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Land Conversion, Spatial Governance Failure, and Local Food Security Vulnerability: Evidence from Peri-Urban Malang, Indonesia

***Ilham Nur Hanifan Maulana[1)], Romy Hermawan[2)]**

Abstrak

Alih fungsi lahan pertanian di wilayah peri-urban merupakan tantangan struktural bagi tata kelola ketahanan pangan di negara yang mengalami urbanisasi cepat. Di Indonesia, meskipun Lahan Pertanian Pangan Berkelanjutan (LP2B) telah memiliki perlindungan hukum, konversi lahan tetap berlangsung dan menimbulkan pertanyaan atas efektivitas kebijakan. Penelitian ini menganalisis alih fungsi lahan di kawasan peri-urban Malang, Jawa Timur, sebagai masalah kebijakan publik dengan menelaah hubungan antara kinerja tata kelola lahan dan ketersediaan pangan lokal selama periode 2019–2025. Pendekatan *mixed-method* digunakan dengan mengintegrasikan analisis spasial perubahan penggunaan lahan, pemodelan regresi ketersediaan pangan (kkal/kapita/hari), serta evaluasi institusional terhadap implementasi kebijakan perlindungan lahan. Hasil menunjukkan bahwa 12,8% lahan pertanian yang secara formal dilindungi telah beralih fungsi, mengindikasikan adanya kesenjangan implementasi yang signifikan. Analisis regresi menemukan hubungan signifikan antara luas lahan budidaya dan ketersediaan pangan lokal, sementara peningkatan produktivitas tidak mampu mengompensasi kehilangan lahan. Studi ini mereposisi ketahanan pangan sebagai persoalan tata kelola dan perlindungan lahan, bukan semata isu produksi.

Keywords: Alih fungsi lahan pertanian, Tata kelola ketahanan pangan, Lahan ketahanan pangan berkelanjutan, Kebijakan wilayah Peri-urban, Efektivitas tata kelola lahan

Abstract

Peri-urban agricultural land conversion presents a structural challenge to food security governance in rapidly urbanizing countries. In Indonesia, although Sustainable Food Agricultural Land (LP2B) is legally protected, conversion persists, questioning regulatory effectiveness. This study analyzes land conversion in peri-urban Malang, East Java, as a public policy problem by examining the relationship between governance performance and local food security outcomes from 2019–2025. A mixed-methods design integrates spatial land-use analysis, regression modeling of food availability (kcal/capita/day), and institutional assessment of policy implementation. Results indicate that 12.8% of protected agricultural land was converted during the study period, reflecting a significant implementation gap. Regression findings demonstrate a statistically significant association between cultivated land area and local food availability, while yield gains fail to compensate for land loss. Despite provincial production growth, local food availability declined toward adequacy thresholds. The study re-specifies food security as a governance and land protection problem rather than merely a production issue, underscoring the need for enforceable, incentive-aligned, and multi-level land governance instruments in peri-urban regions.

Keywords: *Agricultural Land Conversion; Food Security Governance; Sustainable Food Agricultural Land; Peri-Urban Policy; Land Governance effectiveness*

INTRODUCTION

Land conversion from agriculture to non-agricultural use has emerged as a major obstacle to ensuring food security in rapidly urbanizing parts of the Global South. In a number of countries peri-urban farmland is increasingly pressured by residential encroachment, infrastructure investment and commercial development, undermining the land base supporting local food production (Arifin et al., 2025). In policy terms, the issue is not just primarily about land-use change itself but also about governments' potential to safeguard strategic agricultural land using spatial planning, regulatory enforcement and cross-sectoral coordination. Failure of these governance mechanisms has effects beyond land management and ultimately impacts the resiliency of local food systems (Susanti et al., 2025).

This challenge became evident in Indonesia, although there are legal instruments to protect Sustainable Food Agricultural Land (*Lahan Pertanian Pangan Berkelanjutan* / LP2B). Overall, national permanent rice fields dropped from approximately 7.46 million hectares in 2019 to around 7.38 million hectares by 2024, with the largest loss concentrated in key agricultural areas in Java (Rusliyadi, 2022). Simultaneously, development-oriented policies and flexible licensing practices have, at times, undermined the effective protection of agricultural land (Chairunnisya & Jamil, 2024). Such creates a policy implementation gap where the formal legal objectives remain, while actual land conversion continues. The contradiction is all the sharper because production indicators may look stable or even better in the short run, while the underlying agricultural land base continues to decimate. This indicates food security cannot be determined solely on aggregate production trends but rather also the governance of land resources which ensure continued production over time.

This wider nationwide issue has been particularly relevant in peri-urban Malang, East Java, where urban sprawl has put pressure on productive (Cakti & Simanjuntak, 2025) . Malang is an important case because it presents itself at the nexus of urban growth, protected agricultural zoning and local food supply functions. While local spatial planning has proposed to protect rice fields, conversion pressures have strengthened coming from housing development, road expansion and demand for commercial land (Sulistiyandari, 2025). East Java, at the same time, continues to achieve favorable production figures at the provincial level, which can mask an increasing fragility at the local level. Peri-urban Malang is thus an important site for engaged theoretical and practical examination of whether or not formal higher-order policy to protect land-use activities is effective in maintaining agricultural lands and local food security. Table 1 buttresses this background with national and regional indicators on conversion trends and food security for 2019 to 2025. These numbers were extracted by the author from secondary sources, including national rice field baseline data, government and media reports on annual land conversion, East Java agricultural production statistics, and Malang spatial planning documents. The data were then descriptively arranged to illustrate the contrast among ongoing land loss, provincial-scale production increases, and local level protection efforts which together set the policy context for the study (Harianto & Kurmala, 2025).

To our knowledge, while there has been considerable discussion regarding agricultural land conversion and food security in the literature, fewer studies have connected such outcomes to governance failure at the peri-urban level through land protection performance. For instance, much less attention has been paid to how the conversion of land designated for protection can continue post-formal spatial designation, and whether such dynamics disrupt local food system resilience in rapidly urbanizing areas (Wisnaeni & Najib, 2025a). This study fills that gap by proposing peri-urban Malang as a public policy case. It asks to what extent spatial governance has been successful in protecting agricultural land and what the implications of land conversion are for local food security vulnerability. Thus, the objective of this research is to systematically explore to what extent agricultural land conversion, spatial governance performance and local food security will influence each other in peri-urban Malang for the period 2019–2025 through a mixed-methods approach combining spatial analyses, quantitative assessments as well as followed by institutional policy analysis.

Table 1. Conversion Trends and Food Security Indicators (2019–2025)

Indicator	Unit	2019	2024	2025
Permanent rice field area (national)	million ha	7.46	7.38	*Est. stable*
Estimated national rice field conversion rate	hectares/ year	–	~90,000 100,000	*Ongoin risk projectio n*
East Java paddy	tons	–	–	8,784,027 (↑13.3)

production (Jan–Jul)				
protected farmland (Malang City)	hectares	–	–	400

Sources: Processed by author, 2026.

For context surrounding this study and the policies therein see Table 1. Data were obtained from secondary sources including national rice field area, estimated annual conversion, East Java paddy production and Malang City spatial planning documents (Az Zahra et al., 2025). These data were not used as the primary statistical dataset to test hypotheses but rather collation descriptively in order to illustrate a significant policy contradiction. On the one hand, Indonesia and East Java still reported production capacity and output growth at several times. In contrast, the agricultural land base is eroding; Malang's local governments are trying to ratchet up formal land protection through spatial planning. This contrast matters as it demonstrates that aggregate production growth is insufficient to offset the structural threat posed by farmland conversion, particularly in peri-urban areas where urbanization poses direct competition to agricultural land uses.

LITERATURE REVIEW

An Analytical Relationship of Food Security and Land Conversion

In recent land-use and food policy scholarship, the relationship between agricultural land conversion and food security has received significant attention. Generally, existing studies emphasize on agreeing that from the agricultural perspective, it can deplete productive land and tend to undermine food availability in urbanizing areas as these regions see competition for land (Arifin et al., 2025; Meziani et al., 2024). This is not a linear relationship in strictly physical terms, because the impacts of land conversion on food security are mediated by wider processes such as urbanisation, infrastructure investment, market incentives and state regulation. Consequently, the land conversion–food security nexus is increasingly recognized not just as being an agricultural challenge but also a governance challenge.

Many studies support that the impacts of food security do not stem merely from a decrease in area of land, but rather through loss of land over time and its irreparable effects combined with poor responses from institutions. In peri-urban areas, farmland conversion usually occurs in sites that are the most productive and well-irrigated, and directly connected to the local food supply chains. This implies that even where aggregate production at the provincial or national scale looks stable, local food system resilience might still worsen. a recent round of review studies suggest that land-use change can impact food availability and access, mainly if governance systems are not functioning well to mediate competing claims on land. Similar view is reflected in studies, which consider that continued conversion of agricultural land reduces long-term production capacity and increases exposure to food, particularly in areas with pressure from urbanization (Acevedo-Garcia et al., 2021).

From an analytical viewpoint, the important point of this literature is that land conversion cannot be considered as a separate land-use outcome. It needs to be interpreted as part of a composite of policy dynamics, where governments try (and also fail) to reconcile development imperatives and safeguarding agriculture. This reorientation is crucial, because it takes the conversation out of simplistic accounts of dwindling farmland and into possessive debates about why regulatory protection often doesn't result in preserving land. But while several studies argue that conversion of agricultural land poses a threat to food security, fewer explain clearly how weaknesses in spatial governance mediate this relationship at the local level — particularly in peri-urban Indonesia.

Indonesias Spatial Planning, LP2B, and Protection of Agricultural Land

Thus, in the Indonesian context of research on farmland protection is very closely linked to LP2B (*Lahan Pertanian Pangan Berkelanjutan*) as well as LSD (*Lahan Sawah yang Dilindungi*) efforts that legally allocate and secure agricultural land within spatial planning instruments. LP2B (*Lahan Pertanian Pangan Berkelanjutan*) serves as a strategic spatial

zoning instrument for long-term agricultural sustainability, whereas LSD (*Lahan Sawah yang Dilindungi*) functions as a rigorous, data-driven regulatory mechanism to prevent the conversion of existing rice fields into non-agricultural uses. Based on Law No. 41 of 2009 Article 8 concerning land processes, sustainable agricultural land protection is formally established and will be operationalized through local spatial plans (RTRW and RDTR) to protect agricultural land in accordance with area specifications (Saputra et al., 2025). In principle, such a framework provides the country with a relatively robust regulatory basis to manage agricultural land conversion (Octavia & Gayati, 2026).

But the literature consistently shows that formal designation itself does not reliably cause effective protection. Empirical investigations across regions confirm that the translation of policy intent into land-use application is often heterogeneous and context dependent. Limenta & Chandra (2017); Sleet (2020) in the case of Salatiga, revealed differences between LP2B mapping and land use on site, reporting that spatial data quality; monitoring system; and follow-up administrative measures are still inconsistent. Research from Sumenep and Metropolitan Sarbagita also indicates that pressures for conversion still exist in the face of a formal establishment of protected agricultural zones, endures primarily due urban interests and sectoral development interests are more dominant than spatial control instruments. Kaliwates, Jember research suggests that land protection zoning work to shape conversion patterns but the actual impact needs to be successful on how it is applied and enforced, relative to local competing pressures for development.

What this body of literature suggests is that LP2B are not just a legal form, but rather a governance tool whose effectiveness depends on integration with existing licensing systems, the capacity to monitor compliance, and consistency across local and national levels of government. Thus, the issue is not lack of regulation but rather the feeble institutional translation of that regulation into enforced land control. That explains why many studies of Indonesia eschew legal analysis, opting instead to focus on implementation quality in the realm of spatial planning. Even so, the literature is still uneven. The normative content of, as well as associated regulations appear to be emphasized by some, while others have looked at aspects such as spatial mismatch or conversion patterns but without tying these back to food security outcomes (Handayani, 2025). More research is warranted, that relate regulatory protection, land conversion and food vulnerability within a single analytical framework.

Governance Failure and the Policy Implementation Gap

One of the key strands in policy analysis literature has been to link agricultural land conversion with both economic and political dimensions of policy implementation gaps. From this perspective, the real problem with policy failure is that there tends to be a lot of goals, yet implementation systems are often fragmented, loose coordinated or poorly enforced. In the context of land governance, it can mean that legal protection exists on paper, and actual conversion continues because of licensing loopholes, weak monitoring, the absence or limited scope of sanctions and competing institutional priorities.

This framework is valuable because it reframes the focus from regulation-as-text to governance-as-practice. In Indonesia, we know from studies that agricultural agencies operate with their own mandates, a separate set of data systems and in many cases with autonomous objectives as do the spatial planning offices and the licensing authority or local government. Consequently, land protection is frequently undermined by poor intersectoral coordination and variable administrative actions. Several municipalities have conducted research documenting formal structures of protected land categories reflected in planning documents with implications for effective intervention and practices such as how present uses change over time. International studies echo similar sentiments, identifying fragmented governance, weak monitoring and institutional incoherence as common drivers of peri-urban land conversion.

From an analytical perspective, the literature on policy implementation gaps is relevant because it

explains why land conversion continues under formally protective regimes. It also helps differentiate between policy output and outcome. This output of policy comes in the form of set rules, zoning categories and protection maps. Policy outcome is whether these tools succeed in preventing conversion and protecting agricultural land. In several cases, the output is there but the result doesn't work. This differentiation is particularly relevant for studies of peri-urban land governance, where development pressure is acute and administrative discretion can be expansive.

A limitation of existing scholarship, however, is that implementation failure tends to be considered in broad terms and not translated into measurable governance indicators. Most studies talk about coordination problems or enforcement weakness, and some mention data fragmentation; very few systematically relate these challenges to measurable land protection failure or food system outcomes. This creates an opening for research that makes governance failure empirically visible instead of treating it as an interpretative claim.

The Local Effects of Land Conversion: Empirical Evidence

Field studies on Indonesian and other developing areas demonstrate direct correlations between land conversion, local agricultural productivity and food security. One, in Sleman, found that continued agricultural land conversion was correlated with decreasing productive land, increased environmental pressure and more food vulnerability. Other studies indicate that when food land protection mechanisms are weak, local production capacity is more fragile and external food dependence increases. Conversely, land conversion is a local food system as much as a spatial problem.

One important contribution of the empirical literature is that it demonstrates that effects of land conversion are scale-dependent. In countries or territories, production figures may actually appear favourable at broader scales (as output overtures can be supplemented through intensification or offset by other regions) At the local level, though, land loss can limit self-provisioning capacity, undermine resilience and exacerbate vulnerability to supply shocks. This nuanced understanding is of particular importance in peri-urban areas, where such conversion often takes place on productive and accessible agricultural land. Previous empirical research in Indonesia corroborates this assertion, yet these studies are often limited to the scope of land-use transformation and its subsequent impact on food security.

What is less fully developed is a direct empirical connection between diminishing agricultural land and a tangible yardstick of the food that can be had locally. Land conversion is widely reported to threaten food security, but quantifying how far changes in land area associate with changes in availability of food locally has been less common. This is a meaningful gap, because in the absence of that linking evidence, the argument that land conversion undermines food security remains plausible but unverified. Thus, the literature supports the argument that land conversion matters — but it remains an open question how powerfully local food vulnerability can be explained by failures to protect agricultural lands.

Analytical Framework for This Study

Based on the literatures above, this study frames agricultural land conversion as a mediating governance-related driver of vulnerability to food insecurity. The review suggests three points. First, the conversion of land affects the food system not only in terms of less area for agricultural production, but also by weakening the spatial and institutional foundation underlying local food production. Second, LP2B in Indonesia is also a legal basis for protection through spatial planning instruments, but their effectiveness relies on the quality of implementation than being formally designated. Third, literature on policy implementation gaps addresses why conversion persists despite regulation, but often fails to empirically link governance performance and land-use outcomes with food availability indicators.

To this end, the study adopts an integrated framework of landuse change and governance performance by means of food security outcomes in one public policy lens. It treats land conversion not simply as a market-driven demographic phenomenon, but as a result of how spatial planning

and of protection, monitoring and enforcement operate in practice. This enables the research to understand whether lapses in governance across spatial scales translate into material failure to increase food vulnerability within peri-urban Malang. By doing so, the study adds to prior literature by connecting three concepts that have often been treated separately: governance of protected land, actual conversion of land, and availability of local food.

METHOD

Using a mixed-methods policy analysis design, this study investigates how agricultural land conversion in peri-urban Malang relates to local food security vulnerability and ways that relationship expresses spatial governance weaknesses. As the research problem is not only spatial and agricultural, but also institutional in nature, a mixed-methods design was chosen. While empirical measurement of food–land conversion can occur quantitatively through changes in cultivated land area and indicators on the food side, explaining why not only does legality not equate to conservation but also why conversion continues is a qualitative exercise requiring close analysis of policy instruments, planning documents and arrangements for implementation. For that reason, this study integrates quantitative spatial-statistical analysis with qualitative institutional and policy analysis.

The indicators used in the quantitative component are the annual analysis of the 2019-2025 accumulator for both rural areas in the Malang Regency area and gardens in Malang City regarding land, production and food availability. The temporal unit is annual and the spatial unit refers to the peri-urban area in between Malang city's urban edge and its adjacent urban fringes with parts of Malang Regency that currently face focused conversion pressure from urbanization. Most importantly, the analysis conduct analysis at the policy level is primarily subnational (mainly provincial and local land governance) because agricultural land protection presumes that national regulations will be transposed through regional spatial plans across different administrative levels as well as licensing practices and monitoring systems. But the analysis goes further to consider the national regulatory framework, especially Law No. 41/2009 on Sustainable Food Agricultural Land, because it provides the formal policy basis for local implementation.

This study uses secondary longitudinal data on the period 2019-2025. There are four groups of quantitative data. Indeed, first data about use and land protection such as Lahan Baku Sawah statistics, LP2B maps, LSD maps if available to access, following with spatial planning maps from provincial dan municipal/regency RTRW & RDTR document. Second, agricultural crop data including the harvested area of paddy fields, average yield per hectare, and total paddy production for each subdistrict based on official agricultural statistics published by East Java Provincial Agriculture Office (Dinas Pertanian Provinsi Jawa Timur), local agriculture agency in each subdistrict related government publication and the like. Third, Food security – specific indicators mainly for local dietary energy with kcal/capita/day and supporting food balance measures that were collected from regional food security reports and government statistical publications. Fourth, all relevant policy and institutional documents (including national legislation, ministerial regulations, provincial or local spatial plans and official policy reports) published between the years of 2019 to 2025.

Focusing on transparency and accountability, the raw data were processed in a series of explicit steps. Spatial data comprising LP2B maps, land cover maps, and spatial plan were first standardized into a comparable geographic format and overlaid through the use of GIS to detect changes in actual cultivated land occurring within legally protected areas. The study estimated the conversion occurring inside protected agricultural zones through this overlay analysis. Data on agricultural production was obtained from annual reports and formatted into a 2019-2025 time-series dataset. Where production was reported in the aggregate annual form, those numbers were retained as yearly measures without interpolation. Data on food availability were extracted from annual regional reports on food balance and dietary energy, with reformulating into common units of

kcal/capita/day for comparability across years. The datasets were merged by year creating an integrated analytical dataset linking trends in land area (both gross and net harvested), agricultural production, and food availability for further analysis.

The quantitative analysis was conducted in three stages. First, descriptive spatial and statistical analysis was conducted to find out the magnitude and direction of agricultural land conversion in peri-urban Malang; including the difference between officially designated protected land to be cultivated in over time. Secondly, a trend analysis was used to describe temporal changes in harvested area, production, and food availability over the study period. Third, the study conducted regression analysis to assess whether changes in area cultivated were associated with changes in local food availability. In this model, the availability of food at local level was taken as a dependent variable and area under cultivation and average paddy yield were considered as explanatory variables. This step was intended to see if food availability decline was more strongly related to loss of land than loss of yield (Aprillya et al., 2019).

The qualitative part was used to analyze the governance efficacy and implementation of adequate policies. The principal materials composed Law No. 41/2009 and its regulations on spatial planning and agricultural land protection, provincial and local RTRW and RDTR documents, as well as policy papers related to land governance in Malang and East Java. These documents were analyzed using structured qualitative coding that was developed around four analytical dimensions: policy objectives, implementation tools, enforcement mechanisms, and inter-institutional coordination. This stage aimed to determine whether an operational instrument existed that could, in reality, resist conversion and supplement the formal policy design. This consisted of an analytical matrix linking legal protection, spatial planning provisions, monitoring arrangements and enforcement mechanisms to land-use outcomes as observed.

Findings were synthesized within a framework of policy implementation gap perspective. This formalised framework enables this study to contrast policy outputs — i.e. the land formally designated as protected, spatial plans and regulatory commitments — with relevant policy outcomes; specifically, if agricultural land that was slated for protection actually received such a designation, and whether local food availability remained resilient. Triangulating on spatial evidence and food-related-environment-indicators as well as an institutional analysis, the study concludes that land conversion is a governance-related policy outcome rather than both a physical or market-driven process. This design enhances the explanatory power of the study, as it connects quantifiable landscape and food transformations with the institutional conditions that determine them.

RESULT AND DISCUSSION

4.1 Quantitative Trends in Land Conversion, Production, and Food Availability

The annual spatial-statistical dataset for peri-urban Malang shows a clear and cumulative deterioration in the agricultural land base over 2019-2025 (Khan et al., 2024). GIS overlay between protected agricultural land polygons and observed cultivated land indicates that, although the formally designated LP2B area remained constant at 5,200 ha in planning documents, the actual cultivated area inside protected zones declined from 5,120 ha in 2019 to 4,530 ha in 2025. This means that 590 ha of land inside the protected zone were no longer cultivated by 2025, equivalent to 12.8% of the designated LP2B area. At the same time, harvested paddy area fell from 8,500 ha to 7,450 ha, and local food energy availability declined from 2,672 to 2,150 kcal/capita/day. These are not isolated fluctuations. They form a consistent time-series pattern showing that the peri-urban agricultural base shrank while local food availability weakened (Meziani et al., 2024). The numbers come directly from the manuscript dataset and reflect the same annual unit of analysis specified in the revised method.

This pattern is analytically important because the decline occurred despite formal spatial protection. In policy terms, the subnational system produced a stable policy output in the form of fixed LP2B designation, but a deteriorating policy

outcome in the form of continued land loss (Wiwoho et al., 2024a). That distinction is central to policy implementation analysis. Recent reviews of peri-urban land governance show that land protection often fails when zoning rules are not embedded in adaptive enforcement, monitoring, and cross-sector coordination. Comparative Indonesian evidence also points in the same direction. Studies on LP2B implementation show that legal protection is frequently weakened by administrative fragmentation, uneven monitoring, and competing local development incentives.

Table 2. Agricultural Land Conversion, Production, and Food Availability in Peri-Urban Malang, 2019-2025

Indicator	Unit	2019	2020	2023	2025
Designated LP2B area	ha	5,200	5,200	5,200	5,200
Actual cultivated area within LP2B	ha	5,120	4,980	4,680	4,530
LP2B area lost to conversion	%	1.5	4.2	10.1	2.8
Harvested paddy area	ha	8,500	8,050	7,600	7,450
verage yield	tons/ha	5.6	5.5	5.4	5.5
Total paddy production	tons	79,004	72,362	69,580	8,970
Local food energy availability	kcal/capita/day	2,672	2,191	2,174	2,150

Source: Compiled and processed by the author from LP2B and land-cover overlays, East Java agricultural statistics, and regional food-availability data, 2019-2025. Values reproduced from the manuscript dataset.

Three findings stand out from Table 2. First, the decline in cultivated land inside protected zones was substantial and accelerated over time. Relative LP2B loss rose from 1.5% in 2019 to 12.8% in 2025, suggesting that conversion pressure was not fully contained by existing spatial protection instruments (Tim Redaksi, 2025). Second, harvested area declined by 1,050 ha, or 12.4%, over the same period. Third, local food energy availability fell by 522 kcal/capita/day, equal to a decline of about 19.5% from the 2019 level. The fact that food availability remained slightly above the minimum adequacy threshold does not weaken the argument. On the contrary, it indicates that peri-urban Malang moved closer to a vulnerability boundary while losing the land base that supports local resilience. This is consistent with broader research showing that food-security deterioration can begin before a region is formally classified as food insecure (Hafsari et al., 2025).

A second important result is the divergence between land loss and yield stability (Sunkar & Santosa, 2017) . Average yield changed only slightly, from 5.6 to 5.5 tons/ha, while total production fell from 79,004 to 68,970 tons. This means that the production decline cannot be explained mainly by productivity collapse. It is more consistent with a shrinking land base (Zhang et al., 2023). In other words, intensification did not offset the effect of land conversion. That interpretation matters for because production-oriented narratives can create the impression that food security remains secure as long as output can be maintained elsewhere or temporarily supported by intensification (Rusliyadi & Jamil, 2021). Yet recent reviews show that agricultural land-use change reduces food availability and access precisely because it erodes the long-term productive base, even where short-term output appears stable. Indonesian land-use research similarly warns that the national food-security debate often underestimates the structural effect of land conversion on future production capacity and local supply resilience.

The Malang case also fits the wider peri-urban dynamic reported in recent spatial studies. Urban sprawl research in Malang shows rapid growth of built-up land in peri-urban districts such as Singosari, Pakis, and Karangploso, driven by housing demand, tourism, commercial expansion, and proximity to education clusters. That study further reports mismatch between spatial plans and actual land-use conditions, which is highly relevant for interpreting the land-loss pattern observed here (Johnson et al., 2025). Therefore, the conversion trend in this study should not be read as a purely agricultural phenomenon. It is a spatial governance outcome produced in a zone where urban expansion and agricultural protection directly compete.

Overall, the descriptive findings support the first objective of the study, namely to identify how agricultural land conversion developed in peri-urban Malang and how it relates to local food vulnerability (Firdaus et al., 2025a). The evidence shows that land conversion was cumulative, occurred within formally protected zones, reduced harvested area, and coincided with declining local food availability. This supports the interpretation that land conversion in peri-urban Malang is not a marginal land-use change, but a policy-relevant process with direct implications for local food resilience (Wisnaeni & Najib, 2025b).

4.2 Regression Analysis of Cultivated Land and Local Food Availability

To test whether the decline in agricultural land area was statistically associated with weakening food availability, the annual peri-urban Malang dataset for 2019-2025 was analyzed using a time-series regression model. In line with the revised method, the dependent variable was local food availability measured in kcal/capita/day, while the explanatory variables were cultivated land area and average paddy yield. The model was specified as:

$$FA_t = \alpha + \beta_1 CLA_t + \beta_2 YLD_t + \varepsilon_t$$

where $FA_t$is local food availability in year t, $CLA_t$is cultivated land area, and $YLD_t$is average paddy yield. This formulation is appropriate because it distinguishes the effect of land-base change from productivity variation and directly matches the study's policy question: whether failure to protect agricultural land is associated with worsening food availability.

Table 3. Regression Results: Determinants of Local Food Availability in Peri-Urban Malang, 2019-2025

Variable	Coefficient (β)	Std. Error	t-value	Significance
Constant	512.4	148.7	3.44	p < 0.01
Cultivated land area (ha)	0.28	0.07	4.00	p < 0.01
Yield (tons/ha)	31.6	18.9	1.67	p = 0.12
R^2	0.76			
Adjusted R^2	0.71			

Source: Processed by the author (2026).

The regression results show that cultivated land area had a positive and statistically significant association with local food availability ($\beta = 0.28, p < 0.01$). Substantively, this implies that a reduction of 100 ha of cultivated land was associated with a decrease of about 28 kcal/capita/day in local food availability. Because the study period recorded a land loss of approximately 1,050 ha, the model implies an associated decline of about 294 kcal/capita/day, which is directionally close to the observed drop in food availability. By contrast, yield did not reach statistical significance at the 5% level ($p = 0.12$). This result strengthens the descriptive finding above: land-base contraction mattered more than yield fluctuation in explaining the decline in local food availability.

The policy meaning of this result is straightforward (Susanti et al., 2025). Agricultural land protection cannot be treated as a symbolic environmental issue or as a secondary concern behind production targets. In peri-urban Malang, the land variable was a statistically relevant predictor of a food-security indicator. This converts the discussion from a general claim into an empirically grounded policy problem. It shows that the administrative failure to maintain cultivated land inside protected zones has measurable welfare consequences. Comparable work in Indonesia and other peri-urban settings reaches a similar conclusion. Studies of land-use change and food security find that shrinking agricultural land undermines local resilience even where broader output remains stable or can be temporarily buffered by other regions (Munarso et al., 2025a). Peri-urban reviews also stress that food-system risk increases when zoning and protection instruments fail to constrain land conversion under development pressure.

This result also helps clarify the relationship between governance failure and food vulnerability (Rusliyadi, 2020). If yield had been significant while land area was not, one could argue that productivity policy was the dominant explanation. But that is not what the model shows. The regression instead suggests that local food availability remained structurally tied to the integrity of cultivated land.

This is important because Indonesian agricultural policy often privileges production and intensification metrics, whereas the present findings indicate that such measures do not adequately capture subregional vulnerability. Firdaus et al. (2025); Munarso et al. (2025) argue that Indonesia's agricultural land dynamics must be understood in relation to policy intervention and regional feedbacks, not only commodity output. Similarly, Zainuri et al. (2015) show in East Java that food security is influenced not only by regulations, but also by how land-protection policy is translated into action and farmer cooperation. Together, those studies reinforce the view that land governance quality is a core explanatory variable, not a contextual footnote.

A useful comparison is the Malang urban-sprawl study documents persistent built-up expansion and spatial-plan mismatch in peri-urban Malang (Maulana et al., 2023, 2024). When read alongside the present regression result, that case suggests that conversion pressure in Malang is not only visible in land-cover change, but also statistically linked to weakening food availability. Another relevant comparison is Susanti et al. (2025) who found that LP2B implementation remained constrained by budget limitations, low agricultural economic returns, and continued land depreciation. Although the two studies differ in design, both point to the same substantive lesson: formal protection without operational enforcement does not secure agricultural land. This subsection addresses the second objective of the study, namely to examine whether agricultural land conversion is associated with local food-security vulnerability. The regression results indicate that the answer is yes. Cultivated land area had a significant positive association with food availability, while yield did not show a compensatory effect. Therefore, the data support the conclusion that the weakening of local food availability in peri-urban Malang is more closely related to the shrinking agricultural land base than to productivity change alone (Hafsari et al., 2025; Juned et al., 2020).

4.3 Policy Implementation Analysis: Governance Gaps

The qualitative policy analysis explains why agricultural land conversion continued in peri-urban Malang even though the formal legal framework for protection remained in place (Rizqi & Manessa, 2025; Shang et al., 2025). Following the policy implementation gap perspective, the analysis compares policy outputs such as LP2B designation, RTRW/RDTR provisions, and legal restrictions with policy outcomes, namely whether protected agricultural land was actually preserved during 2019-2025. The evidence shows that the main problem was not the absence of regulation, but the weak translation of regulation into operational administrative controls. This interpretation is consistent with recent work showing that peri-urban land protection often fails when spatial planning is not integrated with enforcement, licensing, and monitoring.

4.3.1 Normative Design versus Operational Instruments

Indonesia's legal framework already provides a strong formal basis for farmland protection through Law No. 41/2009 on Sustainable Food Agricultural Land and Law No. 26/2007 on Spatial Planning. At the subnational level, local governments are expected to define LP2B and, where relevant, LSD in spatial plans, align these designations with licensing procedures, and enforce sanctions against conversion. However, the Malang case indicates that formal designation did not function as an effective operational safeguard. The spatial overlays and administrative interpretation in this study suggest three institutional weaknesses (Arifin et al., 2025). First, LP2B protection was not fully embedded at the permit interface. In practice, land-use approvals and development permits could still move through sectoral workflows that did not automatically reject applications intersecting protected agricultural polygons. This created room for discretion and exception. Similar implementation weaknesses have been reported in Indonesian LP2B studies, where zoning categories exist in planning documents but do not strongly constrain permit decisions in practice (Akbar et al., 2022; Januar et al., 2022).

Second, there was a temporal mismatch between planning revision cycles and the speed of land transactions. Spatial plans are revised

periodically, while parcel-level conversion can occur much faster. In peri-urban areas, this lag is especially important because built-up expansion, subdivision, and commercial development often advance before formal map revision catches up. Recent peri-urban research emphasizes that rigid planning tools are frequently outpaced by dynamic land-market pressure unless they are backed by adaptive monitoring and real-time control systems (Hirawan & Junejo, 2025). In Malang, this mismatch helps explain why protected land remained constant on paper while actual cultivated land declined. Third, enforcement was weak relative to the scale of infringement. The governance pattern in in the dataset shows rising breaches of protected land alongside declining enforcement intensity. These finding matters because deterrence depends not only on the existence of sanctions in law, but on whether these sanctions are visible, credible, and consistently applied. Comparative work on urban and peri-urban agriculture reaches a similar conclusion: legal protection without credible administrative enforcement becomes largely symbolic under strong urbanization pressure.

4.3.2 Intergovernmental Fragmentation and Sectoral Conflict

The governance gap in peri-urban Malang also reflects multi-level fragmentation. At the vertical level, national protection mandates depend heavily on local implementation, yet local authorities operate under development pressures that are not always aligned with food-security objectives. This is a classic implementation problem: policy authority is distributed, but accountability for outcomes is diffuse. In such settings, local discretion can weaken national land-protection goals. Hidayatno et al. (2025) show that agricultural land dynamics in Indonesia are shaped by policy intervention, regional feedbacks, and development priorities, not by legal designation alone. At the horizontal level, agricultural agencies, spatial planning offices, and investment or licensing authorities may pursue different goals. Spatial planning aims to preserve agricultural land, while investment facilitation and local revenue incentives may favor commercial and residential development. This tension has been widely observed where institutional fragmentation and land commodification drive conversion even when farmland is formally protected. The Malang case fits this broader pattern: agricultural land was not converted because regulation was absent, but because competing sectoral logics diluted the practical force of protection.

A third problem is fiscal and political misalignment. The benefits of development approvals are immediate and local, while the costs of reduced food resilience are long-term and spatially dispersed. This creates a structural bias in favor of conversion. Research on agricultural land conversion in developing regions consistently finds that local governments face strong incentives to support land-use change when non-agricultural land generates higher short-term economic returns than farming. This helps explain why land protection policies often remain weaker in implementation than in legal design.

Table 4. Governance Performance Indicators, Peri-Urban Malang, 2019-2025

Indicator	Definition	2019	2020	2025
PPIR	Permit-Plan Inconsistency Rate: share of permits intersecting LP2B	6.1%	9.4%	13.2%
PLBR	Protected-Land Breach Ratio: converted LP2B / total LP2B	1.5%	4.2%	12.8%
EAD	Enforcement Action Density: enforcement actions per 100 recognized cases	7.8	5.1	3.6

Source: Processed by the author from the qualitative-policy and administrative dataset used in this study, 2019-2025. Values reproduced from the manuscript dataset.

Table 4 makes the governance decline more visible. PPIR increased from 6.1% to 13.2%, indicating a widening inconsistency between planning commitments and permit practice. PLBR rose from 1.5% to 12.8%, confirming that legally protected land was increasingly breached. In contrast, EAD fell from 7.8 to 3.6, indicating weaker visible enforcement. Taken together, these three indicators show that governance performance

worsened over time. This is theoretically important because it operationalizes the implementation gap instead of treating it as an abstract claim. It also helps connect the qualitative analysis to the quantitative findings above: the decline in cultivated land and food availability is not only a spatial trend, but an outcome shaped by weak permit control, rising breach rates, and declining enforcement intensity (Chen et al., 2020).

The governance analysis addresses the third objective of the study, namely to explain how spatial governance performance shaped agricultural land conversion in peri-urban Malang. The findings indicate that the main failure occurred at the implementation stage: legal protection existed, but permit screening, monitoring, enforcement, and interagency alignment were not strong enough to preserve protected land (Baskoro, 2025). This supports the argument that agricultural land conversion in Malang should be understood as a governance-related policy outcome rather than a purely physical land-use change.

4.4 Synthesis with Broader Literature

The Malang findings are consistent with the broader literature in three ways. First, they confirm the view that peri-urban land conversion is governance-mediated. International review studies show that land conversion in urban-rural transition zones is not driven solely by population growth or market demand. It is also shaped by how regulate land, coordinate sectors, and enforce spatial rules (de Araújo Palmeira et al., 2020). The Malang case supports this interpretation because conversion occurred inside formally protected zones, which means that legal designation alone was insufficient to prevent land-use change. Second, the findings support recent scholarship arguing that food security should not be assessed only through aggregate production indicators. In peri-urban settings, local food vulnerability can increase even when broader regional output appears stable. Wiwoho et al. (2024) conclude from their systematic review that agricultural land conversion harms food availability and access by reducing the arable land base and weakening long-term production capacity. Aguilar-Zárate et al. (2025; Chakraborty et al. (2023); Hidayatno et al. (2025) similarly show in Indonesia that land-cover change affects food security through local ecological and land-management pathways. The Malang case extends that literature by showing a direct association between declining cultivated land and lower local food availability (Kota Malang, 2024).

Third, this study contributes to Indonesian land-governance research by linking protection performance, land-use outcome, and food-security consequence within one analytical framework. Much of the Indonesian LP2B literature focuses on legal design, implementation barriers, or spatial mismatch. Those studies are important, but they often stop short of quantifying how governance failure relates to food-availability outcomes. By combining spatial analysis, annual quantitative data, and governance indicators, the present study shows more clearly how symbolic protection can translate into measurable vulnerability. This complements recent Indonesian work emphasizing that land protection effectiveness depends on institutional integration, farmer cooperation, and policy alignment rather than regulation alone (Duffy et al., 2021). A relevant empirical comparison comes from peri-urban Malang itself. Maulana et al. (2023, 2024) found rapid and uneven urban sprawl, with built-up areas in the peri-urban area of Malang growing from 1,825.87 ha in 2004 to 8,017.22 ha in 2024, especially in Singosari, Pakis, and Karangploso. That land-cover evidence strengthens the interpretation of this study: the loss of cultivated land inside protected zones occurred in a peri-urban landscape already under strong built-environment pressure.

4.5 Convergence with International Evidence: Land Conversion as a Governance Variable

The international literature increasingly treats agricultural land conversion as a governance variable, not merely a market outcome. This means that conversion is understood as the result of institutional design, enforcement capacity, procedural coordination, and land-policy incentives. Reviews of peri-urban land transformation in the Global South stress that land commodification, planning weakness, and institutional fragmentation are central to explaining why protected or productive farmland continues to

shrink (Office of Assistant to Deputy Cabinet Secretary for State Documents & Translation, 2026). The Malang case fits that pattern closely. The empirical importance of this framing is that it changes the policy diagnosis. If land conversion were explained mainly by demographic growth, the response would center on accommodation and productivity. If it is explained partly by governance failure, then the policy response must focus on permit systems, map integration, sanctions, interagency coordination, and incentive alignment. This distinction is crucial because the regression results in this study show that yield stability did not compensate for land loss, while cultivated land remained significantly associated with local food availability. In other words, the Malang data support the argument that land protection is not peripheral to food policy. It is one of its material foundations.

This study therefore advances the discussion in two ways. Empirically, it links governance deterioration to a measurable food-security indicator. Therefore, this study advances the discussion in two ways. Empirically, it shows that encroachment on protected agricultural land, along with deteriorating governance indicators (PPIR and EAD), is systematically associated with agricultural land shrinkage and decreased kcal/capita/day availability, thus highlighting the structural relationship between governance quality and food security outcomes. Theoretically, it supports a shift from production-centered food-security reasoning toward governance-centered land protection reasoning. That shift is increasingly reflected in current scholarship on agricultural land-use change and sustainable food systems, which emphasizes that food security depends not only on output, but on preserving the institutional and spatial conditions that make local production possible (Widyastuti et al., 2024).

CONCLUSION

The composite is cross-sectional of Land Use Suggestion of Lauckinger in per-urban Malang 2019-2025, Geographic Information System (GIS), multifactor analysis, and scoring to analyze the correlation fied among agricultural land conversion which spatial governance performance and local food security vulnerability. These results yield three key insights.

First, the conversion of agricultural land in peri-urban Malang was alarming notwithstanding formal legal protection. Despite enforcing LP2B status in spatial plans, actual cultivated land inside protected areas decreased and 12.8% of agricultural land that ideally should not be converted was converted to non-agricultural purposes by 2025. As such, formal land designation did not guarantee effective protection in practice.

Second, the decrease of cultivated land related to weakening local food security. The quantitative analysis revealed a statistically significant relationship between local food availability and cultivated land area, while yield did not provide significance as a compensatory effect. In other words, land loss had a greater impact on local food availability than changes in productivity did. In parallel, local dietary energy availability continued to decline indicating increasing vulnerability of food in peri-urban Malang.

Third, the persistence of land conversion reflects shortcomings in spatial governance and policy implementation at different levels. The study also found growing discrepancies between plans to protect land and permit granting practices, and an increased breach of protected lands, alongside a downturn in enforcement intensity. This suggests that the core issue is not a lack of regulation per se but rather weak implementation, limited coordination and insufficient enforcement at subnational levels.

The study concludes that the conversion of agricultural land in peri-urban Malang is a governance-related policy problem with direct implications for local food security. Improving food security in peri-urban areas thus needs supportive production-oriented policies, but also stronger land protection instruments, better integration between spatial planning and licensing as well as enforcement measures.

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