Mapping food system vulnerabilities and multilevel governance across spatial typologies in Jambi Province

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Abstract
Uneven production capacity, spatial disparities, distribution constraints, and governance fragmentation shape food security conditions in Jambi Province. Although aggregate indicators show improvement between 2022 and 2024, persistent territorial inequalities and structural vulnerabilities remain. This study maps food system vulnerabilities and multilevel governance dynamics across spatial typologies in Jambi Province. Using a mixed-methods design that integrates Likert-scale surveys of provincial and district/municipal officials with thematic qualitative analysis of academic perspectives, the study synthesizes institutional perceptions across the four FAO pillars—availability, access, utilization, and stability. The findings reveal scalar asymmetries in governance perceptions: provincial actors rely on aggregate indicators and formal coordination mechanisms, whereas district and municipal actors emphasize operational constraints and localized bottlenecks. Academic perspectives highlight longer-term structural pressures, including land-use conversion, climate exposure, and demographic shifts in farming communities. Through iterative thematic integration, the study constructs three spatial configurations of food system vulnerability: (1) urban and peri-urban areas dependent on external supply and sensitive to price volatility; (2) highland production centers characterized by strong output capacity but climate-related risks; and (3) rural–coastal regions constrained by infrastructural limitations and environmental exposure. The results demonstrate that food security in Jambi is territorially differentiated and mediated by multilevel governance dynamics. Mapping these configurations provides a structured basis for spatially differentiated and coordination-sensitive policy design.

Keywords: *Food security; Multilevel governance; Spatial differentiation*

JEL Classification: H70, O18, Q01, Q18, R58

INTRODUCTION

Over the past decade, food security has re-emerged as a pressing development concern. Climate variability, price volatility, disruptions in global supply chains, and geopolitical tensions have exposed structural weaknesses in food systems across regions (Kumar et al., 2024; Narayan et al., 2024; Nguyen et al., 2024). Recent reports from the Food and Agriculture Organization (FAO, 2025) highlight a convergence of pressures—

extreme weather events, land degradation, rising production costs, and uneven distribution networks—that increasingly strain national and subnational food systems. These pressures are particularly consequential for developing countries, where agriculture remains central not only to food supply but also to livelihoods.

In Indonesia, food security has long been framed as a national priority. Yet beneath aggregate indicators, significant regional disparities persist. Jambi Province illustrates this complexity. Although the province's Food Security Index (Indeks Ketahanan Pangan/IKP) improved between 2022 and 2024—reflected in the growing number of subdistricts categorized as "Highly Food Secure"—239 villages remain classified as vulnerable or food-insecure. These figures suggest that progress at the provincial level does not necessarily translate into evenly distributed resilience at the village level.

From the standpoint of availability, Jambi continues to face a structural rice deficit. In 2024, self-sufficiency stood at approximately 50.8 percent, necessitating the import of more than 157 thousand tons from other regions. Production capacity is unevenly distributed: Kerinci Regency and Sungai Penuh City consistently record surpluses, while Batang Hari, Merangin, Muaro Jambi, Bungo, and parts of Tanjung Jabung Barat experience recurring deficits and price instability. Land-use patterns further complicate this situation. Of the province's 2.54 million hectares of cultivated land, plantations account for more than 40 percent, whereas food crops occupy less than 7 percent and paddy fields only about 2.35 percent. Demographic trends add another layer of concern, as more than half of farmers are over 45, raising questions about the long-term sustainability of food production (Kanwil DJPb Provinsi Jambi, 2025).

These empirical realities call for a framework that captures both the material and institutional dimensions of food security. The FAO conceptualizes food security through four interrelated pillars: availability, access, utilization, and stability (FAO, 1996, 2008). Availability concerns the physical presence of sufficient food through production, stocks, and trade. Access refers to individuals' and households' ability to obtain food, whether economically or physically. Utilization addresses how food is consumed, including nutritional quality, food safety, and health conditions. Stability emphasizes the continuity of these dimensions over time, particularly in the face of shocks such as disasters or price fluctuations. Rather than functioning independently, these pillars interact dynamically; weakness in one domain often reverberates across the others (Berry et al., 2015; Camacho-Vallejo & Totosaus, 2025).

Research consistently demonstrates that spatial and infrastructural factors shape these interactions. Limited transport networks, high logistics costs, and extended distribution chains constrain access and stability, particularly in geographically remote areas. Meanwhile, disparities in health services and nutrition literacy affect utilization outcomes. Studies across diverse contexts highlight the consequences of spatial mismatches between production centers and consumption zones, often resulting in price volatility and unequal access (Anggraeni et al., 2022; Chen et al., 2023; Kuai & Zhao, 2017; McClelland et al., 2025).

However, food systems are shaped not only by geography and infrastructure. Governance arrangements play a decisive role in determining how risks are identified, coordinated, and addressed (Candel, 2014; van Bers et al., 2019). In decentralized settings such as Indonesia, provincial governments typically assume responsibility for planning and interregional coordination, while district and municipal governments oversee implementation at the local level. Academic institutions and researchers contribute through analysis, evidence generation, and policy recommendations. Although these actors operate within the same policy domain, they do not necessarily perceive problems in the same way. Differences in perspective can influence how priorities are set, resources allocated, and interventions designed.

The literature on multilevel governance suggests that such differences are consequential. Divergent perceptions across administrative levels may affect coordination capacity and policy coherence (Hooghe & Marks, 2003). Effective governance requires alignment between strategic planning and operational realities (Pahl-Wostl, 2009). However, empirical studies of food security in Indonesia rarely examine how institutional perspectives across levels interact or diverge. Most existing research focuses on household consumption, village-level conditions, or composite indices such as the IKP and SUSENAS (Dewanti, 2020; Fatchiya et al., 2016; Heryanah, 2016; Sinaga et al., 2022). Consequently, limited attention has been paid to how governance dynamics themselves shape food system vulnerabilities.

This study addresses this gap by examining food security in Jambi Province through an institutional lens. Rather than focusing solely on household outcomes, it explores how provincial, district, and municipal governments, as well as academics, perceive food security across the four FAO pillars. Specifically, the study asks: How do these actors assess the conditions of availability, access, utilization, and stability? Which structural factors do they consider most influential in shaping food system performance? How do variations in institutional perception correspond to spatial patterns of vulnerability and policy priorities?

By mapping institutional perceptions onto spatial configurations, this study makes three contributions to the literature on food systems and multilevel governance. First, it advances a perception-based spatial-mapping framework that links institutional interpretation to patterns of territorial vulnerability. Rather than treating perceptual differences across governance levels as inconsistencies, the study conceptualizes them as diagnostic signals of scalar governance asymmetry. Second, the study spatializes multilevel governance dynamics by demonstrating how vertical coordination structures interact with geographically differentiated production capacity, logistical accessibility, and environmental exposure. In doing so, it moves beyond household-level or index-based analyses and situates food security within a territorially embedded governance configuration. Third, it develops a thematic spatial typology of food system vulnerability that integrates availability, access, utilization, and stability within a multilevel institutional context. This typological mapping provides a structured analytical basis for designing spatially differentiated and coordination-sensitive food policies in decentralized regional settings.

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METHODS

Research design

This study employs a mixed-methods approach to examine food security and governance in Jambi Province. The quantitative and qualitative components were conducted concurrently and integrated during the interpretation phase. The objective was not only to compare perceptions across levels of government but also to uncover structural dynamics that may not be fully captured through numerical indicators alone. By situating survey responses alongside narrative accounts, the study seeks to illuminate how food security is assessed, experienced, and interpreted across institutional contexts.

Data sources and instruments

Primary data were collected using three survey instruments developed around the four FAO pillars of food security alongside governance-related dimensions. Two instruments were designed in parallel form for provincial and district/municipal government respondents. This parallel structure enabled systematic comparison across governance levels while maintaining consistency in question framing. The instruments comprised Likert-scale items and open-ended questions addressing food supply

conditions, price stability, agricultural inputs, distribution infrastructure, access to nutritious food, and inter-agency coordination.

A separate instrument was developed for academic respondents. Rather than employing standardized scales, it consisted of open-ended questions exploring long-term structural risks, spatial inequality, institutional capacity, and governance challenges. The aim was to elicit analytical reflections rather than quantifiable perception scores. Accordingly, academic responses were excluded from the aggregation of Likert-scale data. Their contribution was interpretive rather than comparative, providing contextual and critical insights into patterns emerging from governmental responses.

Sampling

Respondents were selected purposively based on their institutional roles. At the provincial and district/municipal levels, participants included officials and technical staff directly involved in food security, agriculture, logistics, distribution, nutrition, or spatial planning. Academic participants were selected based on demonstrated expertise in food systems and regional development, as evidenced by publication records and prior research experience.

In total, 104 respondents participated in the study: 17 from provincial agencies, 81 from district/municipal agencies representing all 11 regencies and cities in Jambi Province, and six academics from three universities. Each regency and city was represented, although the number of respondents per district varied according to local institutional structures and staffing patterns. These variations reflect administrative differences rather than selective exclusion.

Given differences in institutional capacity across districts, it is possible that such variation influenced perception patterns. Rather than treating these differences as sampling bias, the study interprets them as part of the governance landscape under examination.

Data analysis

The quantitative analysis focused on responses from provincial and district/municipal governments. Frequency distributions were generated to identify patterns across indicators and to highlight areas of convergence and divergence between governance levels.

Qualitative analysis followed a thematic approach inspired by Braun and Clarke (2006). The process involved repeated reading of responses, initial coding, clustering related codes, and refining overarching themes. Narratives from provincial officials, district/municipal actors, and academics were analyzed within a shared coding framework to identify recurring structural issues and governance dynamics.

The two strands were integrated during the interpretation phase. Quantitative patterns were compared with qualitative themes using a structured integration matrix, enabling systematic examination of areas of alignment and divergence. Rather than treating inconsistencies between strands as methodological limitations, divergences were interpreted as indicators of scalar governance differences and contextual constraints.

Academic perspectives played a complementary role in this process. Although included in the thematic coding, their primary contribution was interpretive, helping to situate governmental perceptions within broader structural and theoretical contexts.

Beyond cross-level comparison, the study also developed a thematic spatial typology. Regions were grouped according to recurring combinations of structural characteristics—such as production capacity, logistical accessibility, service coverage, environmental exposure, and governance conditions—identified through iterative comparison of coded themes and regional summaries. This typology was derived not from statistical clustering but from qualitative convergence, emphasizing shared structural

patterns rather than numerical similarity.

RESULTS AND DISCUSSION

Patterns of perceptions of food security across government levels

Across the four pillars, food security in Jambi Province is generally perceived positively. Most respondents describe current conditions as adequate or relatively stable. However, beneath this broad agreement, a consistent difference in emphasis emerges across governance levels. Provincial officials tend to frame conditions more optimistically, drawing on aggregate indicators and province-wide trends. District and municipal actors, by contrast, more frequently refer to operational constraints encountered in specific localities. Academic respondents add a further dimension by highlighting longer-term structural pressures that may not be immediately visible in administrative assessments.

Food availability

Perceptions of food availability are generally positive. Across both provincial and district/municipal respondents, more than three-quarters rate food supply conditions as "fairly good" or "very sufficient" (Table 1). Provincial actors interpret improvements in the Food Security Index and the decline in food-insecure subdistricts as confirmation of strengthened availability.

Table 1. Perceptions of food availability across government levels in Jambi Province, 2025

Indicator	Perception	District/ Municipal (%)	Provincial (%)	Total (%)
Food supply conditions	Very insufficient	2.47	0.00	2.04
	Insufficient	4.94	5.88	5.10
	Sufficient	14.81	17.65	15.31
	Fairly good	46.91	41.18	45.92
	Very sufficient	30.86	35.29	31.63
	Total	100.00	100.00	100.00
Adequacy of agricultural land	Very insufficient	1.23	0.00	1.02
	Insufficient	14.81	17.65	15.31
	Sufficient	27.16	11.76	24.49
	Fairly good	30.86	52.94	34.69
	Very sufficient	25.93	17.65	24.49
	Total	100.00	100.00	100.00
Farmer access to fertilizer, seeds, and production tools	Very difficult	0.00	0.00	0.00
	Difficult	11.11	17.65	12.24
	Fairly easy	34.57	29.41	33.67
	Easy	44.44	47.06	44.90
	Very easy	9.88	5.88	9.18
	Total	100.00	100.00	100.00
Farmer regeneration	Very poor	7.41	17.65	9.18
	Poor	25.93	5.88	22.45
	Fair	34.57	47.06	36.73
	Good	24.69	23.53	24.49
	Very good	7.41	5.88	7.14
	Total	100.00	100.00	100.00

However, a closer examination of individual indicators reveals greater nuance. The most pronounced divergence appears in assessments of agricultural land adequacy. Provincial respondents tend to evaluate land conditions more positively, whereas district and municipal respondents more frequently identify limitations in productive land within their jurisdictions. Academic narratives align more closely with local-level concerns,

particularly regarding land-use conversion and increasing competition between food crops and plantation commodities.

Access to production inputs is generally described as manageable at both governance levels. Most respondents report that farmers can obtain inputs without major difficulty. Nevertheless, academic respondents caution that physical availability does not capture the full complexity of the issue. They point to recurring challenges, including rising input prices, inconsistent subsidy distribution, and weaknesses in irrigation and supporting infrastructure. In this respect, the constraint lies not solely in access per se, but in the broader conditions under which inputs are distributed and utilized.

Farmer regeneration emerges as the most fragile component within the availability pillar. District and municipal respondents express greater concern about the aging farming population and the limited participation of younger generations in food-crop agriculture. Although provincial assessments are somewhat less critical, academic accounts reinforce the perception that declining youth engagement poses a long-term risk to the sustainability of production. This issue introduces a temporal dimension to food availability: even where current supply appears sufficient, uncertainty remains regarding who will sustain it in the future.

Food accessibility

Survey responses indicate that interregional distribution is generally functioning, yet perceptions diverge across governance levels. Provincial respondents more frequently characterize flows as smooth, while district and municipal actors report greater logistical friction, particularly in inland and coastal areas (Table 2).

Table 2. Perceptions of food accessibility across government levels in Jambi Province, 2025

Indicator	Perception	District/ Municipal (%)	Provincial (%)	Total (%)
Interregional food distribution	Very not smooth	0.00	0.00	0.00
	Not smooth	8.64	0.00	7.14
	Fairly smooth	38.27	17.65	34.69
	Smooth	43.21	64.71	46.94
	Very smooth	9.88	17.65	11.22
	Total	100.00	100.00	100.00
Supporting infrastructure for food supply	Very unsupportive	2.47	0.00	2.04
	Unsupportive	12.35	5.88	11.22
	Fairly supportive	46.91	35.29	44.90
	Supportive	30.86	35.29	31.63
	Very supportive	7.41	23.53	10.20
	Total	100.00	100.00	100.00
Food price dynamics	Very unstable	3.70	0.00	3.06
	Unstable	8.64	17.65	10.20
	Fairly stable	35.80	23.53	33.67
	Stable	35.80	41.18	36.73
	Very stable	16.05	17.65	16.33
	Total	100.00	100.00	100.00
Effectiveness of inter-agency cooperation to maintain price stability	Very ineffective	11.11	5.88	10.20
	Ineffective	25.93	5.88	22.45
	Moderately Effective	40.74	41.18	40.82
	Effective	22.22	47.06	26.53
	Very effective	7.41	5.88	7.14
	Total	100.00	100.00	100.00

A similar pattern emerges in assessments of supporting infrastructure. Although most respondents consider roads, transport links, and related facilities to be generally supportive, provincial officials consistently evaluate these conditions more positively

than their district counterparts. Local-level respondents are more likely to emphasize damaged production roads, limited bridge capacity, and uneven connectivity between rural villages and urban markets. Academic perspectives identify geography as a decisive factor: mountainous terrain, coastal exposure, and long distances to distribution hubs shape how accessibility is experienced across territories.

Food price dynamics are also perceived as relatively stable overall. At both governance levels, most responses fall within the "fairly stable" to "stable" categories. Nevertheless, this apparent stability does not imply uniform resilience. Academic respondents note that certain commodities—particularly perishables such as chili, shallots, and vegetables—remain highly sensitive to seasonal fluctuations and transport disruptions. In this respect, price stability appears conditional rather than absolute.

Perceptions of inter-agency cooperation follow a pattern similar to that observed in other pillars. Provincial respondents are more likely to characterize coordination as effective, whereas district and municipal actors are more moderate in their evaluation. From an academic perspective, coordination mechanisms are in place and operational, but their effectiveness varies considerably across regions. Performance often depends on local administrative capacity and the consistency of cross-sectoral engagement.

Utilization

Regarding utilization, most respondents assess community access to healthy, nutritious food as adequate or better (Table 3). Provincial assessments are again slightly more positive, reflecting confidence in service coverage and program outreach.

Table 3. Perceptions of food utilization across government levels in Jambi Province, 2025

Indicator	Perception	District/Municipal (%)	Provincial (%)	Total (%)
Community access to healthy and nutritious food	Highly inadequate	0.00	5.88	1.02
	Inadequate	11.11	5.88	10.20
	Adequate	38.27	23.53	35.71
	More than adequate	37.04	41.18	37.76
	Highly adequate	13.58	23.53	15.31
	Total	100.00	100.00	100.00
Implementation of nutrition education programs for vulnerable groups	Very ineffective	0.00	0.00	0.00
	Ineffective	8.64	5.88	8.16
	Fairly effective	37.04	29.41	35.71
	Effective	40.74	52.94	42.86
	Very effective	13.58	11.76	13.27
	Total	100.00	100.00	100.00

However, qualitative accounts present a more differentiated picture. Access to nutritious food is unevenly distributed across population groups and territories. Coastal communities, remote villages, and low-income households face greater constraints, as do specific demographic groups such as young children, pregnant women, older persons, and individuals with disabilities. For these groups, the challenge often lies not in food availability per se, but in the interaction between purchasing power, nutritional knowledge, and access to basic services.

Nutrition education programs are generally perceived as functioning effectively. Most respondents rate their implementation as fairly effective or effective. Nonetheless, academic respondents point to variations in coverage and intensity. In certain remote areas, the number of community health volunteers is limited, and *posyandu* services do not always operate with the same regularity or capacity as in urban centers. This uneven provision suggests that utilization outcomes depend heavily on the strength of local health and education networks.

Taken together, the accessibility and utilization pillars reveal a recurring pattern: aggregate stability coexists with localized vulnerability. While province-wide indicators suggest adequacy, conditions on the ground vary according to geography, infrastructure, and institutional capacity.

Stability

Food stability is generally perceived as maintained across governance levels, with most responses clustering in the "fairly stable" and "stable" categories. However, differences in emphasis emerge among provincial, district-, and municipal-level actors. Regarding supply stability, district and municipal respondents express slightly greater confidence than provincial officials (Table 4). At the local level, stability is often associated with routine stock monitoring and regular inflows from other regions. Provincial respondents, by contrast, adopt a somewhat more cautious stance, possibly reflecting a broader awareness of interregional dependencies and exposure to external shocks. Academic perspectives reinforce the view that stability is uneven across territories. Regions with limited transport infrastructure or high logistical costs are more vulnerable to temporary disruptions, even when aggregate indicators suggest overall stability.

Table 4. Perceptions of Food Stability Across Government Levels in Jambi Province, 2025

Indicator	Perception	District/Municipal (%)	Provincial (%)	Total (%)
Supply stability	Very unstable	0.00	0.00	0.00
	Unstable	11.11	18.75	12.24
	Fairly stable	16.05	6.25	14.29
	Stable	64.2	50.00	62.24
	Very stable	8.64	25.00	11.22
	Total	100.00	100.00	100.00
Access stability	Very unstable	0.00	0.00	0.00
	Unstable	19.75	31.25	21.43
	Fairly stable	28.4	25.00	27.89
	Stable	45.68	37.50	44.39
	Very stable	6.17	6.25	6.12
	Total	100.00	100.00	100.00
Utilization stability	Very unstable	0.00	0.00	0.00
	Unstable	22.22	31.25	23.47
	Fairly stable	34.57	37.5	35.00
	Stable	38.27	31.25	37.14
	Very stable	4.94	0.00	4.39
	Total	100.00	100.00	100.00

A similar pattern is evident in assessments of access stability. Most respondents consider food access to be relatively consistent over time; however, provincial assessments are marginally more critical. Academic narratives help contextualize this difference. Household purchasing power, seasonal income fluctuations, and geographic isolation all shape the continuity of access to food. In remote or economically constrained areas, stability depends heavily on transport conditions and the resilience of local markets.

Regarding utilization stability, perceptions are again broadly positive. Respondents generally believe that the consumption of nutritious food can be sustained under normal circumstances. However, qualitative accounts indicate that such stability is conditional. In low-income households and remote villages, consistent access to diverse and nutritious diets depends on the continuity of community health services. The functioning of *posyandu*s, the availability of nutrition counseling, and the presence of trained volunteers all influence the stability of utilization in practice.

Taken together, the stability pillar reflects a recurring pattern observed across the previous dimensions: although province-wide assessments convey relative steadiness, local experiences reveal varying degrees of vulnerability. Stability, in this sense, is not a fixed condition but a dynamic equilibrium that may shift in response to logistical, economic, and environmental pressures.

Structural dynamics in food security in Jambi Province

Although the survey results portray food security conditions as generally adequate, the qualitative material reveals a more complex structural landscape. Across interviews and open-ended responses, provincial officials, district and municipal actors, and academics repeatedly identified underlying pressures shaping the food system in practice. These pressures do not always appear in aggregate indicators; yet they significantly influence the sustainability of production, access, and long-term resilience.

Structural challenges in food availability

Within the availability pillar, structural vulnerabilities persist despite favorable perceptions (Table 5). Jambi remains partly dependent on interprovincial rice supply, with surplus production concentrated in only a few areas. In deficit regions, stability hinges on distribution performance, creating exposure to logistical shocks.

Table 5. Structural factors influencing food availability in Jambi Province, 2025

Node (Theme)	Sub-node (Code)	Definition
A1. Dependence on External Supply & Rice Deficit	rice deficit; insufficient local production; interprovincial supply reliance; Kerinci surplus vs. deficits in other regions	Perception that supply stability remains fragile because external sources fulfil most food needs.
A2. Land-Use Change & Pressure from Nonfood Commodities	paddy field conversion; dominance of palm oil/rubber; nonfood expansion; declining food-crop land	Declining production capacity due to land-use shifts and the expansion of nonfood commodities.
A3. Limitations in Inputs & Production Infrastructure	limited fertilizer; high fertilizer prices; inadequate seeds; damaged irrigation; limited production technology	Technical barriers that reduce efficiency and the sustainability of agricultural production.
A4. Climate Risks & Extreme Weather	drought; floods; crop failure; changing seasonal patterns	Climate-related risks are significant factors disrupting food production stability.
A5. Human Resource Constraints & Weak Farmer Regeneration	ageing farmers; low youth interest; limited human resource capacity	Long-term threats to production sustainability due to limited farmer regeneration.

Land-use dynamics further constrain production capacity. Respondents frequently refer to the expansion of oil palm and rubber plantations, which have reduced the land allocated to food crops. In several districts, food crop farming is increasingly perceived as less economically attractive than plantation crops. Over time, this shift alters the structural balance of the agricultural landscape, limiting the long-term expansion of staple production.

Production constraints extend beyond land availability. Many respondents describe practical challenges related to inputs and infrastructure, including delays in fertilizer distribution, rising input prices, limited access to high-quality seeds, and deteriorating irrigation systems. Although these issues do not necessarily halt production, they reduce efficiency and narrow the margin of stability, particularly for smallholders with limited capital.

Climate variability introduces an additional layer of uncertainty. Droughts, flooding, and shifting seasonal patterns are increasingly cited as factors affecting crop

yields. Regions with weaker infrastructure are especially exposed, as inadequate irrigation and drainage systems amplify the impact of extreme weather events. In this context, production stability becomes closely intertwined with environmental conditions.

Demographic change also emerges as a long-term structural concern. The farming population is aging, and younger generations show limited interest in food-crop agriculture. Respondents across governance levels acknowledge this trend, although district and municipal actors express greater urgency. The issue relates more to future continuity than to current output: without generational renewal, the sustainability of food production remains uncertain.

Taken together, these themes suggest that availability in Jambi is not merely a matter of present supply volumes. Rather, it reflects a constellation of intertwined structural conditions—external dependence, land-use transformation, input constraints, climate exposure, and demographic shifts—that shape the resilience of the production base over time.

Structural challenges in food accessibility

Food accessibility in Jambi is closely linked to geography. Differences in terrain, distance, and infrastructure significantly influence how food circulates across regions (Table 6). Although distribution systems are in place, their performance varies markedly by location.

One of the most frequently cited constraints concerns road and logistical conditions. Respondents from inland, hilly, and coastal areas describe damaged village roads, limited bridge capacity, and extended travel distances to distribution centers. In such areas, food does not necessarily become unavailable; rather, it arrives more slowly and at a higher cost. Transport expenses are ultimately reflected in retail prices, placing additional pressure on households in remote communities.

Distribution structures themselves contribute to uneven accessibility. Outside urban centers, food often moves through multiple intermediaries before reaching consumers. In some regions, flows are relatively smooth and supported by established market hubs; in others, supply chains depend heavily on a single route or intermediary. When that route is disrupted—by weather events, infrastructure damage, or market fluctuations—local availability and prices quickly become unstable.

Table 6. Structural factors influencing food accessibility in Jambi Province

Node (Theme)	Sub-node (Code)	Definition
B1. Road and Logistics Infrastructure Constraints	damaged roads; difficult access; remote areas; high logistics costs	Physical and geographical barriers that slow or hinder the smooth flow of food.
B2. Long Distribution Chains and Dependence on Hubs	multiple intermediaries; stock accumulation in towns; layered distribution routes	Inefficient distribution structures that create spatial disparities across regions.
B3. Price Fluctuations Due to Supply Disruptions	production disturbances; seasonal price increases; supply imbalances	Disruptions in distribution or production trigger food price vulnerabilities.
B4. Vulnerable Groups in Food Access	low-income households; remote villages; coastal communities; young children; the elderly	Population groups with the least access to healthy, nutritious food.

Price volatility is therefore closely tied to logistical conditions. Respondents frequently mention seasonal spikes affecting perishable commodities such as chili, shallots, and fresh vegetables. Temporary disturbances in production or transport are rapidly transmitted through local markets. What appears as a price issue often reflects deeper structural characteristics of distribution and connectivity.

Accessibility is also shaped by social vulnerability. Low-income households, residents of remote villages, coastal communities, young children, and older persons are consistently identified as particularly at risk. In geographically isolated areas, higher prices and irregular supply further constrain these populations. Accessibility challenges are thus both spatial and social, arising from the interaction between infrastructure and household capacity.

Structural challenges in food utilization

The utilization pillar reveals a distinct set of dynamics centered on consumption practices and nutritional awareness (Table 7). Institutional reach plays a pivotal role in shaping outcomes.

Table 7. Structural factors influencing food utilization in Jambi Province, 2025

Node (Theme)	Sub-node (Code)	Definition
C1. Schools and Posyandu as Nutrition Education Channels	school programs; healthy canteens; posyandu; community health centers	The role of basic service institutions as primary channels for delivering nutrition messages and interventions.
C2. Changes in Consumption Behavior	vegetable consumption; healthy eating campaigns; reducing instant foods	Interventions focused on shaping healthy and sustainable dietary practices.
C3. Priority Target Groups	young children; school-age children; adolescent girls; pregnant women	Population groups requiring special attention in nutrition interventions due to high vulnerability levels.

Schools, community health centers, and *posyandu* emerge as central platforms for delivering nutrition education. These institutions maintain regular contact with families and children, providing avenues for counseling, healthy canteen initiatives, prenatal guidance, and community-based outreach. In areas where such services operate consistently, respondents report higher levels of nutritional awareness.

At the same time, respondents emphasize efforts to influence everyday consumption habits. Initiatives promoting increased consumption of vegetables and fruits, greater protein intake, and reduced reliance on instant foods and sugar-sweetened beverages are frequently mentioned. Simplified dietary frameworks, such as the “My Plate” model, are cited as practical tools for reshaping household practices. These initiatives reflect recognition that utilization depends not only on availability, but also on knowledge and behavior.

Priority target groups are clearly defined. Young children, school-age students, adolescent girls, and pregnant women are consistently identified as requiring focused intervention due to their heightened vulnerability and long-term health implications. Consequently, nutrition programs concentrate resources on these groups, particularly through school-based initiatives and maternal health services.

Collectively, the accessibility and utilization themes underscore that food security is not determined solely by aggregate supply. It is shaped by infrastructure, market organization, institutional reach, and social vulnerability. Geographic conditions influence how food moves, while educational and health systems influence how it is used.

Structural challenges in food system stability and governance factors

Stability in Jambi’s food system is shaped not only by production and distribution dynamics but also by institutional coordination, regulatory coherence, and sustained policy implementation. The qualitative findings highlight governance arrangements and territorial risks as critical determinants of long-term resilience (Table 8).

Table 8. Structural factors influencing food stability and governance in Jambi Province, 2025

Node (Theme)	Sub-node (Code)	Definition
D1. Primary Coordination for Food Governance	Food Security Office as lead; Bappeda coordination; food working groups	Perceptions of institutions holding primary responsibility for coordinating food policy and planning.
D2. Institutional and Regulatory Challenges	overlapping authorities; weak regulations; fragmented data	Cross-sector governance obstacles affecting the formulation and implementation of food policies.
D3. Financing Constraints and Program Consistency	limited budgets; project dependency	Funding constraints and inconsistent program continuity hinder the stability of food interventions.
D4. Structural Territorial Risks	flooding; coastal zones; limited infrastructure; land conflicts	Geographical and ecological vulnerabilities that heighten risks to the stability of food supply and distribution.
D5. Priority Policy Areas to Strengthen	farmland protection; distribution infrastructure; data systems; nutrition education	Policy reform priorities identified by respondents to reinforce long-term food security.

Leadership and coordination feature prominently in respondents' accounts. The Food Security Office is widely regarded as the principal agency responsible for substantive food-related matters, while the Regional Development Planning Agency (*Bappeda*) plays a cross-sectoral coordinating role. Formal and informal coordination forums—such as food working groups—are viewed as essential for aligning agencies. Stability, in this sense, depends not only on technical capacity but also on continuous institutional synchronization.

Nevertheless, coordination mechanisms do not always function seamlessly. Overlapping mandates, limited regulatory clarity, and fragmented food-related data are frequently cited as challenges. When responsibilities are dispersed without clear integration, program implementation becomes inconsistent. Weak data integration further complicates monitoring and long-term planning. Although these institutional frictions rarely halt interventions altogether, they reduce policy coherence and adaptive capacity.

Financial continuity represents another structural concern. Several food-related programs depend on short-term budgets or project-based funding. Changes in funding allocations can interrupt initiatives such as nutrition education, food reserve management, or infrastructure improvement. Consequently, program sustainability remains vulnerable to fiscal adjustments and administrative cycles. Stability is therefore closely linked to predictable and sustained financing mechanisms.

Territorial characteristics further shape governance outcomes. Flood-prone areas, coastal zones, remote villages, and regions with limited infrastructure are particularly exposed to supply disruptions and price volatility. In such contexts, institutional responses must contend with environmental and geographic constraints that intensify vulnerability. Stability cannot be disentangled from spatial context.

Respondents also identify priority areas for strengthening long-term resilience, including farmland protection, improvements in distribution infrastructure, enhanced integration of food data systems, and sustained nutrition education programs. These proposals reflect a shared recognition that maintaining stability requires structural reinforcement rather than relying solely on reactive measures.

Overall, the governance themes demonstrate that food system stability in Jambi extends beyond buffering short-term shocks. It depends on institutional clarity,

coordinated leadership, fiscal continuity, and territorial awareness. These dimensions were subsequently synthesized into a thematic spatial typology, grouping regencies and cities according to recurring configurations of vulnerability across production, access, utilization, and governance conditions.

Thematic spatial typology of the food system in Jambi Province

Integrating cross-level perceptions with thematic patterns indicates that Jambi's food system does not function as a single, uniform structure. Rather, it comprises distinct territorial configurations shaped by production capacity, logistical accessibility, service coverage, environmental exposure, and governance conditions. Through iterative comparison of qualitative themes and regional perception summaries, three broad spatial groupings can be identified.

Typology 1 – Urban and Peri-Urban Areas

Jambi City, Muaro Jambi, and Batang Hari form a cluster characterized by high population density and substantial consumption demand. These areas rely heavily on supplies from other districts and from outside the province. Although local production contributes to availability, stability depends primarily on the smooth operation of inbound distribution networks.

At the same time, service infrastructure—including schools, community health centers, and *posyandu*—is relatively well developed. Consequently, utilization indicators tend to be stronger here than in more remote regions. Governance priorities in this cluster center on coordination: maintaining price stability, ensuring consistent supply inflows, and synchronizing agencies in contexts marked by significant demand pressures.

Typology 2 – Highland Production Centers

Kerinci and Sungai Penuh represent a distinct configuration. These highland areas possess comparatively strong agricultural capacity, particularly in horticulture and fresh commodities. Several villages generate surpluses that supply other parts of the province, positioning these regions as key contributors to overall food availability.

Favorable agroecological conditions and established agricultural traditions underpin this production strength. However, climate variability introduces significant uncertainty. Changes in rainfall patterns and temperature fluctuations directly affect yields, rendering environmental exposure the principal vulnerability within this cluster. Despite these risks, utilization outcomes remain relatively robust, supported by established education and health service networks.

Typology 3 – Rural and Coastal Regions with Logistical Constraints

Merangin, Sarolangun, Tebo, Bungo, Tanjung Jabung Barat, and Tanjung Jabung Timur comprise a third grouping defined less by production potential than by infrastructural limitations. Road conditions, bridge capacity, and transport accessibility strongly influence how food circulates within and across these territories. Even where production potential exists, distribution bottlenecks constrain market integration and contribute to price disparities.

Coastal zones face additional ecological pressures, while inland remote villages experience relative isolation from major distribution hubs. Nutrition services are available but unevenly covered, particularly in geographically distant settlements. In this cluster, vulnerability arises from the interaction of logistical barriers, environmental exposure, and limited institutional reach.

Taken together, these typologies demonstrate that food system resilience in Jambi is spatially differentiated. Urban areas confront demand-driven pressures; highland regions are primarily exposed to climate-related risks; and rural–coastal regions grapple with connectivity and infrastructure constraints. Vulnerability, therefore, varies not only in intensity but also in structural configuration.

Joint integration of quantitative and qualitative findings

To integrate quantitative perception patterns with qualitative structural themes, a joint display was constructed (Table 9). This matrix links aggregate survey ratings with the thematic dynamics underlying each food security pillar.

Table 9. Joint integration of quantitative and qualitative findings across food security pillars

Pillar	Quantitative pattern	Qualitative themes	Meta-inference	Policy implication
Availability	Mostly positive ratings; provincials are more optimistic	A1, A2, A5	Perceived adequacy coexists with structural production vulnerabilities	Protect farmland; strengthen regeneration
Accessibility	Distribution rated smooth; provincial higher	B1, B2, B3	Macro-level smoothness masks local logistical constraints	Improve rural logistics
Utilization	Programs rated effective	C1–C3	Positive program assessment with uneven reach among vulnerable groups	Expand targeted nutrition outreach
Stability	Generally stable ratings	D2–D4	Stability perception alongside governance and territorial risk exposure	Strengthen coordination & risk planning
Cross-Level Governance	Provincial coordination rated higher	D1–D3	Perception asymmetry reflects vertical coordination differences	Develop integrated data & coordination mechanisms

The integration reveals a consistent pattern across pillars. While survey responses cluster within positive categories, qualitative narratives uncover structural vulnerabilities beneath these surface assessments, including supply dependence, land-use pressures, logistical constraints, uneven service coverage, and governance fragmentation.

Divergence between provincial optimism and district-level operational caution reflects differing institutional vantage points within a multilevel governance system. Rather than constituting a contradiction, these perception gaps function as diagnostic signals of scalar governance asymmetry, highlighting where coordination, information flows, and territorial conditions mediate policy implementation and shape food system resilience.

Discussion

Integrating the quantitative and qualitative findings reveals a food system that appears stable on the surface yet rests on uneven structural foundations. Across the four pillars—availability, accessibility, utilization, and stability—most respondents characterize current conditions as adequate. However, the qualitative evidence indicates that these assessments reflect present functionality rather than long-term resilience. Beneath aggregate ratings lie structural pressures that shape how the system operates across territories.

Dependence on interregional food inflows, continued conversion of food-crop land, limitations in distribution infrastructure, climate variability, and the aging farming population all constrain the durability of Jambi's food system. Although these pressures do not necessarily disrupt supply in the short term, they reduce the system's margin of safety.

A recurring pattern concerns differences between provincial and district/municipal perspectives. Provincial respondents tend to frame food conditions in relatively positive

terms, drawing on province-wide indicators and formal coordination mechanisms. District and municipal actors, by contrast, more frequently emphasize operational bottlenecks—damaged production roads, transport costs, geographic remoteness, limited budgets, and fluctuating local markets. These differences are not merely subjective variations; rather, they reflect distinct institutional positions within a multilevel governance structure.

At the provincial level, assessments are typically informed by aggregated data and cross-regional comparisons. At the district level, evaluations are shaped by direct engagement with communities and the practical constraints of implementation. Gaps in data integration, regulatory clarity, and administrative capacity further amplify this divergence. The result is a form of vertical misalignment in which planning frameworks do not always fully capture local realities. Rather than viewing these perception gaps as inconsistencies, they may be interpreted as indicators of strained or incomplete coordination.

Within the availability pillar, survey responses suggest adequate supply, yet qualitative findings point to structural fragility. Reliance on external sources, shrinking food-crop land, and weak farmer regeneration indicate that present adequacy may not translate into future security. These patterns align with previous research highlighting the risks associated with land conversion and the decline in the renewal of agricultural labor (Akmal & Mohammadi, 2025; Gultom et al., 2021; Maryati et al., 2018; Ruhf, 2015).

Logistical constraints primarily shape accessibility. Rural and coastal areas face higher transport costs and weaker connectivity, which in turn affect price dynamics and market integration. Similar relationships between logistical constraints and food access have been documented in other contexts (Bayir et al., 2022; Todorovic et al., 2018). In Jambi, distribution flows may appear smooth in aggregate, yet spatial disparities persist at the periphery of the system.

Utilization reflects a comparable pattern. Nutrition services operate relatively effectively in urban and highland areas, supported by schools, health centers, and *posyandu* networks. In more remote regions, however, coverage is less consistent, and access depends heavily on local institutional capacity. Stability, meanwhile, is closely linked to price dynamics and household purchasing power. Even when food is physically available, fluctuations in commodity prices and income can undermine effective access to it. Global evidence suggests that price volatility disproportionately affects low-income households (Mendoza, 2009; Putra et al., 2021), a pattern echoed in several districts of Jambi. Climate risks further complicate this dynamic, as flood-prone and environmentally exposed areas experience more frequent supply disruptions (Tirivangasi, 2018).

The thematic spatial typology clarifies how these pressures vary territorially. Urban and peri-urban areas confront demand-driven challenges, including dependence on external supply and sensitivity to price fluctuations. Highland regions benefit from relatively strong production capacity but remain vulnerable to climatic instability. Rural and coastal regions experience persistent logistical constraints, compounded by environmental exposure and limited infrastructure. These patterns indicate that spatial inequality in food security cannot be reduced to geographic distance alone; rather, it reflects a layered configuration of environmental risk, market structure, infrastructure quality, and institutional reach.

Spatial inequality and governance gaps appear to reinforce one another. Regions facing greater structural risks often operate with more fragmented information systems and weaker inter-agency alignment. At the same time, policies formulated primarily on the basis of aggregate provincial indicators may overlook localized vulnerabilities. When planning assumptions diverge from territorial realities, implementation gaps widen.

In this sense, food security challenges in Jambi are not solely technical or infrastructural; they are embedded in the coordination of institutions across governance levels. Perceptual divergence reflects the hybrid nature of Indonesia's multilevel governance arrangement, in which hierarchical authority coexists with sectoral and functional networks. Strengthening integration across these layers is therefore essential to reducing fragmentation and enhancing policy coherence.

The findings also carry practical implications. A uniform strategy is unlikely to address the differentiated vulnerabilities observed across typologies. Urban areas require strengthened inbound logistics, price-monitoring mechanisms, and adaptive reserve management. Highland production centers would benefit from farmland protection and climate-responsive agricultural innovation. Rural and coastal regions require sustained investment in transport infrastructure, strengthened local institutional capacity, and consistent nutrition outreach. Such differentiated approaches align with broader arguments for spatially tailored food policy (Mathenge et al., 2023; Morrison et al., 2012; Noer, 2016).

Within this multilevel framework, the provincial government occupies a pivotal role. Beyond coordination, it functions as an integrative node—aligning interregional planning, improving data integration, clarifying regulatory mandates, and facilitating cross-sector collaboration (Tang et al., 2022; Zhang & Rasiah, 2015). The effectiveness of this integrative function will determine whether perception gaps narrow over time or persist as unresolved coordination challenges.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Food security in Jambi Province appears stable in aggregate indicators, yet underlying structural vulnerabilities persist across all four pillars. Availability remains partly dependent on interregional inflows and constrained by land conversion and aging farmers; accessibility is shaped by logistical quality rather than absolute supply; utilization reflects uneven service reach; and stability is contingent on price dynamics, climate exposure, and household purchasing power.

Beyond these sectoral dimensions, a central finding concerns divergence in perceptions across governance levels. Provincial assessments tend to rely on aggregated indicators and formal coordination mechanisms, whereas district and municipal actors more frequently emphasize immediate operational constraints. This divergence reflects differences in institutional positioning rather than simple disagreement. However, when planning assumptions fail to adequately incorporate local conditions, policy alignment may weaken, and implementation gaps may widen.

The thematic spatial typology further indicates that Jambi's food system is territorially differentiated. Urban areas experience demand-driven vulnerability and heightened price sensitivity; highland regions exhibit strong production capacity but remain exposed to climate variability and land-use pressures; rural and coastal regions face persistent logistical and environmental constraints. Although these clusters are functionally interdependent, their risk configurations differ. Strengthening food security, therefore, requires governance approaches that recognize territorial differentiation rather than presuming uniform conditions across the province.

Recommendations

The findings underscore the importance of spatially differentiated policy design. In urban and peri-urban areas, priorities include maintaining consistent inbound supply flows, strengthening price-monitoring mechanisms, and enhancing urban food reserve management. In highland production centers, farmland protection, climate-responsive

agricultural innovation, cold-chain integration, and stricter land-use oversight are essential to sustaining productivity. Rural and coastal regions require sustained investment in transport infrastructure, reinforcement of village-level institutions, and consistent nutrition outreach to reduce disparities in access.

At the systemic level, the provincial government performs a critical integrative function. Aligning planning frameworks, harmonizing food-related data systems, clarifying regulatory mandates, and institutionalizing cross-level coordination mechanisms are central to reducing fragmentation. Instruments such as a Provincial Food System Master Plan, strengthened implementation of LP2B, integrated food data platforms, and formalized multilevel coordination forums could support more coherent territorial governance.

These recommendations should be considered in light of several limitations. The analysis relies primarily on institutional perceptions and does not directly capture household-level consumption patterns or lived experiences of food vulnerability. Qualitative inputs are drawn from institutional actors and may underrepresent the perspectives of vulnerable groups. Moreover, the study does not incorporate real-time price monitoring or dynamic market-flow analysis, which could provide a more granular understanding of volatility.

Future research would benefit from integrating household-level consumption data, spatial modeling of price and stock movements, and longitudinal analysis of climate impacts on production zones. Evaluating the implementation of cluster-based policies and further developing multilevel governance frameworks for food systems also represent important directions for advancing regional food security planning.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

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