



# Adaptation and Social Responses of Farmers to Land Conversion in Achieving Food Self-Sufficiency: A Regional Analysis

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**Abstract.** The conversion of agricultural land for the development of national strategic infrastructure poses a significant challenge to the sustainability of food self-sufficiency and the resilience of farmers' livelihoods in Indonesia. This study aims to analyze the differences in farmers' perceptions and adaptation behaviors to land conversion in three sub-districts in Magelang Regency: Mungkid, Muntilan, and Ngluwar. The research employed an exploratory quantitative approach, collecting data through questionnaires from 95 farmers affected by toll road construction. Data analysis was conducted using the Kruskal–Wallis test and the Dunn follow-up test, with the presentation of the median, interquartile range (IQR), and the large size of the epsilon-squared effect ( $\epsilon^2$ ). The results showed significant differences between regions in the variables of concern for livelihood sustainability, behavior in seeking alternative economic opportunities, and adaptation behavior in response to land conversion, with small to medium effects. Ngluwar District was identified as the most vulnerable area with the highest level of concern and the lowest adaptation capacity, while Mungkid District showed the strongest adaptation capacity. The variables of farmer identity perception, risk communication, economic transition policies, and farmer network participation did not show significant differences between regions. These findings confirm that farmers' adaptive capacity is strongly influenced by spatial context and access to resources. This research provides an empirical basis for formulating place-based development policies that minimize the inequality in farmers' adaptation amid infrastructure development dynamics.

**Keywords:** Farmer resilience, adaptation, land conversion, food self-sufficiency, social response

## 1 Introduction

Infrastructure development in developing countries has been a major driver of economic growth, but it often poses a dilemma for the sustainability of the agricultural sector. In Indonesia, the rate of conversion of agricultural land into industrial estates, housing, and national strategic projects, such as toll roads, continues to increase, creating significant pressure on food self-sufficiency efforts that have long been a key goal of national policy [1]. Government policies create inequality in the field. On the one hand, the government encourages food security, but on the other hand, its infrastructure development policies actually undermine the primary foundation of food production: agricultural land.

The gap between the vision of the food self-sufficiency policy and the development agenda that ignores the protection of agricultural land has an impact on the sustainability of farmers' lives. Land conversion leads to a decrease in farmers' income, reduced employment in the farming sector, and increased food dependence on imports [2]. Academically, a literature gap remains, and research has been limited in understanding how spatial and social factors influence farmers' adaptive responses to land conversion. Many studies focus more on macroeconomic impacts or ecological changes, while mapping regional differences to farmers' socio-economic adaptation responses is still relatively minimal [3].

The conceptual framework used in this study is based on the adaptive capacity approach in socio-ecological change. This theory emphasizes the capacity of communities or individuals to adapt to environmental changes, including physical, social, and economic ones [4]. In the context of farmers affected by infrastructure development, adaptive capacity includes the ability to access information, manage resources, and develop new strategies to sustain livelihoods. Previous research has shown that factors such as access to training, collective experience, and institutional support strongly determine farmers' adaptation rates [5].

This study aims to analyze the differences in farmers' perceptions and adaptation behaviors to land conversion resulting from toll road construction in three sub-districts of Magelang Regency. Using exploratory quantitative approaches and non-parametric statistical analysis, specifically the Kruskal-Wallis test and the post hoc Dunn test, this study explicitly identifies the dimensions of farmers' socio-economic adaptation in the context of change and spatial utilization. The variables used in the research are concerns about livelihoods, initiatives to find new opportunities, and adaptation capacity to land changes.

The scientific contribution of this article lies in the integration of regional analysis in the study of farmers' adaptation to land conversion, which has been rarely explored [6]. This article aims to demonstrate how geographical differences lead to variations in farmers' social responses, while also providing an empirical basis for the formulation of place-based policies to mitigate the negative impacts of land conversion, particularly in areas affected by toll road infrastructure development. In addition, this article makes an essential contribution to strengthening the argument that food security is not only determined by productivity, but also by the social and psychological resilience of its

key stakeholders, namely farmers [7] [8] [9]. Using the Kruskal-Wallis test and the post hoc Dunn test, this article provides a data-driven analytical framework to identify the most vulnerable and most resilient sub-districts to changes resulting from toll road construction. This approach makes an empirical and theoretical contribution to place-based policymaking.

This research is an original work that has not been previously published and is not currently under consideration for publication in other journals or proceedings.

## **2 Methods**

This study employs a quantitative approach with an exploratory design to analyze differences in farmers' perceptions and adaptation behaviors regarding land conversion due to the construction of the Yogyakarta-Bawen Toll Road in Magelang Regency. This approach was chosen because it is suitable for identifying general patterns of socio-economic adaptation among farmers based on differences in regional contexts, without assuming a normal distribution of data.

### **2.1 Location and Research Subject**

The research was conducted in three sub-districts in Magelang Regency, namely Mungkid, Muntilan, and Ngluwar, which are areas directly affected by the construction of the Yogyakarta-Bawen Toll Road. The selection of the location is based on data on the determination of toll road construction locations (Decree of the Governor of Central Java Number 590/13 of 2022) and the realization rate of compensation payments (UGR), where Ngluwar and Muntilan Districts have reached 80–90%, while Mungkid District is in the range of 60–70%.

The respondents of the study are farmers whose agricultural land is directly affected by the construction of toll roads, namely, as owners and cultivators.

### **2.2 Sampling Techniques and Number of Respondents**

Sampling was conducted using a combination of purposive sampling and snowball sampling. The respondents' inclusion criteria include (1) farmers who own or manage agricultural land affected by the toll road project; (2) have received or are in the process of receiving compensation money; and (3) are willing to be a research respondent.

The number of valid respondents analyzed was 95 people, with the following distribution: Mungkid District (28 respondents), Muntilan (32 respondents), and Ngluwar (35 respondents). This distribution reflects the proportion of affected farmers in each region.

### 2.3 Variable Research and Operationalization Instruments

Primary data were collected using a closed questionnaire compiled based on the framework of adaptive capacity and sustainable livelihoods. The research instrument consisted of 42 questions grouped into seven main variables, namely:

1. X1 – Concerns about livelihood sustainability (7 items);
2. X2 – Perception of traditional values and identity as farmers (6 items);
3. X3 – Perception of crisis communication and risk management (7 items);
4. M1 – Behavior of seeking alternative economic opportunities (5 items);
5. M2 – Assessment of policies that support economic transition (6 items);
6. Y1 – Adaptive behavior to changes due to toll road construction (5 items);
7. Y2 – Farmers' adaptation behavior to land conversion (6 items).

All items were measured using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Variable scores are obtained by summing the scores of items in each construct, where higher scores indicate a stronger level of perception or adaptation.

### 2.4 Reliability and Research Ethics

The research instrument underwent limited trials before the main data collection. Reliability tests are performed using Cronbach's Alpha to ensure the internal consistency of each construct. The reliability test of the instrument was carried out using Cronbach's Alpha coefficient with a total of 30 test respondents. The test results showed that most constructs had good to excellent internal consistency ( $\alpha = 0.650\text{--}0.939$ ). The variables of traditional value perception and farmer identity (X2) exhibited a lower alpha value ( $\alpha = 0.519$ ), which can be attributed to the multidimensional and heterogeneous nature of the construct. Given that this study is exploratory, all variables are retained for further analysis.

All respondents provided informed consent before the interview, and their identities were kept confidential to ensure adherence to the ethical principles of social research. This research also has ethical clearance.

### 2.5 Data Analysis Techniques

The data analysis technique employed the Kruskal-Wallis test, a non-parametric statistical method suitable for ordinal and non-normally distributed data [10]. After significant differences were found between groups, a post hoc Dunn test was conducted to determine which group pairs had statistically significant differences. The entire data analysis process was performed using IBM SPSS software version 26, which enabled the efficient and accurate execution of the Kruskal-Wallis and Dunn tests [11]. Non-parametric statistical approaches are widely used in the evaluation of development programs that impact agrarian societies, where the assumption of normality is often not met due to inhomogeneous data distribution [12]

## 2.6 Research Hypothesis

H<sub>0</sub> (Null Hypothesis):

There was no statistically significant difference in the median perception and behavior of farmers' adaptation to land conversion between farmers in Mungkid, Muntilan, and Ngluwar Districts.

H<sub>1</sub> (Alternatif Hypothesis):

There was a statistically significant difference in the median perception and/or adaptation behavior of farmers to land conversion between farmers in Mungkid, Muntilan, and Ngluwar Districts.

## 3 Result and Discussion

### 3.1 Result

The Kruskal-Wallis test was conducted to examine the differences in farmers' perceptions and adaptation behaviors between three sub-districts in Magelang Regency: Mungkid, Muntilan, and Ngluwar. Because the data are ordinal, results are presented using the median and interquartile ranges (IQR), accompanied by H-values, degrees of freedom (df), and epsilon-squared ( $\epsilon^2$ ) as a considerable measure of the effect. A post hoc test of Dunn follows these results if significant differences are found.

#### 3.1.1 Results of the Kruskal–Wallis Test between Districts.

Of the seven variables analyzed, three variables showed statistically significant differences between sub-districts, namely:

1. X1 (Concern for Livelihood Sustainability),
2. M1 (Alternative Opportunity Seeking Behavior),
3. Y1 (Adaptive Behavior to Change).

The other four variables (X2, X3, M2, and Y2) showed no significant difference ( $p > 0.05$ ).

**Table 1.** Results of the Kruskal-Wallis Test between Sub-Districts

Variabel	H	df	p-value	Effect Size ( $\epsilon^2$ )	Remarks
X1 – Livelihood Concerns	7,046	2	0,030	0,053	Signifikan
X2 – Farmer Identity	3,449	2	0,178	0,015	Insignifikan
X3 – Crisis Communication	1,168	2	0,558	0,003	Insignifikan
M1– Alternative Opportunities	8,528	2	0,014	0,069	Signifikan
M2 – Transition Policy	2,999	2	0,223	0,011	Insignifikan
Y1 – Adaptation to Change	6,181	2	0,045	0,045	Signifikan
Y2 – Adaptation of Land Use Change	5,058	2	0,080	0,033	Insignifikan

Note: Effect size was calculated using the formula  $\varepsilon^2 = (H-k+1) / (n - k)$ , with  $k$  = number of groups (3) and  $n$  = number of respondents (95). The value of  $\varepsilon^2$  indicates that the effects of differences between regions are in the small to medium category, which is reasonable for exploratory social studies.

### 3.1.2 Descriptive Statistics (Median and IQR).

**Table 2.** Median (IQR) Significant Variables per District

Variabel	Mungkid	Muntilan	Ngluwar
X1 – Livelihood Concerns	4,29 (IQR 0,71)	3,86 (IQR 0,86)	4,57 (IQR 0,57)
M1 – Alternative Opportunities	4,40 (IQR 0,60)	4,20 (IQR 0,80)	3,50 (IQR 0,75)
Y1 – Adaptation to Change	4,50 (IQR 0,50)	4,10 (IQR 0,70)	3,70 (IQR 0,80)

### 3.1.3 Dunn's Post Hoc Test Results.

The Dunn test is performed with Bonferroni adjustments to identify significantly different regional pairs.

1. X1 (Livelihood Concerns): Significant differences were found between Ngluwar–Muntilan, where farmers in Ngluwar showed higher levels of concern.
2. M1 (Behavior Seeking Alternative Opportunities): Significant differences were found between Mungkid–Ngluwar and Muntilan–Ngluwar. This result shows that farmers in Ngluwar have the least initiative in seeking alternative economic opportunities.
3. Y1 (Adaptation to Change): Significant differences were found between Mungkid–Ngluwar, with Mungkid showing the highest level of adaptation and the lowest Ngluwar.

### 3.1.4 Summary of Key Findings.

Overall, the results of the analysis show that:

1. Regional context plays a significant role in shaping farmers' adaptive concerns and responses.
2. Ngluwar District emerged as the most vulnerable area, characterized by a high level of concern and low adaptation capacity;
3. Mungkid District demonstrates the strongest adaptation capacity, particularly in its pursuit of alternative economic opportunities.

These findings confirm that farmers' adaptation to land conversion is not homogeneous, but is influenced by spatial conditions, resource access, and local institutional contexts.

### 3.2 Discussion

The results of this study indicate that farmers' adaptive responses to land conversion resulting from infrastructure development are not uniform across regions, even though they are located in the same district and affected by the same development project. These findings reinforce the argument that farmer adaptation is a highly contextual process, influenced by spatial, social, and institutional differences at the local level.

#### 3.2.1 Spatial Differences in Livelihood Sustainability Concerns (X1).

The variable of concern for livelihood sustainability (X1) shows significant differences between sub-districts, with Ngluwar being the area with the highest level of concern. This great concern can be understood within the framework of sustainable livelihoods, particularly in relation to the limitation of natural capital (productive agricultural land) and financial capital following land conversion.

Farmers in Ngluwar lose access to relatively larger rice fields than in other areas, so land conversion is not only perceived as a physical change, but also as a threat to the sustainability of identity and household economic security. These findings align with the research of Chepkoech et al, which emphasizes that the loss of key productive assets will increase the perception of vulnerability, especially in agrarian communities that are heavily dependent on natural resources [13].

In contrast, farmers in Mungkid and Muntilan show lower levels of concern, indicating better buffering capacity, both through economic diversification and proximity to administrative centers and trade activities. This condition may be due to the fact that Muntilan and Mungkid are geographically located in areas closer to urban areas and tourist destinations.

#### 3.2.2 Behavior of Seeking Alternative Opportunities as an Indicator of Adaptive Capacity (M1).

The behavior of seeking alternative economic opportunities (M1) is one of the strongest indicators in distinguishing adaptive capacity between regions. The results showed that Mungkid and Muntilan had higher economic adaptation scores, while Ngluwar was consistently at the lowest position.

From the perspective of adaptive capacity, these findings indicate that farmers' ability to respond to change is determined not only by perceived threat levels but also by access to human capital and social capital, including non-agricultural skills, social networks, and proximity to economic centers. Mungkid District, as the center of district government, provides greater opportunities for farmers to access information, training, and alternative livelihoods outside the agricultural sector.

These findings are consistent with de Boon et al, who assert that the perception of adaptability is strongly related to the actual opportunities available in the surrounding environment [14]. In other words, adaptation is not only a matter of individual will, but also a matter of spatial opportunity structure.

### **3.2.3 Adaptive Behavior to Regional Capacity Changes and Inequality (Y1).**

The significant difference in the Y1 variable confirms the inequality of adaptation capacity between sub-districts, with Mungkid being the most adaptive area and Ngluwar being the most vulnerable area. Adaptation in this context includes mental readiness, work flexibility, and the ability to adjust livelihood strategies after toll road construction.

Interestingly, although the economic transition policy variable (M2) did not reveal significant differences between regions, the results of the different adaptations indicated that the existence of policies alone was insufficient. This suggests a gap between formal policies and farmers' ability to effectively utilize these policies. In other words, access and utilization of policies are more decisive than the existence of the policy itself.

These findings support the argument of OforiKyereh et al that smallholder adaptation is influenced more by local contextual and institutional factors than by demographic characteristics alone [15].

### **3.2.4 Variables That Are Not Different and Their Implications.**

The absence of significant differences in the variables of farmers' identity perception (X2), crisis communication (X3), transition policies (M2), and participation in networks (Y2) shows that the general narratives and experiences related to toll road construction are relatively homogeneous in all three regions. This can be interpreted as the result of an administratively uniform policy approach.

However, this homogeneity of perception does not necessarily result in homogeneous adaptation. These findings reinforce the conclusion that farmer adaptation is a multidimensional process, where the same perception can elicit different responses depending on the resources available.

### **3.2.5 Theoretical and Policy Implications.**

Theoretically, this study enriches the literature on human security and planetary health by demonstrating that food security is not only related to production and land, but also to the social and psychological resilience of farmers, who are the primary actors in the food system. The regional analysis approach employed in this study provides empirical evidence that spatial heterogeneity is a crucial factor in the study of agrarian adaptation.

In terms of policy, this finding highlights the need for a place-based approach in addressing the impact of land conversion. Areas like Ngluwar require more targeted interventions, such as assistance in managing compensation funds to purchase agricultural land. Currently, their expertise is primarily focused on farming or providing non-agricultural skills training, entrepreneurship support, and strengthening access to information and economic networks. On the other hand, adaptive practices in Mungkid can serve as a learning model for various regions.

## 4 Conclusion

This study demonstrates that land conversion resulting from toll road construction has spatially distinct adaptation impacts in Magelang Regency. Ngluwar District was identified as the most vulnerable area, with high levels of concern and low adaptation capacity, while Mungkid District showed the highest adaptive resilience.

The policy implications of these findings underscore the importance of a place-based policy approach. In areas such as Ngluwar, policies need to be focused on: (1) Strengthening information services and adaptation assistance, (2) Region-specific non-agricultural skills training programs, and (3) An economic transition scheme that links land compensation with livelihood sustainability, especially in agriculture, which has been the main livelihood of farmers so far.

In contrast, in areas with higher adaptation capacity, such as Mungkid and Muntilan, policies can be directed at strengthening local economic networks and community-based business innovation.

Thus, national infrastructure development should not be treated as a uniform policy, but rather designed contextually to prevent adaptation inequalities and maintain the sustainability of food self-sufficiency.

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