079)	0.081 (0.080)	0.077 (0.080)
Constant	5.129*** (0.303)	5.133*** (0.303)	5.192*** (0.304)
R-squared	0.217	0.214	0.210
No. of observations	12000	12000	12000
Number of households	7117	7117	7117
Month of interview	Yes	Yes	Yes
Household and Year Fixed effects	Yes	Yes	Yes

Agricultural production diversity on household dietary diversity (AFGF)

Variables	Aggregated Food Group Frequency (AFGF)		
	7	8	9
Agricultural Richness Score (ARS)	0.564*** (0.029)		
Agricultural Diversity Score (ADS)		1.290*** (0.068)	
Simpson's Index of Diversity (SID)			0.059 (0.460)
Output Market Participation (OMP)	-0.128 (0.378)	-0.139 (0.375)	0.199 (0.382)
Climate shock experienced	-0.448 (0.298)	-0.378 (0.299)	-0.345 (0.305)
Age of the household head (years)	-0.012 (0.012)	-0.009 (0.012)	-0.008 (0.012)
Sex of the household head (Male=1)	0.661** (0.296)	0.594** (0.297)	0.796*** (0.301)
Year of schooling of household head	0.095* (0.048)	0.113** (0.048)	0.121** (0.049)
Edu of best-educated female member of hh	0.066** (0.031)	0.078** (0.031)	0.073** (0.032)
Household size	0.719*** (0.085)	0.765*** (0.085)	0.822*** (0.087)
Share of children	2.314*** (0.805)	2.140*** (0.809)	2.273*** (0.827)
Share of working age	1.836*** (0.677)	1.809*** (0.679)	2.110*** (0.700)
Total own cultivable land (acres)	-0.013 (0.158)	0.027 (0.159)	0.142 (0.185)
Housing walling (Brick or concrete=1)	0.155 (0.287)	0.179 (0.289)	0.145 (0.291)
Constant	31.958*** (0.982)	31.811*** (0.983)	32.298*** (0.998)
R-squared	0.457	0.449	0.433
No. of observations	18500	18500	18500
Number of households	7503	7503	7503
Month of interview	Yes	Yes	Yes
Household and Year Fixed effects	Yes	Yes	Yes

Agricultural production of individual food groups on household dietary diversity

Variables	Household Dietary Richness Score (HDRS)		Household Dietary Diversity Score (HDDS)		Aggregated Food Group Frequency (AFGF)	
Production	Coeff.	SE	Coeff.	SE	Coeff.	SE
Cereals	0.755***	0.155	0.073	0.052	0.718***	0.182
White tubers and roots	-0.207	0.282	-0.126	0.094	-0.071	0.321
Vegetables	0.592***	0.187	-0.028	0.057	-0.591***	0.216
Fruits	0.740***	0.173	0.161***	0.057	2.132***	0.192
Meat	1.898***	0.218	0.194***	0.075	0.697***	0.244
Eggs	0.823***	0.144	-0.027	0.049	1.596***	0.166
Fish and other seafoods	0.676**	0.268	0.035	0.092	0.332	0.311
Legumes and seeds	0.884***	0.284	0.092	0.098	1.401***	0.336
Milk and milk products	0.737***	0.195	0.594***	0.065	4.942***	0.221
Oils and fats	-0.219	0.603	-0.011	0.208	-0.308	0.652
Sugar and sweets	0.4507	0.672	-0.4586**	0.225	1.1840	0.759
Spice condiments	2.435***	0.689	0.933***	0.174	2.413***	0.716
Constant	17.530	0.682	5.221***	0.221	31.273***	0.735
R-squared	0.210		0.222		0.470	
No. of observations	18500		12000		18500	
Number of households	7503		7117		7503	
HH and Year Fixed effects	Yes		Yes		Yes	

Effects of hotspot zone on household dietary diversity

Variables	Household Dietary Richness Score (HDRS)	Household Dietary Diversity Score (HDDS)	Aggregated Food Group Frequency (AFGF)
	[1]	[2]	[3]
Base: Relatively Less Hazard Prone (RLHP) Areas			
Coastal Zone	0.089 (0.242)	0.200*** (0.055)	0.577** (0.269)
Barind and Drought Prone Areas	-1.457*** (0.257)	-0.422*** (0.053)	-2.802*** (0.273)
Haor and Flash Flood Areas	-0.580** (0.226)	0.043 (0.046)	-0.043 (0.244)
Chattogram Hill Tracts	1.032* (0.621)	0.308** (0.147)	2.971*** (0.741)
River Systems & Estuaries	-0.216 (0.217)	0.116** (0.048)	-0.024 (0.252)
Coastal PLUS River system	-1.619*** (0.220)	0.001 (0.051)	-0.123 (0.257)
Barind PLUS River system	-0.625** (0.270)	-0.431*** (0.056)	-2.199*** (0.285)
Constant	17.739*** (0.415)	5.150*** (0.111)	32.818*** (0.479)
R-squared	0.247	0.263	0.487
No. of observations	18500	12000	18500
Number of households	7503	7117	7503
Control variables	Yes	Yes	Yes

Note: ***$p<0.01$, ** $p<0.05$, and *$p<0.10$. Standard errors are presented in parentheses.

Summary and Conclusions

Summary and conclusions

- Agricultural production diversity measures (the ARS, and ADS) have positive and significant effects on all dietary diversity measures (the HDRS, HDDS and AFGF).
- Relationship between ARS, and ADS with HDRS and AFGF shows that diversity in own production were the major driver of diversity in diet.
- Agricultural diversity measures of SID shows there was a significant effect of output market participation on dietary diversity.
- Therefore, agricultural production can affect the dietary diversity of the households by producing food for the household's own consumption and by generating an income through agricultural marketing.

Summary and conclusions

- We observe consistent effects of two control variables i.e., level of education of the best-educated female member of the household, and the household size. Both variables have positive and significant effects on dietary diversity.
- Shocks from the climate related events has positive but insignificant effects dietary diversity.
- The household production of meat, milk and milk products increases household diversity.
- Significant regional variations in dietary diversity were observed across hotspot zones, with drought-prone and river-affected areas often facing more significant dietary challenges.

Implications

- Policies promoting agricultural diversification and market access can significantly improve dietary diversity and resilience to climate shocks in rural Bangladesh.
- Cross-cutting policies addressing climate resilience are critical, especially in areas with compounded hazards (e.g., combined Coastal plus River or Barind plus River areas).
- Integrating region-specific, climate-resilient agricultural practices is crucial.
- Further research should target interventions that support education, income generation through market access , and climate-resilient farming to enhance household nutrition and food security amid climate stress.

Thank You!!!