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DETERMINANTS OF URBAN FARMING INCOME IN YOGYAKARTA: AN EMPIRICAL ANALYSIS OF OPERATIONAL, BIOTIC STRESS, AND INSTITUTIONAL FACTORS

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ABSTRACT

Although Indonesia's metropolitan districts are experiencing rapid economic expansion, urban residents remain at risk due to unstable incomes and limited job opportunities. Urban poverty and unemployment rates in the Special Region of Yogyakarta remain relatively high, highlighting the need for alternative livelihood strategies. Although urban farming has emerged as a supplementary source of income to enhance household resilience, the factors influencing its income performance remain unclear. This study aims to examine the structural, operational, biotic, and institutional aspects affecting urban farming income in Yogyakarta City. In 2024, primary data were collected from 217 urban farming households using a systematic questionnaire. Stata 19 was used for hypothesis testing, while SPSS 27 was used for descriptive analysis. Net urban farming income served as the dependent variable in a multiple linear regression model, with 22 independent variables representing sociodemographic characteristics, farm structure, input management, biotic stress, and institutional support. Eleven variables significantly affect income, and the results demonstrate strong explanatory power (R^2 = 0.7448). Farm size is the most influential factor, followed by financial support, seed subsidies, and technical assistance. Gender and family size also have positive effects, underscoring the importance of women's participation and household labor. Crop type shows a negative correlation with income, while fertilizer type and expenditure increase income. Biotic stress, particularly pest type and severity, substantially reduces income. Training and market access variables are not statistically significant. In Yogyakarta, land access, household labor, efficient input use, pest and disease control, and institutional support are the main factors influencing urban farming income.

Keywords: *urban farming; income determinants; income contribution; poverty reduction; community resilience.*

INTRODUCTION

Despite sustained progress toward the Sustainable Development Goals (SDGs), poverty remains one of the most persistent development challenges in Indonesia. While the national poverty rate has declined to approximately 9–10 percent in recent years, the pace of reduction has been uneven, and vulnerability remains high in urban areas, where living costs and labor market pressures are concentrated. In the Special Region of Yogyakarta, for example, the urban poverty rate stands at approximately 10.11 percent, compared to 11.31 percent in rural areas. Furthermore, the urban unemployment rate (3.36 percent) exceeds that of rural areas (2.62 percent). These figures suggest that urban residents face structural challenges related to income instability and limited employment opportunities. Rapid urbanization, restricted access to land, and the expansion of the informal sector further exacerbate urban vulnerability, highlighting the need for supplementary livelihood strategies to support income and resilience.

Agriculture continues to play an important role in Indonesia's economy by generating employment, ensuring food availability, and providing income. However, as cities expand, agricultural activities are becoming increasingly urbanized. Urban farming, defined as the production and marketing of agricultural products within or around cities, has gained growing attention due to its potential contributions to food security, income diversification, and social cohesion (Mougeot, 2005; Zezza & Tasciotti, 2010). Empirical studies suggest that urban agriculture can reduce food expenditures, generate cash income, and enhance livelihood security (Drechsel & Dongus, 2010). In Indonesia, urban farming initiatives have expanded through home gardens, hydroponic systems, rooftop cultivation, and community plots, often supported by local governments and civil society organizations. However, empirical findings on income contribution remain mixed: some studies report modest supplementary income, while others identify significant earnings among commercially oriented urban farmers (Poulsen et al., 2015). This divergence raises questions regarding the conditions under which urban farming functions as an income-generating activity rather than solely as a subsistence or social practice.

A broad body of empirical literature has examined the determinants of farm income. Previous studies highlight the influence of factors such as education, farm size, technology adoption, labor input, access to credit, and institutional support on income levels (Ellis, 2000; Todaro & Smith, 2015). Research in Asia and Africa demonstrates that land ownership, capital availability, and access to extension services significantly affect farm productivity and income (Asfaw et al., 2012; Ogutu et al., 2014).

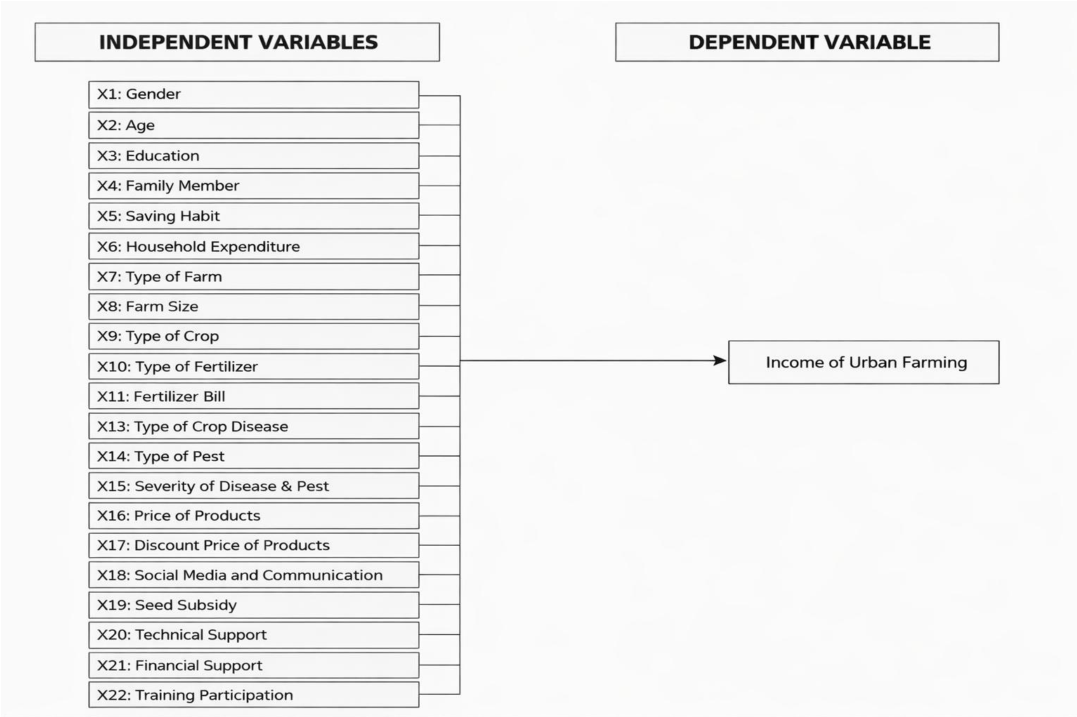

Figure 1. Conceptual Framework

Source: Author's compilation (2025).

Figure 1 depicts the conceptual framework of this study. Overall, 22 independent variables are employed based on the empirical literature review. However, most previous studies focus on rural agriculture, while urban farming contexts remain underexplored. In Indonesia, urban agriculture research has primarily addressed program implementation, social benefits, and food security outcomes (Arifin, 2020). Limited empirical attention has been given to the determinants of urban farming income and its contribution to total household income. Moreover, systematic quantification of the interactions among sociodemographic characteristics, operational farm factors, biotic stress, and institutional support in shaping urban farming income remains scarce.

Yogyakarta City provides a relevant empirical context for this analysis. The province consistently records poverty rates above the national average, and urban residents experience relatively high vulnerability due to informal employment, rising living costs, and spatial constraints on land use. Local governments and communities increasingly promote urban farming as a complementary livelihood strategy, particularly following the COVID-19 pandemic, when households converted yard spaces into productive gardens. However, existing empirical evidence indicates that the contribution of urban farming to household income remains modest, with many households participating primarily for subsistence, social cohesion, or environmental benefits rather than as a primary economic activity. This raises an important question regarding the conditions under which urban farming can enhance household income and serve as a meaningful poverty reduction mechanism in urban settings.

To address these research gaps, this study empirically analyzes the determinants of urban farming income and evaluates its contribution to overall household income in Yogyakarta City, Indonesia. Using primary household survey data, the study applies multiple regression techniques to identify key socioeconomic, input-related, and institutional factors influencing urban farming income. The findings are expected to have both academic and policy relevance. Academically, this study contributes to the urban agriculture literature by clarifying the conditions under which urban farming generates income, rather than focusing solely on its social or environmental functions. From a policy perspective, the results provide an evidence base for designing more effective urban farming programs, including targeted training, input support, technology adoption, and institutional strengthening. Ultimately, understanding these determinants is essential for positioning urban agriculture as a complementary poverty alleviation strategy and for enhancing livelihood resilience in rapidly urbanizing regions such as Yogyakarta.

MATERIALS AND METHODS

This study employed a quantitative, cross-sectional research design to identify factors influencing urban farming income among households engaged in urban agriculture in Yogyakarta City, Indonesia. Due to the absence of an official sampling frame of urban farmers, primary data were collected from 217 urban farming households using a convenience sampling technique. Respondents were accessed through community networks, with urban farming group coordinators distributed across all 14 subdistricts of

Yogyakarta City. This approach ensured the inclusion of diverse urban farming activities, including household gardens, community-based cultivation, and hydroponic systems within densely populated urban areas.

Data were collected using a structured questionnaire administered between mid-February and late April 2025. The questionnaire covered household characteristics, urban farming income, operational costs (such as fertilizer and electricity), production constraints related to pests and diseases, marketing strategies, and institutional support received by farmers. The questionnaire consisted of both open- and closed-ended questions and was originally developed in English before being translated into Indonesian to ensure clarity and contextual relevance. Participation in the survey was voluntary; informed consent was obtained, and the anonymity and confidentiality of respondents were strictly maintained.

The dataset comprises one dependent variable, urban farming income, and 22 independent variables representing socioeconomic, operational, biotic stress, marketing, and institutional support factors. These variables include gender, age, education level, household size, savings behavior, household expenditure, farm type, farm size, crop type, fertilizer type, fertilizer cost, electricity bill, types of pests and diseases, severity of pest and disease attacks, pricing strategy, discounting practices, product placement, use of social media and communication platforms, receipt of seed subsidies, technical assistance, financial support, and participation in proposed urban farming training. These variables were selected based on theoretical expectations and empirical evidence from previous studies linking demographic, production, and institutional factors to farm income outcomes.

Data processing and statistical analysis were conducted using SPSS Statistics 27 and Stata 19. SPSS was used to generate descriptive statistics summarizing the distribution, central tendency, and variability of all variables, while Stata 19 was used for model estimation and inferential testing. Prior to analysis, data screening was performed to identify missing values and outliers. Categorical variables were converted into binary (0/1) dummy variables, and logarithmic transformations were applied to positively skewed continuous variables—including urban farming income and key cost variables—to stabilize variance and improve the interpretability of regression coefficients. Pearson's correlation analysis was conducted to evaluate the strength and direction of bivariate relationships among independent variables and to detect potential multicollinearity.

Classical assumption diagnostics were performed to ensure the appropriateness of ordinary least squares (OLS) estimation. The normality of residuals, homoscedasticity, independence of error terms, and absence of problematic multicollinearity were examined, with multicollinearity assessed using the Variance Inflation Factor (VIF). Only after these assumptions were satisfied was the multiple linear regression model estimated to quantify the effect of each determinant on urban farming income. The regression model is specified in **Equation 1.**

$$\log(Y) = \alpha+\beta1X1+\beta2X2+\cdots+\beta23X23+\varepsilon, \quad (1)$$

Where Y denotes urban farming income, α represents the intercept, β are the regression coefficients associated with each explanatory variable, and ε is the random error term. Model adequacy and explanatory power were assessed using the coefficient of determination (R^2). The F-test was applied to examine overall model significance, while t-tests were used to evaluate the statistical significance of individual predictors. Variables with statistically significant coefficients were interpreted as key determinants of urban farming income.

The analytical procedures undertaken in this study provide a rigorous empirical basis for identifying socioeconomic, operational, biotic, marketing, and institutional support variables that significantly influence income derived from urban farming. The findings from this analysis form the core results of the research and directly address the primary objective of identifying factors shaping urban farming income in Yogyakarta City.

RESULTS AND DISCUSSION

In Yogyakarta, women and older household members are the primary practitioners of urban farming. Urban farming is predominantly managed by housewives and retirees rather than full-time employees, as more than 80 percent of respondents are female and the average age exceeds 60 years. Consistent with findings by Smit et al. (2001), Poulsen et al. (2015), and Foeken (2006), urban agriculture largely serves as a household-based and supplementary income source rather than a primary commercial occupation. With an average farm size of approximately 107 m², most respondents cultivate ornamental plants and vegetables on small plots.

Consistent with evidence from other emerging cities, where urban land scarcity constrains agricultural productivity and intensification, limited land availability restricts production scale and income potential (Orsini et al., 2013; Pribadi & Pauleit, 2015; Wijayanti & Bendesa, 2019). The average annual income from urban farming is approximately IDR 14 million, although some households earn up to IDR 125 million. This variation indicates that a subset of farmers utilizes urban farming as a profitable microbusiness rather than solely for subsistence purposes (Foeken, 2006; Emran et al., 2021).

The statistical validity of the regression model is confirmed through standard assumption tests. The Breusch–Pagan test indicates no heteroskedasticity (**Table 2**), the residuals are normally distributed (**Table 1** and **Figure 2**), and VIF values indicate no multicollinearity (**Table 3**). According to the multiple regression model, the 22 explanatory variables account for nearly 74% of the variation in urban farming income, demonstrating strong explanatory power ($R^2 = 0.7448$; Adj. $R^2 = 0.7158$; **Table 4**).

The regression results (**Table 5**) indicate that farm size is the strongest determinant of urban farming income ($\beta = 0.660$, $p < 0.001$), confirming that access to cultivated space remains the primary structural constraint in urban agriculture. This finding aligns with a substantial body of rural and peri-urban literature identifying land as a core driver of farm income (Hassan, 2015).

Table 1. Normality Test Result (Shapiro–Wilk W test)

Variable	Obs	W	V	z	Prob > z
Residual	217	0.99015	1.577	1.053	0.14616

Source: Author's Survey (2025).

Table 2. Heteroskedasticity Test Results (Breusch–Pagan/ Cook–Weisberg Test)

Test Type	Variable	χ^2 (1)	Prob > χ^2	Decision
Breusch–Pagan / Cook–Weisberg	Fitted values of log Urban Farming Income	0.50	0.4777	No heteroskedasticity detected

Source: Author's Survey (2025).

Table 3. Variance Inflation Factor (VIF) Result

No	Variable	VIF	1/VIF
1	Gender (X_1)	1.11	0.904726
2	Age (X_2)	1.22	0.820927
3	Education (X_3)	1.13	0.884271
4	Family Member (X_4)	1.18	0.846793
5	Saving Habit (X_5)	1.25	0.802371
6	Household Expenditure (X_6)	1.08	0.925165
7	Type of Farm (X_7)	1.10	0.909011
8	Farm Size (X_8)	1.14	0.873432
9	Type of Crop (X_9)	1.16	0.863100
10	Type of Fertilizer (X_{10})	1.11	0.898881
11	Fertilizer Bill (X_{11})	1.14	0.879398
12	Electricity Bill (X_{12})	1.08	0.924119
13	Type of Crop Disease (X_{13})	1.08	0.924232
14	Type of Pest (X_{14})	1.15	0.868590
15	Severity of Disease and Pest (X_{15})	1.12	0.893782
16	Price of the Products (X_{16})	1.26	0.792099
17	Discount Price of the Products (X_{17})	1.06	0.945293
18	Use of Social Media and Communication (X_{18})	1.24	0.809612
19	Seed Subsidy (X_{19})	1.18	0.846424
20	Technical Support (X_{20})	1.16	0.859281
21	Financial Support (X_{21})	1.15	0.870329
22	Proposed Training in Urban Farming (X_{22})	1.13	0.883067
	Mean VIF	1.15	

Source: Author's Survey (2025).

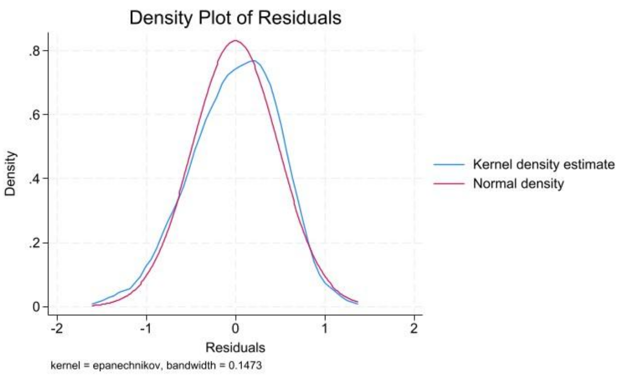

Figure 2. Histogram of The Normality Test
Source: Author's Survey (2025).

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In urban settings, this relationship becomes even more pronounced because land scarcity increases the marginal productivity of additional cultivated space (Foeken, 2006; Wijayanti & Bendesa, 2019). Even modest expansions of usable area—through backyard plots, rented land, or vertical systems—can generate substantial income gains and differentiate subsistence-oriented farmers from income-oriented micro-entrepreneurs (Gupito et al., 2014; Emran et al., 2020; Owusu et al., 2020).

Additionally, gender has a positive and significant influence ($\beta = 0.172$, $p = 0.025$), indicating that female farmers earn more income from urban farming than male farmers. This contrasts with a large portion of the literature on rural income, which generally finds male dominance due to easier access to capital and land (Ampaw et al., 2017). However, because urban farming is labor-intensive, time-flexible, and spatially compact, women can actively engage in daily production, supervision, and small-scale marketing in addition to household duties (Foeken, 2006; Kawarazuka et al., 2017; Dewanggi et al., 2022). This finding adds to the literature by demonstrating that income generation in small-scale urban agricultural systems depends more on labor continuity and managerial intensity—dimensions in which women play a key role—than on formal resource access.

Table 4. Model Summary

Statistic	Value
Number of observations	217
R-squared	0.7448
Adjusted R-squared	0.7158
F-statistic (22, 194)	25.73
Prob > F	0.0000
Root MSE	0.53308

Source: Author's Survey (2025).

The significance of household labor availability in labor-intensive urban farming systems is highlighted by the positive correlation between family size and income ($\beta = 0.154$, $p < 0.001$). This validates research that views family size as a stand-in for human capital and labor endowment in smallholder farming (Akouegnonhou & Demirbaş, 2021; Keray et al., 2023). Income gains are more dependent on labor intensification within constrained space than on area growth when there is a shortage of land. Larger households can reduce their dependency on hired labor, distribute labor internally among production, maintenance, and marketing responsibilities, and respond to pest and nutritional issues more quickly.

Table 5. Summary of Multiple Linear Regression Analysis Results

Variable (Framework)	Coefficient	Std. Error	t-value	p-value	Hypothesis Outcome
Gender (X_1)	0.171924	0.076112	2.26	0.025	Accepted — As Expected (significance expected ± → matches expected assumption)
Age (X_2)	.0088387	.0400329	0.22	0.825	Rejected
Education (X_3)	.1520288	.0809205	1.88	0.062	Rejected
Family Member (X_4)	.1538828	.0394167	3.90	0.000	Accepted — As Expected (± hypothesized)
Saving Habit (X_5)	-.071764	.1205115	-0.60	0.552	Rejected
Household Expenditure (X_6)	.0341725	.0377103	0.91	0.366	Rejected
Type of Farm (X_7)	.0156167	.047094	0.33	0.741	Rejected
Farm Size (X_8)	.660154	.038811	17.01	0.000	Accepted — As Expected
Type of Crop (X_9)	-.2020851	.0429099	-4.71	0.000	Accepted — Opposite to Expected (expected + but result –)
Type of Fertilizer (X_{10})	.1699033	.0528047	3.22	0.002	Accepted —As Expected
Fertilizer Bill (X_{11})	.088472	.0386791	2.29	0.023	Accepted —As Expected (± hypothesized)
Electricity Bill (X_{12})	.0530518	.0377316	1.41	0.161	Rejected
Type of Crop Disease (X_{13})	-.0421508	.0753494	-0.56	0.577	Rejected
Type of Pest (X_{14})	-.250777	.109511	-2.29	0.023	Accepted — Opposite to Expected (expected – but result +)
Severity of Disease & Pest (X_{15})	-.7488991	.0944148	-7.93	0.000	Accepted —As Expected
Price of Products (X_{16})	.071678	.048804	1.47	0.144	Rejected
Discount Price of Products (X_{17})	.0575677	.045738	1.26	0.210	Rejected
Social Media and Communication (X_{18})	-.1044325	.0805409	-1.30	0.196	Rejected
Seed Subsidy (X_{19})	.4712698	.0893789	5.27	0.000	Accepted — As Expected
Technical Support (X_{20})	.5962048	.0785203	7.59	0.000	Accepted — As Expected
Financial Support (X_{21})	.4161852	.0897209	4.64	0.000	Accepted — As Expected
Training Participation (X_{22})	.0062157	.0487402	0.13	0.899	Rejected

Source: Author's Survey (2025).

Differentiated effects are displayed through input-related variables. Income is positively impacted by fertilizer spending (β = 0.088, p = 0.023), indicating that management accuracy and nutrient sufficiency are more significant than input category choices (Gupito et al., 2014; Emran et al., 2020). Crop type, on the other hand, has a negative and highly significant effect (β = −0.202, p < 0.001), suggesting that under small-scale, risk-prone urban conditions, growing "high-value" crops does not necessarily result in higher net income (Foeken, 2006; Orsini et al., 2013; Almagthani et al., 2023). These crops frequently require more intensive inputs and pest management, which raises expenses and increases risk. Therefore, cost-effectiveness, scale compatibility, and managerial skill are more important factors in urban farming profitability than nominal crop selection..

Biotic stress can have significant detrimental effects. According to Altieri et al. (2012), biological stress continues to be a substantial barrier to profitability in dense urban agricultural systems, as evidenced by the fact that both the type of pest and the severity of pest and disease infestation considerably lower income. Increased cultivation intensity raises pest pressure, which lowers yields and increases production costs in the absence of adequate control. This highlights how crucial pest and disease management is for maintaining production in small-plot, high-density urban agriculture (U.S. Department of Agriculture, National Institute of Food and Agriculture, 2023).

After farm size, institutional support variables are the most potent drivers of revenue growth. Financial, technical, and seed subsidies all have substantial, positive, and statistically significant impacts. This is consistent with research in institutional and development economics that highlights the need for coordinated support systems rather than standalone interventions to increase productivity in small-scale farming (Zhang, 2015; Ampaw et al., 2017; Akouegnonhou & Demirbaş, 2021). Financial assistance relaxes liquidity constraints that limit intensification, technical assistance improves farmers' ability to manage inputs and pests effectively, and seed subsidies lower entry and replacement costs. These findings suggest that the institutional setting in which production occurs

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influences urban farming income more than human effort alone.

On the other hand, market- and technology-related factors—such as pricing strategies, discounting policies, social media use, and training participation—do not exhibit statistical significance. This implies that access to land, labor, inputs, pest control, and institutional support—rather than marketing practices or digital engagement—are the primary determinants of income generation within the studied sample. Similar patterns have been documented in early-stage urban farming systems and subsistence-oriented farming systems, where market integration is secondary to production constraints (Smit et al., 2001; Poulsen et al., 2015).

Overall, the findings show that urban farming income in Yogyakarta is governed by an integrated system in which outcomes are simultaneously shaped by land access, household labor, input efficiency, biotic risk management, and institutional support. When urban land is scarce and output remains small-scale, the effectiveness and sustainability of urban agriculture are determined more by structural and institutional variables than by demographic and market-based considerations.

CONCLUSIONS

This study provides new empirical evidence showing that income formation in urban farming is shaped primarily not by demographic characteristics, but by structural, biotic, and institutional conditions. Using data from 217 urban farming households in Yogyakarta, the analysis demonstrates that land access (farm size), household labor capacity (gender and family size), and coordinated institutional support are the dominant drivers of income in spatially constrained urban agriculture. The novelty of this study lies in demonstrating that, in an urban context, productivity and profitability depend more on access to productive space, effective pest control, and institutional frameworks than on individual socioeconomic attributes or market behavior.

The results further reveal that biotic stress significantly reduces income, whereas technical assistance, seed subsidies, and financial support substantially enhance it. This integrated perspective—linking land scarcity, biological risk, and institutional intervention—extends the existing literature, which often treats these dimensions separately. The findings suggest that urban farming policy should focus less on generic training and more on improving land access mechanisms, strengthening technical advisory services, and supporting integrated pest and input management systems.

Future research should move beyond cross-sectional designs toward longitudinal and spatially explicit analyses to capture dynamic income changes and location-specific constraints. Comparative studies across cities and governance contexts are also needed to assess the generalizability of these findings and to better integrate urban farming into urban planning and poverty-reduction strategies.

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