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Agricultural Productivity and Undernourishment in Developing Economies: Panel Evidence from Cereal Yield

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ABSTRACT

Agricultural productivity is linked to lower undernourishment in developing economies, but the relationship is weaker and more conditional than standard policy narratives often assume. The evidence shows a negative association between cereal yield and undernourishment after accounting for country-specific conditions, common annual shocks, and broader development factors: a 1,000 kg/ha increase in lagged cereal yield corresponds to an estimated 0.7 percentage-point decline in the prevalence of undernourishment. The coefficient is modest and only weakly significant, suggesting that productivity matters, but not as a self-sufficient route to food security. A clearer signal appears when productivity is measured more broadly: replacing cereal yield with the food production index produces a stronger and more precisely estimated negative association, indicating that food security gains are not confined to staple grains alone. The relationship is also sharply uneven across income groups. It is strongest in lower-middle-income countries, where domestic markets are more capable of transmitting productivity gains while undernourishment remains high enough to respond. In low-income countries, the coefficient is larger in magnitude but imprecise, consistent with weak market access, storage constraints, conflict exposure, and

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distribution bottlenecks. In upper-middle-income countries, the association is close to zero, reflecting low baseline undernourishment and the diminishing role of agriculture in national food security outcomes. These findings suggest that agricultural productivity remains an important part of the food security agenda, but policies focused only on raising yields are unlikely to be sufficient unless they are paired with improvements in storage, distribution, and access to food markets.

Introduction

Global progress against food insecurity has slowed, while food price inflation and climate pressure have widened disparities among developing economies. The *State of Food Security and Nutrition in the World 2025* highlights the continuing effect of high food prices on purchasing power and diet quality, especially among low-income populations (FAO et al., 2025). Long-run projections also suggest that climate and socioeconomic change will remain central to food and nutrition security outcomes, even where aggregate food availability improves (Rosegrant et al., 2024).

Agricultural productivity remains a central policy response. Higher yields can expand domestic food supply, ease pressure on staple prices, support rural income, and reduce exposure to external market shocks. This pathway is especially relevant for cereals because rice, wheat, and maize remain major calorie sources in many developing economies. Mughal and Fontan Sers (2020) show that cereal production and yield are associated with lower undernourishment and food insecurity in South Asia. Evidence from Nigeria further links staple food price changes to child undernutrition among agricultural households, while national-level evidence also connects agricultural yield patterns with food nutrition and dietary energy supply (Akerele et al., 2024; Akano et al., 2023). These findings support a productivity–nutrition link, but they also show that production gains matter only when they pass through markets, prices, and household access.

This access condition is central to the argument. Sen's (1981) entitlement approach frames hunger as a problem of command over food, not only food availability. Yield growth may therefore have limited nutritional effects when transport costs are high, storage is weak, conflict disrupts distribution, or food prices rise faster than purchasing power. In this sense, agricultural productivity is better understood as a conditional pathway to food security rather than a self-contained solution.

The empirical problem follows directly from this logic. Countries with higher cereal yields are usually richer, better connected, and less food insecure for reasons that are not purely agricultural. Cross-country correlations may therefore confuse productivity with broader development. The more policy-relevant question is whether undernourishment falls when productivity improves within the same country over time, after persistent national differences and common annual shocks are accounted for. This study addresses two questions:

RQ1: Is higher cereal yield associated with lower undernourishment within developing economies over time?

RQ2: Does this relationship differ across low-, lower-middle-, and upper-middle-income countries?

Using a panel of 98 developing economies from 2001 to 2023, the results point to a modest and conditional productivity channel. Yield improvements are associated with lower undernourishment, but the clearest evidence appears in lower-middle-income countries. The relationship is imprecise in low-income countries, where storage, market access, conflict, and distribution constraints may weaken transmission, and close to zero in upper-middle-income countries, where baseline undernourishment is already low.

The paper contributes in three ways. First, it shifts attention from cross-country productivity gaps to within-country changes in productivity and undernourishment. Second, it shows that the productivity–food security relationship differs across income groups. Third, it qualifies yield-centred food security policy by showing that productivity gains are more likely to matter when supported by storage, distribution, market access, and household purchasing power. The remainder of the paper is organised as follows. Section 2 reviews the literature and theoretical channels. Section 3 presents the data and empirical strategy. Section 4 reports and discusses the results. Section 5 concludes.

2. Literature Review and Theoretical Channels

2.1 Agricultural productivity and food security

Agricultural productivity serves as a foundational lever for food security in developing regions, primarily by raising rural incomes and expanding aggregate food supplies (Timmer, 1988; World Bank, 2008). In low- and middle-income contexts, this mechanism relies heavily on cereal yields, especially rice, wheat, and maize, which constitute the primary caloric baseline. Empirical expansions in cereal output are consistently linked to reduced undernourishment and improved caloric availability, though the survival of these nutritional benefits depends on post-harvest value chains and distribution efficiency rather than farm-gate production alone (Grote et al., 2021; Mughal & Fontan Sers, 2020; Pauw & Thurlow, 2011).

Systemic climate stress, input-market volatility, and food price inflation further suggest that aggregate supply growth is insufficient to guarantee food access (Rosegrant et al., 2024; FAO et al., 2025; World Bank, 2026). Mitigating these environmental and structural pressures increasingly requires targeted technological adaptation, including improvements in water-use efficiency, to stabilise crop yields and protect

vulnerable supply chains (Kaabache & Badaoui, 2022; Zerrouki & Khireddine, 2026). Agricultural productivity therefore remains important, but its food-security dividend is strongly contingent on whether yield growth is paired with food quality, post-harvest systems, and transmission efficiency across the wider food system (Bouis & Welch, 2010; Grote et al., 2021).

2.2 Market transmission and development thresholds

The loose coupling between output growth and hunger highlights the primacy of food access. Guided by Sen's (1981) entitlement framework, undernourishment is not simply a consequence of insufficient supply, but a failure of households to command food through income, prices, transfers, or own production. Agriculture can influence this command through income, food prices, and livelihood channels (Headey & Masters, 2019). Macroeconomic supply shocks and local price spikes can harm net food-buying households when domestic markets transmit external volatility into staple prices (Headey & Fan, 2010; Dithmer & Abdulai, 2017), raising undernutrition risks even within agricultural communities (Akerele et al., 2024). Securing nutritional returns from productivity growth therefore requires effective storage, processing, distribution, and sectoral linkages; without efficient domestic marketing and inter-industry coordination, localised yield gains may fail to reduce retail food prices or improve diet access (Hawkes et al., 2007; Grote et al., 2021; Lamri et al., 2022).

This transmission efficiency varies systematically across development thresholds. In low-income countries, storage deficits, poor rural connectivity, thin markets, conflict exposure, and rain-fed production systems often isolate farm-level gains from vulnerable consumers, especially where climate stress amplifies undernutrition risks (Lloyd et al., 2011; Phalkey et al., 2015; Connolly-Boutin & Smit, 2016). Lower-middle-income countries occupy a more plausible transmission zone: they still face substantial undernourishment but possess more integrated domestic markets through which productivity gains can pass into prices and household income (Headey, 2013; Mughal & Fontan Sers, 2020). In upper-middle-income settings, the channel tends to attenuate as food security challenges shift away from staple crop availability towards dietary quality, relative prices, and institutional safety nets (Rosegrant et al., 2024; FAO et al., 2025).

2.3 Research gap and hypotheses

Although the intersection of agricultural output, price dynamics, and nutrition is well documented, existing evidence remains constrained by two empirical limitations. Much of the literature is localised or household-specific, leaving broad cross-country panel dynamics underexplored (Belesova et al., 2017; Akerele et al., 2024). At the same time, conventional macro-level comparisons often struggle to separate agricultural productivity from confounding shifts in income, infrastructure, market development, and institutional quality. This study addresses these connected gaps by evaluating the within-country association between lagged cereal yield and undernourishment in 98 developing economies, while explicitly testing whether this association changes across income groups.

Based on these theoretical channels, two hypotheses are proposed:

H1: Higher cereal yield is negatively associated with the prevalence of undernourishment within developing economies over time.

H2: The negative association between cereal yield and undernourishment is heterogeneous across income groups, with the strongest and most precise association concentrated in lower-middle-income countries.

3. Data and Methodology

3.1 Data and sample

This study constructs an annual country-level panel from the World Development Indicators (WDI) for 2000–2023. The sample is restricted to low-, lower-middle-, and upper-middle-income economies, excluding high-income countries where undernourishment is either negligible or inconsistently reported. After incorporating the one-year lag structure and retaining observations with complete baseline covariates, the final estimation sample contains 2,013 country-year observations from 98 developing economies over 2001–2023. The sample comprises 18 low-income, 41 lower-middle-income, and 39 upper-middle-income countries.

3.2 Variables and operationalisation

The dependent variable is the prevalence of undernourishment, defined as the share of the population whose habitual dietary energy intake falls below the minimum requirement. The main explanatory variable is cereal yield, measured in kilograms per hectare and entered with a one-year lag. The lag reflects the delay between harvest conditions, storage, market adjustment, and observed food-security outcomes. This timing is consistent with the access-based view that agricultural output affects

undernourishment only after passing through prices, distribution systems, and household command over food (Sen, 1981; Grote et al., 2021; Akerele et al., 2024).

The control vector covers the main confounding channels identified in the food security literature: purchasing power, agricultural structure, land endowments, rural population exposure, domestic price instability, and external market exposure. Specifically, it includes log GDP per capita, agriculture value added as a share of GDP, arable land, rural population, inflation, and trade openness. These controls account for the fact that undernourishment is shaped not only by domestic production, but also by income, price pressure, structural agricultural conditions, and market integration (Dithmer & Abdulai, 2017; FAO et al., 2025; World Bank, 2026). Table 1 presents the variable definitions and data sources.

Table 1. Variables and Data Sources

Role	Variable	Measurement	Source
Dependent variable	Undernourishment	Population below minimum dietary energy requirement (%)	WDI / FAO
Alternative outcome	Severe food insecurity	Population facing severe food insecurity (%)	WDI / FAO FIES
Main explanatory variable	Cereal yield (t−1)	Lagged cereal yield (kg/ha)	WDI / FAO
Alternative productivity measure	Food production index (t−1)	Lagged food production index (2014–2016 = 100)	WDI / FAO
Control	GDP per capita	Natural log of GDP per capita, constant 2015 USD	WDI
Control	Agriculture value added	Agriculture, forestry, and fishing value added (% of GDP)	WDI
Control	Arable land	Arable land (% of land area)	WDI / FAO
Control	Rural population	Rural population (% of total population)	WDI
Control	Inflation	CPI inflation, winsorised at 1st and 99th percentiles (%)	WDI
Control	Trade openness	Exports plus imports (% of GDP)	WDI

Note. Lagged variables use previous-year values. WDI = World Development Indicators; FAO = Food and Agriculture Organization; FIES = Food Insecurity Experience Scale.

3.3 Empirical strategy

The baseline specification estimates the within-country association between lagged cereal yield and undernourishment:

$$\text{Undernourishment}_{it} = \alpha + \beta \text{CerealYield}_{i,t-1} + \boldsymbol{X}'_{\boldsymbol{it}}\boldsymbol{\gamma} + \mu_i + \lambda_t + \varepsilon_{it}, \qquad (1)$$

where i and t denote country and year, respectively. $\mathbf{X_{it}}$ is the vector of controls, μ_i denotes country fixed effects, and λ_t denotes year fixed effects. Country fixed effects absorb persistent national differences in geography, institutions, and agricultural structure, while year fixed effects absorb common annual shocks. This design follows the logic that cross-country productivity gaps may reflect broader development differences rather than agricultural productivity alone. Standard errors are clustered at the country level.

To test whether trade openness conditions the productivity–undernourishment relationship, the interaction specification is:

$$\begin{aligned}\text{Undernourishment}_{it} &= \alpha + \beta \text{CerealYield}_{i,t-1} \\ &+ \theta\left(\text{CerealYield}_{i,t-1} \times \text{TradeOpen}_{it}\right) + \boldsymbol{X}'_{\boldsymbol{it}}\boldsymbol{\gamma} + \mu_i + \lambda_t + \varepsilon_{it}. \qquad (2)\end{aligned}$$

Income-group heterogeneity is examined by estimating the preferred model separately across development thresholds:

$$\text{Undernourishment}^{g}_{it} = \alpha^{g} + \beta^{g\text{CerealYield}}_{i,t-1} + \boldsymbol{X}'_{\boldsymbol{it}}\boldsymbol{\gamma}^{\boldsymbol{g}} + \mu_i + \lambda_t + \varepsilon^{g}_{it}, \quad g \in \{\text{LIC,LMC,UMC}\}. \qquad (3)$$

The preferred specification is the two-way fixed effects model. The coefficient β is interpreted as a conditional association rather than a causal effect, since time-varying unobserved factors may still affect both agricultural productivity and food security.

3.4 Robustness framework

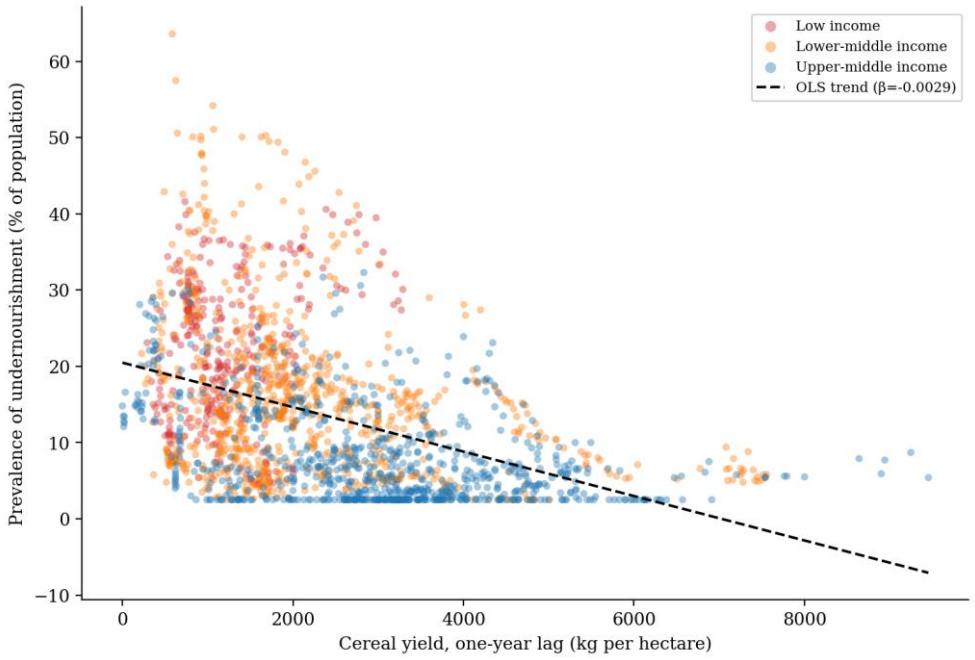
Robustness checks examine the sensitivity of the baseline association to lag structure, measurement, and sample composition. The analysis replaces the one-year cereal-yield lag with a two-year lag, substitutes the food production index for cereal yield, uses severe food insecurity as an alternative outcome, excludes the COVID-19 years 2020–2021, and re-estimates the model on a broader sample by omitting the inflation covariate.

4. Results and Discussion

4.1 Descriptive patterns

Before fixed effects are imposed, the productivity–undernourishment relationship is strongly shaped by development thresholds rather than following a uniform linear pattern, as shown in Figure 1. Low-income countries remain concentrated in a low-productivity, high-undernourishment range, while upper-middle-income countries cluster where cereal productivity is higher and caloric deprivation is lower. Lower-middle-income economies occupy the critical intermediate range, where undernourishment remains responsive enough for productivity gains to matter, but market systems are more developed than in low-income settings.

Figure 1. Cereal Yield and Undernourishment by Income Group



Note. Points represent country-year observations. The dashed line shows the pooled OLS trend. Cereal yield is lagged one year.

The summary statistics in Table 2 show a similar income gradient across these development thresholds. This baseline distribution provides initial support for H2 and cautions against treating the raw cross-country gradient as an unconfounded productivity relationship. Because cereal yield, income, infrastructure, and institutional capacity are closely bundled across

countries, the fixed-effects framework provides a more conservative within-country test.

Table 2. Descriptive Statistics and Income-Group Profile

Panel A. Overall sample

Variable	N	Mean	SD	Min	Max
Undernourishment (%)	2,013	13.56	10.16	2.50	63.60
Severe food insecurity (%)	585	11.92	11.21	0.00	56.30
Cereal yield, t−1 (kg/ha)	2,013	2,374.59	1,505.07	0.10	9,453.70
Food production index, t−1	2,013	91.85	20.63	29.55	183.45
Ln GDP per capita	2,013	7.75	0.89	5.77	9.61
Agriculture value added (% GDP)	2,013	15.05	9.59	0.97	41.37
Arable land (% land)	2,013	16.04	14.63	0.09	63.79
Rural population (%)	2,013	49.51	19.03	7.32	88.10
Inflation (%)	2,013	7.08	9.17	−2.29	65.17
Trade openness (% GDP)	2,013	74.41	35.69	4.13	347.72

Panel B. Income-group profile

Income group	Observations	Countries	Undernourishment (%)	Cereal yield, t−1	Ln GDPpc	Rural population (%)	Trade openness (%)
Low income	335	18	21.70	1,250.73	6.48	67.30	52.15
Lower-middle income	845	41	15.84	2,180.44	7.47	55.60	76.64
Upper-middle income	833	39	7.97	3,023.50	8.55	36.18	81.10

Note. Panel A reports the estimation sample; Panel B reports income-group means. GDPpc = GDP per capita.

4.2 Baseline estimates

The baseline estimates reported in Table 3 show that moving from pooled comparison to within-country fixed-effects estimation sharply reduces the estimated productivity channel. The cereal-yield coefficient remains negative, but its magnitude declines once time-invariant national characteristics and common annual shocks are absorbed. This attenuation confirms that cross-country correlations overstate the independent role of agricultural output in reducing undernourishment.

The preferred two-way fixed effects model provides qualified support for H1. Lagged cereal yield is negatively associated with undernourishment, but the relationship is modest rather than decisive. This pattern fits an access-based interpretation of food security: productivity can ease undernourishment, but its transmission depends on market availability, retail prices, and household purchasing power. National income remains a stronger within-country correlate, consistent with Sen's (1981) entitlement logic and recent evidence that contemporary food insecurity is increasingly shaped by purchasing power and price pressure rather than production volume alone (FAO et al., 2025).

Table 3. Baseline Panel Estimates

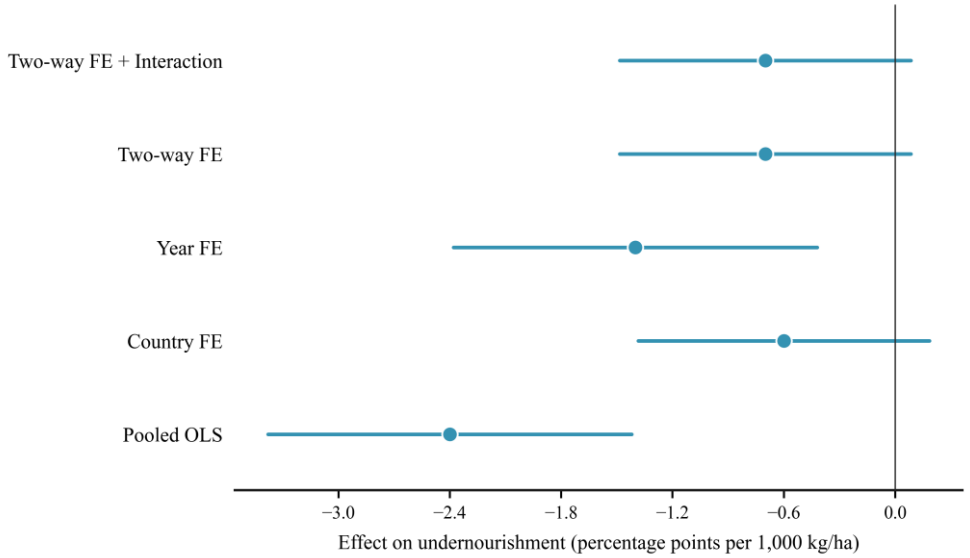
Variable	Pooled OLS	Country FE	Year FE	Two-way FE	Interaction
Cereal yield, t−1	−2.400***	−0.600*	−1.400***	−0.700*	−0.700*
	(0.500)	(0.400)	(0.500)	(0.400)	(0.400)
Cereal yield × Trade	—	—	—	—	−0.000
					(0.000)
Ln GDP per capita	0.799**	−10.257***	−7.169***	−9.717***	−9.727***
	(0.320)	(1.774)	(1.642)	(1.941)	(1.920)
Inflation	0.176**	0.046	0.137**	0.038	0.038
	(0.073)	(0.042)	(0.069)	(0.046)	(0.047)
Trade openness	−0.007	0.035**	−0.015	0.037**	0.040
	(0.017)	(0.017)	(0.015)	(0.018)	(0.025)
Additional controls	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes
Observations	2,013	2,013	2,013	2,013	2,013
Countries	98	98	98	98	98
Within R^2	0.138	0.325	0.203	0.323	0.323

Note. Dependent variable: undernourishment. Cereal-yield coefficients are per 1,000 kg/ha. Clustered standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Adding the trade interaction does not produce a clear conditioning effect. This should not be read as evidence that trade integration is irrelevant. Aggregate trade openness is too broad to capture food-import dependence, commodity-specific exposure, or local price pass-through. Recent food security monitoring continues to show that grain markets and external

supply-chain shocks remain central to vulnerable food systems, but those channels require more disaggregated trade and price data than the present specification contains (World Bank, 2026). Figure 2 further illustrates the attenuation of the cereal-yield coefficient across alternative estimators, reinforcing the conditional nature of H1.

Figure 2. Estimated Yield Effect across Model Specifications



Note. Coefficients show the effect on undernourishment in percentage points per 1,000 kg/ha increase in lagged cereal yield. Horizontal bars indicate 95% confidence intervals.

4.3 Robustness checks

The robustness checks presented in Table 4 confirm the directional stability of the baseline result while clarifying its empirical limits. Extending the lag structure to two years weakens precision, suggesting that the cereal-yield channel is more visible within a short post-harvest window than as a long-delayed structural effect. This temporal sensitivity is consistent with a mechanism running through storage, seasonal availability, and price adjustment.

A stronger and more precise negative association emerges when cereal yield is replaced with the broader food production index, suggesting that nutrition-relevant productivity may operate through the wider agricultural system rather than staple output alone. It also aligns with evidence that

agricultural growth can improve caloric availability, but that nutrition effects depend on the type and transmission of agricultural growth (Pauw & Thurlow, 2011; Headey & Masters, 2019; Rosegrant et al., 2024; FAO et al., 2025).

The severe-food-insecurity specification does not reproduce the baseline pattern. Rather than indicating a substantive reversal, this result marks a measurement boundary: the indicator covers fewer countries and years, is concentrated in the recent period, and captures survey-based household hardship rather than the dietary-energy deficits measured by undernourishment. Excluding the 2020–2021 pandemic years leaves the main estimate largely unchanged, while omitting the inflation control and expanding the sample strengthens the negative association. Overall, the robustness evidence supports H1 in a conditional sense, showing that the estimated relationship depends on how agricultural output and food insecurity are operationalised.

Table 4. Robustness and Heterogeneity Tests

Test	Main variable	Outcome	Coefficient	SE	p-value	N	Within R^2
Two-year lag	Cereal yield, t−2	Undernourishment	−0.600	0.400	0.141	1,935	0.307
Food production index	Food production index, t−1	Undernourishment	−0.078***	0.016	0.000	2,052	0.342
Alternative outcome	Cereal yield, t−1	Severe food insecurity	0.500***	0.100	0.001	602	−0.063
Excluding 2020–2021	Cereal yield, t−1	Undernourishment	−0.700*	0.400	0.070	1,829	0.327
No inflation control	Cereal yield, t−1	Undernourishment	−0.900**	0.400	0.031	2,131	0.319
Low income	Cereal yield, t−1	Undernourishment	−1.800	2.000	0.359	335	0.179
Lower-middle income	Cereal yield, t−1	Undernourishment	−2.600**	1.000	0.011	845	0.412
Upper-middle income	Cereal yield, t−1	Undernourishment	−0.100	0.300	0.854	833	0.415

Note. Models use two-way fixed effects unless stated otherwise. Cereal-yield coefficients are per 1,000 kg/ha. Severe food insecurity results are

interpreted cautiously due to shorter coverage. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

4.4 Income-group heterogeneity

The stratified subsample estimates offer the strongest evidence in the paper. The productivity–undernourishment relationship is concentrated in lower-middle-income economies and weakens at both ends of the income distribution, providing direct support for H2.

In low-income economies, the estimated coefficient is negative but imprecise. This pattern suggests that high baseline hunger does not automatically guarantee effective supply transmission. Climate exposure, agrarian risk, weak infrastructure, storage deficits, and fragmented markets can prevent farm-level yield gains from becoming stable food access for vulnerable households, consistent with regional evidence on agricultural conditions, child undernutrition, and food security risks (Kaabache & Badaoui, 2022; Pinchoff et al., 2021).

The lower-middle-income subsample drives the paper's central finding. This group shows the strongest and most precisely estimated negative association between cereal yield and undernourishment. The result suggests that lower-middle-income economies combine two necessary conditions: baseline caloric deprivation remains high enough to respond to supply changes, while domestic marketing systems, infrastructure, and value chains are sufficiently developed to transmit agricultural gains through food prices and rural incomes. This interpretation is consistent with evidence that food prices affect nutritional outcomes even among agricultural households, and that marketing efficiency and sectoral organisation shape the broader development returns of agriculture (Akerele et al., 2024; Lamri et al., 2022).

In upper-middle-income economies, the coefficient moves close to zero. This attenuation reflects a development-stage shift in which national food security becomes less directly tied to staple crop availability and more dependent on income distribution, relative prices, social protection, and dietary quality (Rosegrant et al., 2024; FAO et al., 2025). The heterogeneity pattern therefore sharpens the paper's core claim: agricultural productivity is not a universal food-security lever, but a conditional mechanism bounded by development thresholds.

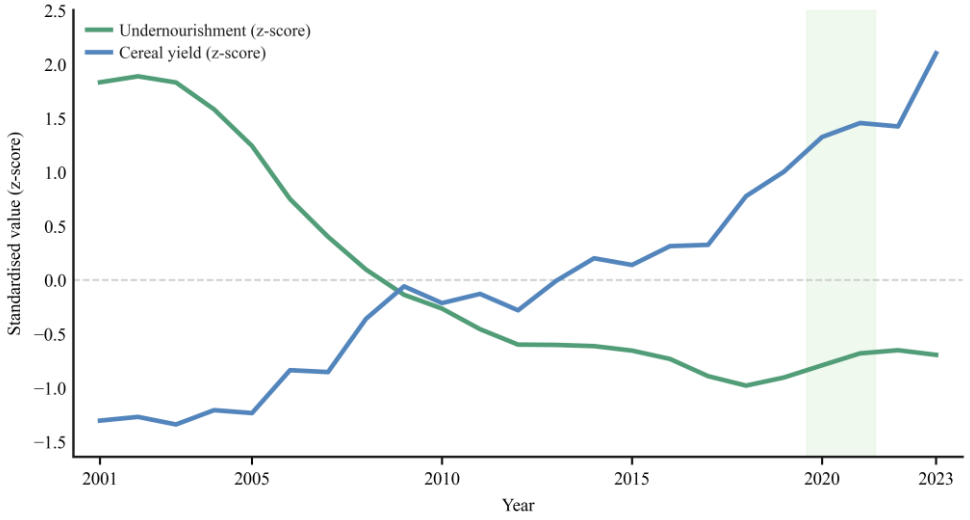
4.5 Discussion

The long-run trend evidence plotted in Figure 3 helps explain why the estimated within-country productivity channel is modest. Cereal yield continues to rise, yet undernourishment does not fall at a symmetrical pace throughout the sample period. This divergence illustrates the limits of an

unconditional supply narrative: if productivity growth operated as a stand-alone remedy, sustained yield expansion would have generated a more consistent decline in hunger.

These findings point to a selective rather than blanket yield-maximising policy framework. Agricultural productivity remains important, especially in lower-middle-income economies where the empirical association is strongest, but higher yields cannot function as an isolated target. The food-security return to agricultural investment depends on whether post-harvest logistics, domestic marketing channels, storage, and purchasing-power support allow production gains to reach vulnerable households rather than stopping at the farm gate. This interpretation is consistent with recent evidence that food insecurity is increasingly shaped by climate stress, price volatility, and household access, rather than aggregate production alone (Rosegrant et al., 2024; FAO et al., 2025; World Bank, 2026).

Figure 3. Standardised Trends in Cereal Yield and Undernourishment



Note. Values are z-scores. The shaded area marks 2020–2021.

5. Conclusion and Policy Implications

This study examined the within-country association between lagged cereal yield and undernourishment across 98 developing economies from 2001 to 2023. The results provide cautious support for H1: higher cereal productivity is associated with lower undernourishment, but the relationship

becomes modest once country characteristics and common annual shocks are absorbed. Productivity matters, yet its food-security value depends on whether output gains pass through markets, prices, income, and household access.

The clearest evidence concerns H2. The productivity–undernourishment relationship is strongest in lower-middle-income economies, where undernourishment remains responsive and market systems are developed enough to transmit agricultural gains beyond the farm gate. The channel is weaker in low-income countries, where storage deficits, poor connectivity, climate exposure, and market fragmentation restrict transmission. It also fades in upper-middle-income countries, where food insecurity is shaped less by staple availability than by affordability, distribution, social protection, and diet quality.

The policy message is therefore transmission-centred. Yield growth should be paired with storage, rural roads, climate-resilient infrastructure, post-harvest logistics, market integration, price stabilisation, and purchasing-power support. The exact mix should vary by development stage, but the principle is the same: productivity reduces undernourishment only when farm-level gains reach vulnerable households.

The study is limited by its macro-panel design, which cannot capture household distribution, subnational market frictions, or differences between net food producers and consumers. Future research should use household surveys, subnational yield data, commodity prices, and trade-flow measures to trace the pathway from agricultural productivity to food access more directly. Overall, higher yields remain important, but they are not enough; food security policy should move from a narrow production-centred approach towards a transmission-centred strategy that connects agricultural output with equitable household access.

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