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An Analysis of the Effectiveness of Farm Road Development on Productivity and Farmer Welfare in Lamongan Regency

Ida Suryawati

Regional Planning, Development, Research, and Innovation Agency
of Lamongan Regency

Correspondence Email: ida.suryawati78@gmail.com

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Abstract

The development of agricultural infrastructure, particularly farm roads, constitutes a strategic policy intervention designed to enhance food security, agricultural productivity, and the welfare of farmers in Lamongan Regency. This study aims to critically evaluate the effectiveness of farm road construction on optimizing crop yields and improving the socio-economic resilience of rural agrarian communities. Employing a comprehensive mixed-methods approach, the research integrates quantitative and qualitative data acquired through in-depth interviews, direct field observations, and the analysis of institutional documents. The findings reveal that farm road development significantly improves spatial accessibility, substantially reduces logistical transportation costs, and curtails post-harvest losses. These improvements cumulatively elevate agricultural productivity and drive a consistent upward trajectory in the Farmers' Terms of Trade (NTP). Furthermore, the infrastructure democratizes market access by dismantling oligopsonistic practices, thereby amplifying the bargaining power of primary producers. However, the long-term efficacy of this development is impeded by persistent structural constraints, including the absence of systematic post-construction maintenance, uneven infrastructural quality across the region, and the escalating threat of productive land capitalization. The study concludes that while farm roads are highly effective in augmenting immediate agrarian welfare, sustaining these socio-economic benefits necessitates the rigorous integration of Environmental, Social, and Governance (ESG) principles, stringent spatial planning, and robust grassroots institutional empowerment.

Keywords: Agricultural Infrastructure; Farm Roads; Farmer Welfare; Political Ecology; Rural Development; Sustainable Governance.

Introduction

Agriculture constitutes a strategic sector in the economic development of Lamongan Regency. This sector functions not only as a food provider for the community but also serves as the primary livelihood for the majority of the population, particularly in rural areas. Furthermore, the agricultural sector contributes to the supply of industrial raw materials, export enhancement, and the maintenance of national economic stability. The transformation towards a sustainable agricultural system is becoming increasingly urgent to respond to the dynamics of modern markets. This aligns with the local government's commitment to realizing the Sustainable Development Goals (SDGs), specifically in alleviating rural poverty (Sholikin et al., 2026). Consequently, the modernization of agricultural governance in Lamongan Regency is no longer merely an option but a strategic imperative. The increasingly massive land-use changes in the northern coastal area of East Java demand robust protection of the living spaces of farmers. A political ecology approach becomes highly relevant here to examine how power relations in spatial planning directly implicate regional food security (Sholikin, 2025b). It must be ensured that this modernization guarantees the sovereignty of natural resources so they are not eroded by the expansion of extractive and non-environmentally friendly manufacturing industries.

In navigating global challenges such as climate change, population growth, escalating food demand, and geopolitical conflicts in various parts of the world, the agricultural sector is compelled to continuously enhance productivity and production efficiency to support the national strategic program for food self-sufficiency. The government of Lamongan Regency has implemented several agricultural development policies aimed at elevating agricultural productivity and farmer welfare. These policies encompass fertilizer subsidies, provision of facilities, construction of agricultural infrastructure, agricultural extension services, and price protection for agricultural commodities, all of which are expected to assist farmers in augmenting crop yields and income. Fundamentally, these policies represent state intervention in maintaining socio-ecological balance at the local level. Without comprehensive regulations, farmers' vulnerability to price fluctuations and environmental degradation will inevitably intensify.

Synergy among the government, farmers, and other stakeholders is pivotal to ensuring that such policies are not merely populist but genuinely address the root of structural issues. In practice, the formulation and evaluation of these policies must begin adopting Environmental, Social, and Governance (ESG) principles to ensure systematic ecological risk mitigation. The transition toward this agricultural model can also be bolstered by integrating the concept of a circular economy, which serves as a rational solution to fertilizer scarcity and soil nutrient depletion. Therefore, regional regulations are required to be more adaptive in incubating forward-looking agribusiness innovations.

The role of agricultural infrastructure in agricultural development is becoming increasingly strategic and paramount, closely correlating with efforts to achieve the targets of the national food security program. Adequate agricultural infrastructure support, such as roads, is indispensable for fostering efficient agricultural development. The existence of roads facilitates easier and more cost-effective transportation of agricultural production inputs to farming sites, as well as the transport of agricultural outputs to temporary collection points, storage, processing, and marketing facilities. Consequently, agricultural enterprises become significantly more efficient. Adequate accessibility also unlocks opportunities for the application of circular economy models within agricultural zones, where crop residues can be distributed more swiftly to be repurposed into value-added products. Furthermore, this logistical fluidity directly reduces post-harvest losses, which have long constituted a hidden detriment for farmers. Ultimately, this supply chain efficiency culminates in the heightened competitiveness of local commodities in broader markets. In turn, integrated physical infrastructure will facilitate the transition of agricultural hubs into highly resilient and self-sustaining ecosystems. The circulation of organic materials, such as the utilization of agricultural waste for alternative livestock feed, becomes vastly more massive and measurable when inter-village connectivity is optimally established. On a broader scale, the availability of these facilities can mitigate the "resource curse" phenomenon, ensuring that regions endowed with abundant natural potential circumvent the trap of inefficiency caused by poor logistical governance (Sholikin, 2025a).

One of the implemented government policies is the construction of farm road infrastructure, which functions as a distribution access route for production inputs and harvests. This infrastructure is anticipated to lower production costs and augment the efficiency of agricultural activities. However, the effectiveness of farm road construction remains questionable, particularly concerning the improvement of farmer welfare. Based on these circumstances, this study is crucial to examine the extent to which the development of farm roads impacts the productivity and welfare of farmers in Lamongan Regency. A critical evaluation of this infrastructure policy is highly necessary to ensure that regional budget allocations are not confined merely to administrative achievements but yield tangible impacts on the grassroots economy. Discrepancies between policy expectations and field realities frequently arise due to a lack of post-construction supervision. Therefore, this study aims to bridge the evaluation of physical infrastructure with a more comprehensive analysis of socio-economic welfare governance. Concurrently, this research dissects the technocratic narratives of public policy into an incisive analysis that remains accessible to the wider public, including the younger generation poised to inherit the agrarian sector. Uncovering the reality behind governmental statistical figures will provide a factual overview of the distribution of value-added benefits from village development. Through critical and grounded academic dialectics, the effectiveness of development policies can be tested transparently and held accountable.

Effectiveness itself constitutes the degree of a program's success in achieving the objectives stipulated in the 2025–2029 strategic plan document. Farm roads are defined as supporting agricultural infrastructure utilized to facilitate the mobility of equipment, materials, and agricultural outputs. Productivity can be measured by yield per hectare and input utilization efficiency, whereas farmer welfare is gauged by the farmer's terms of trade indicator. Intrinsically, the measurement of welfare is not confined solely to financial accumulation; it also encompasses social autonomy and the resilience of farmers in confronting economic crises. The integration of these indicators is imperative to obtain a holistic picture of the impacts of rural infrastructure development. It is anticipated that this holistic

understanding will yield an objective, inclusive, and adaptive evaluation tailored to the needs of the farming community. These various indicators should be positioned as diagnostic instruments that ignite the emergence of applicable solutions, rather than serving merely as year-end reports. An independent research and innovation paradigm is highly essential to validate whether the increase in the farmers' terms of trade is genuinely congruent with the preservation of the surrounding environmental carrying capacity(Sholikin, 2021). At this juncture, the parameters for successful rural development must be broadened to incorporate social security and the ecological quality of life of farm laborers.

Furthermore, the sustainability of physical infrastructure, such as farm roads, heavily relies on governance at the village institutional level and the active participation of farmer groups. The development of facilities and infrastructure that is not accompanied by human resource capacity building often culminates in premature infrastructure deterioration. An integrated community empowerment approach becomes crucial to foster a sense of communal ownership over village development assets. Consequently, farm roads function not merely as physical transportation routes but also as sociological spaces that reinforce the cohesion and autonomy of local farming institutions. This comprehensive empowerment undeniably necessitates a space for cross-disciplinary collaboration, engaging perspectives from political science, sociology, and pure sciences to assist farmers in managing their assets. Farmer groups equipped with robust governance literacy will transform into positive pressure groups, advocating for democratic village policies. Structured academic mentorship also assumes a central role in transferring knowledge regarding public policy advocacy to grassroots government apparatuses.

This research offers novelty by positioning agricultural infrastructure not merely as an object of physical utility, but as a public policy instrument capable of restructuring the local economic landscape in Lamongan Regency. Through comprehensive analysis, the findings of this study are projected to serve as a strategic reference for the development of infrastructure models that are responsive to the dynamics of environmentally and socially conscious governance. Ultimately, the results of this study are expected to contribute to formulating an independent agricultural

policy research and innovation framework that is equitable for all strata of society. This model of infrastructure and welfare improvement in Lamongan can subsequently be utilized as a prototype to be piloted in surrounding regions with similar characteristics, such as Gresik, Bojonegoro, and Tuban. The success of the policy incubation process at the local level will enrich the literature and serve as a crucial reference for the compilation of future local government textbooks. This reaffirms the essential principle that a commitment to ecological sustainability and the welfare of farmers is a non-negotiable foundation for the civilizational advancement of a region.

Method

This study employs a mixed-methods approach, comprehensively combining and integrating quantitative and qualitative methods within a single inquiry. The research was conducted in Lamongan Regency, East Java Province, which is geographically situated in the northern coastal lowlands at coordinates ±7°08′ S and 112°25′ E. Lamongan Regency was selected due to its substantial agricultural potential, with its primary commodities encompassing rice, corn, and vegetables. The relatively flat topography of the region highly supports various agricultural activities, including the facilitation of farm road infrastructure development, which serves as the primary focus of this study. This mixed-methods approach was chosen to bridge the evaluation of statistical figures with the socio-economic realities of the grassroots community. Furthermore, Lamongan Regency represents a strategic area within the agrarian cluster of the northern coast of East Java, ecologically and economically intersecting closely with surrounding regions such as Gresik, Bojonegoro, and Tuban (Miles et al., 2014). The selection of this location is expected to provide a representative overview of the dynamics of resource and infrastructure governance in areas characterized by a high intensity of regional development.

To acquire holistic and valid data, this study applies several multidimensional data collection techniques. The first technique involves in-depth interviews conducted both directly and indirectly with key stakeholders, including farmers, village officials, and representatives from the local Department of Agriculture. These interviews are intended not only to extract quantitative technical information but also to map the dynamics of policymaking and decision-

making processes at the village level regarding infrastructure allocation. Additionally, the researchers conducted field observations through direct visits to agricultural sites. Through these observations, all cultivation activities, the physical condition of farm roads, and other relevant on-site objects were directly examined. These observations also focused on identifying the ecological interactions between the physical development and the surrounding environment and landscape (Yin, 2018). To complement and strengthen the validity of the information, the researchers collected secondary data from relevant agencies and compiled various documentation pertinent to the study's focus. The utilization of these integrated instruments ensures that the subsequent analysis does not overlook the social and environmental dimensions that are often neglected in the evaluation of purely physical projects.

The data analysis process in this study was conducted systematically and continuously through three primary stages. The first stage is data reduction, wherein the researchers sort, summarize, and simplify the raw data gathered from the field to focus more precisely on the core issues. Subsequently, data display is performed by organizing and presenting the reduced data into structured and easily comprehensible descriptive narratives or visual formats. This reduction and presentation process prioritizes the principle of source triangulation, enabling the statistical findings from questionnaires to be directly corroborated by the profound narratives of the farmers' lived experiences. Through this systematic data processing workflow, in the final stage, the researchers are able to draw accurate and credible conclusions to address the research questions regarding the effectiveness of farm road construction. This conclusion-drawing stage does not merely evaluate the attainment of government target figures but also formulates a theoretical synthesis rooted in the realities of political ecology in the field. Ultimately, this methodological framework is designed to generate public policy recommendations that are independent, adaptive, and oriented toward the sustainable enhancement of structural welfare.

Results and Discussion

Results

The Effectiveness of Farm Road Development

Agricultural infrastructure constitutes a vital component within the

upstream subsystem, anticipated to support the farming, processing, and marketing subsystems, particularly in centers producing horticulture, plantation, livestock, and fishery commodities (Lilja et al., 2017). Farm roads are an essential element of infrastructure in agricultural development, designed to enhance food security, foster agribusiness growth, and elevate farmer welfare. In the Strategic Planning Document of the Department of Food Security and Agriculture for 2025–2029, ten indicators of development success have been established. These include the increased production of food crops, horticulture, and plantations; the price index received by farmers for these three crop types; the desirable dietary pattern score; risk management values; the community satisfaction index; and the SAKIP (Government Agency Performance Accountability System) score. Intrinsically, measuring these indicators requires a structured evaluation instrument to align with regional macroeconomic targets. The achievement of these ten parameters cannot be viewed in isolation; rather, they must be integrated into an accountable governance framework. Therefore, institutional strengthening in the upstream sector becomes an absolute prerequisite before massive physical interventions are undertaken. Periodic evaluation of this Strategic Plan also necessitates the involvement of academic elements and practitioners to ensure the resulting derivative policies are more adaptive to field dynamics. Consequently, this cross-sectoral engagement will enrich the epistemological foundation in assessing the effectiveness of comprehensive rural development programs.

The research findings demonstrate that the development of farm roads significantly enhances farmers' accessibility to agricultural land and markets, which can be elucidated through the frequency of farmers' mobility and the ease of harvest distribution. Adequate farm roads facilitate routine access to agricultural plots, spanning from planting to harvesting, which results in time and energy conservation, reduced production costs, and augmented productivity. Furthermore, robust infrastructure streamlines the transport of agricultural products to markets, thereby mitigating distribution costs and the risk of damage, and ultimately boosting income as a greater proportion of the yield is sold in optimal condition. This increasingly open accessibility directly mitigates the

economic vulnerability frequently experienced by smallholder farmers during peak harvest seasons. With a substantially truncated supply chain, commodities can be promptly absorbed by the market without incurring significant weight loss or quality degradation. Moreover, the efficiency of distribution time affords farmers broader latitude to engage in rational price negotiations with various purchasing agents. Gradually, this transformation of the mobility landscape erodes information asymmetry and dismantles the dominance of third parties who previously monopolized logistical access in isolated regions.

Table 1. Data on the Development of Farm Roads and Irrigation Networks in Lamongan Regency

No	Description	2023	2024	2025
1	Farm roads	34	59	73
2	Irrigation networks	6	8	19

Based on the available data, the trajectory of agricultural infrastructure from 2023 to 2025 exhibits a continuous upward trend for both farm roads and irrigation networks. The construction of farm roads escalated from 34 units in 2023 to 59 units in 2024, and further increased to 73 units in 2025. This progression signifies a consistent effort to improve accessibility to agricultural land. Concurrently, the development of irrigation networks also rose from 6 units (2023) to 19 units (2025), reflecting heightened attention to water availability. The quantitative augmentation in both foundational pillars indicates a paradigm shift in regional capital expenditure orientation toward strengthening agrarian-based production assets. It is postulated that the combination of stable water availability and adequate logistical access will cultivate a farming ecosystem resilient to anomalous climatic fluctuations. If this positive trend of infrastructural expansion can be replicated in surrounding areas—such as the Gresik, Bojonegoro, and Tuban clusters—the probability of establishing an integrated regional food security belt will significantly increase. The synchronization of road and irrigation availability constitutes a crucial foundational step toward macro-scale agricultural modernization.

Furthermore, when examined through the lens of political ecology, the effectiveness of farm road construction is construed not merely as the provision of physical facilities but as a form of spatial intervention that redistributes access to

and control over resources. The advent of this infrastructure fundamentally alters the pattern of interaction between farmers and their agrarian landscape, minimizing geographical barriers that have historically perpetuated economic marginalization in hinterland areas. Consequently, farm roads operate as an instrument of spatial democratization, empowering smallholder farmers to participate more equitably in the broader agribusiness value chain. Through this perspective, infrastructural development is no longer viewed in a vacuum but is replete with power negotiations between the state and civil society at the local level. Equitable accessibility possesses the potential to prevent the monopolization of logistical assets by a select village elite, ensuring that every farming entity holds equal rights to public distribution facilities. This equitable access is also pivotal in fortifying agrarian zones against the threat of land conversion expansion, which frequently exploits the isolation of community living spaces. This reaffirms that the creation of spatial justice is a cardinal pillar in realizing genuine natural resource sovereignty.

From the perspective of sustainable governance, or Environmental, Social, and Governance (ESG) principles, the meticulously planned development of farm roads reflects a regional administration responsive to the needs of vulnerable demographics. This effectiveness is measured not solely by the additional kilometers of concreted or paved roads, but by its capacity to incubate social sustainability (such as local job creation) alongside environmental stewardship. Planning that integrates these governance principles ensures that physical development harmonizes with the environmental carrying capacity of the village. The application of ESG indicators at the rural project level guarantees that every developmental intervention incorporates accountable ecological risk mitigation right from the planning phase. Additionally, the social governance dimension of this framework mandates the structural inclusion of marginalized groups in the project oversight process. Transparency in technical field implementation will minimize the potential for budgetary leakages, which often delegitimize the efficacy of regional public policies. Ultimately, the integration of these oversight values will restructure the local government's paradigm, shifting from a mere pursuit of physical targets toward a

visionary governance of environmental civilization.

The presence of these farm roads also acts as a catalyst for implementing a circular economy system in rural areas. Prior to the existence of adequate access, crop residues or agricultural biomass were frequently burned or summarily discarded due to exorbitant transportation costs. With logistics now substantially more affordable, agricultural waste can be efficiently distributed and reprocessed into organic compost or alternative livestock feed. This not only curtails greenhouse gas emissions stemming from open burning but also engenders a circulation of added value that diminishes the village's reliance on external chemical inputs. Inherently, the transition to this circular model necessitates a reorientation of cultivation practices from linear and extractive patterns to a regenerative system. The seamless circulation of organic materials opens avenues for the emergence of new cottage industries, such as local fertilizer production centers, which can be cooperatively managed. This facilitated spatial mobility also accommodates interdisciplinary research—bridging the fields of biology, chemistry, and sociology—to optimize waste processing formulas rooted in local wisdom. Thus, the farm road transcends its role as a mere concrete corridor, evolving into an artery of innovation that converges scientific discourse with the quotidian realities of farmers.

Ultimately, the effectiveness of this development is heavily contingent upon institutional synergy between the supra-village level (regency government) and local institutions at the grassroots level. The active involvement of farmer groups in determining the coordinates of construction ensures that infrastructural allocations are accurately targeted and shielded from the political biases of village elites. This synergy guarantees that the developmental vision outlined in the regional Strategic Plan is genuinely grounded as an empirical solution to the fundamental logistical predicaments that have long constrained farmers' mobility. This transformation of institutional relations urgently requires a policy research and innovation platform capable of facilitating sustained, constructive dialogue between regulatory formulators and field actors. Academic mentorship is absolutely essential to translate such political will into applicable and autonomous Standard Operating Procedures (SOPs) for maintenance. In the absence of a

structured transfer of governance management knowledge, the established physical assets face a high risk of premature technical dysfunction. The entirety of this dialectical process substantiates that rural autonomy cannot be dictated from above; rather, it must be scientifically incubated from below.

Impact on Productivity

Farm roads function as connecting routes between agricultural lands and distribution centers, thereby significantly influencing the fluidity of farming activities. The existence of these roads exerts a positive impact on productivity enhancement by facilitating farmers' access to their fields. This accessibility enables the frequency of activities—such as planting, fertilizing, and harvesting—to be executed more optimally and punctually. Furthermore, farm roads support the seamless distribution of production inputs (fertilizers, seeds, and equipment) at a reduced cost. The established connectivity indirectly reduces the price disparity of production facilities between the central regency government areas and remote villages. Moreover, the resulting operational time efficiency allows farmers to focus more intently on improving the quality of their agricultural land management. This spatial transformation serves as a crucial starting point in realizing agribusiness production autonomy on a local scale.

Table 2. Agricultural Production Data (Tons) in Lamongan Regency

No	Component	Yr. 2021	Yr. 2022	Yr. 2023	Yr. 2024	Yr. 2025
1	Rice production	1,196,310	1,211,821	1,111,651	1,138,114	1,335,099
2	Corn production	570,200	558,666	582,662	479,944	536,245
3	Soybean production	9,406	10,412	13,213	5,354	4,573

Rice production has tended to experience a significant increase over the last five years, despite a decline in 2023 caused by a planthopper pest infestation. Meanwhile, corn and soybean production have remained relatively stagnant, as they are secondary commodities planted on rice field bunds or following the second rice planting season. Food crop productivity has fluctuated; in 2025, rice productivity reached 7.34, corn 8.67, and soybeans 1.75. The fluctuation in these

secondary commodities essentially reflects the rational prudence of farmers in allocating capital amidst microclimatic uncertainties. Therefore, the presence of road infrastructure is expected to stimulate farmers' confidence to maximize the potential of fallow land through more extensive intercropping practices. If this inter-commodity integration is managed using a precise environmental governance approach, the per capita productivity accumulation of farmers is anticipated to increase sharply.

This productivity enhancement is also inseparable from the acceleration of agricultural mechanization, made possible by the availability of representative roads. Adequate infrastructure allows heavy agricultural machinery and equipment, such as four-wheeled tractors and combine harvesters, to access the rice plots directly. The substitution of human labor with machinery not only addresses the scarcity of farm laborers during peak planting or harvesting seasons but also drastically improves land cultivation time efficiency, which directly correlates with the stability of the Cropping Index (IP). The integration of this mechanical technology also mitigates excessive physical fatigue, thereby providing farmers with a transitional space to shift their roles into more strategic agribusiness managers. In agrarian regions intersecting with extractive or industrial zones, mechanization becomes an absolute solution to stem the exodus of the productive rural workforce. This structural transformation will gradually modernize the face of rural agriculture, rendering it a far more attractive sector for the younger generation.

Additionally, logistical fluidity directly reduces post-harvest loss rates, which have historically been a variable that depletes total production. Horticultural and food commodities possess physical characteristics that are highly vulnerable to mechanical impact and temperature fluctuations. With improved road surfaces and shorter travel times to drying or milling facilities, the integrity of rice grains and the quality of other harvests can be preserved. A reduction in commodity damage mathematically provides a tangible contribution to the recorded final production volume. This decline in yield loss aligns with sustainability principles by minimizing the accumulation of commercial organic waste discarded vainly along the supply chain. Cumulatively, this harvest optimization fortifies the stability of regional food

reserves without the need for excessive extraction or the clearing of new land. The protection of the economic value of post-harvest commodities constitutes an essential pillar in agricultural governance oriented towards Environmental, Social, and Governance (ESG) principles.

In the context of ecological resilience, excellent accessibility enables farmers to respond more swiftly to climate anomalies and pest population outbreaks, as exemplified by the planthopper infestation in 2023. The distribution of organic pesticides, biological agents, and agricultural supplements can be executed responsively and massively, unhindered by adverse terrain. The velocity of crisis mitigation at this micro-level becomes a determining factor in salvaging the remaining harvest, preventing annual productivity graphs from experiencing extreme contractions. This established resilience proves that the fluidity of climate change adaptation in the agrarian sector depends heavily on the readiness of its supporting logistical infrastructure. The ability to maneuver amidst ecological crises also prevents farmers from succumbing to collective panic, which frequently triggers the uncontrolled use of synthetic chemicals. Ultimately, well-established physical infrastructure acts as an ecological shield that maintains the balance of biological carrying capacity in rice field areas.

The ease of mobility for production inputs, in turn, opens avenues for a more commercially oriented diversification of commodities. When the transportation costs of soil ameliorants and fertilizers become rational, farmers gain the flexibility to experiment with optimizing fallow land during the dry season. Although data indicates that soybeans and corn remain stagnant as catch crops, mature logistical infrastructure forms a crucial foundation that will eventually undergird the transformation from monoculture farming to a more productive and profitable integrated polyculture system. The transition toward this polyculture system is highly relevant for comprehensive implementation across administrative boundaries, forging a solid integration of agricultural economic resilience in strategic regional areas such as Lamongan, Gresik, Bojonegoro, and Tuban. Well-managed harvest diversification will buffer inflationary shocks at the regional level should a primary commodity suffer a mass crop failure. Thus, farm roads are not merely physical supporting facilities, but rather

politico-economic infrastructures that actively empower rural communities to reclaim their food sovereignty independently.

Impact on Farmer Welfare

Transportation costs constitute a crucial component in the farming cost structure that significantly influences farmers' profit margins. In Lamongan Regency, transportation costs experienced a decline from 2023 to 2025, corresponding with the construction of farm roads. This cost reduction indicates an enhancement in distribution efficiency, which subsequently impacts farmers' income. Ease of access also enables farmers to sell their products at competitive prices, eliminating their absolute dependence on middlemen (*tengkulak*) who dictate low selling prices. Capital accumulation, previously consumed by logistical transport costs, can now be reallocated toward the procurement of higher-quality and environmentally friendly production inputs. Consequently, farmers gain broader fiscal space to initiate a transition from a reliance on chemical fertilizers to the utilization of organic fertilizers or self-produced compost. Essentially, this operational cost efficiency functions as an economic cushion that protects the purchasing power of farming households against macro-inflationary shocks. With a more rational financing structure, the agricultural sector in this region can sustainably maintain its commodity competitiveness amidst fierce regional food supply competition.

Table 3. Farmers' Terms of Trade (NTP) in Lamongan Regency

No	Description	2021	2022	2023	2024	2025
1	NTP Lamongan	106.81	109.26	116.05	123.93	124.97

The trajectory of the Farmers' Terms of Trade (NTP) in Lamongan Regency demonstrates an ameliorating trend. In 2021, the NTP was recorded at 106.81 and consistently exhibited a significant increase, reaching 124.97 by 2025. The index received by farmers (pertaining to product sales) surpassed the index paid, indicating that agricultural enterprises continue to yield profitability. This persistent rise in NTP suggests that the inflation rate of basic necessities and production facilities is effectively counterbalanced by an increased market appreciation for local harvest commodities. These statistical figures represent the fortification of farmers' economic resilience, marking a shift from mere subsistence-level

survival to a more measurable commercial economic management. Concurrently, this positive trend solidifies Lamongan Regency's position as a robust food granary within the agrarian regional constellation alongside Gresik, Bojonegoro, and Tuban. Sustaining the momentum of these NTP achievements in the future invariably necessitates a consistent regional governance commitment, particularly in securing base price stabilization instruments during the peak harvest season.

This elevated welfare is tangibly reflected through the deconstruction of the historically asymmetric local market structure. Prior to the establishment of the infrastructure, exorbitant logistical transaction costs engendered an oligopsony wherein middlemen emerged as the sole entities possessing the transport capital required to penetrate the hinterlands. The construction of farm roads dismantled this monopoly, unlocked the channels of inter-merchant competition, and granted farmers the latitude to select marketing avenues that offer the most rational profit margins. This paradigm directly amplifies the farmers' bargaining power within the market structure. From a political ecology perspective, this shift in market dynamics signifies the collapse of exploitative relations that have impoverished primary producers at the grassroots level for decades. Farmers now possess absolute sovereignty to access real-time market price information, undistorted by the speculative narratives of intermediary agents. The democratization of logistical access gradually cultivates a collective consciousness among farmer groups to establish more progressive, independent economic institutions, such as agribusiness cooperatives. Ultimately, farm roads do not merely provide physical access; rather, they serve as instruments of structural liberation that restore the control of production and distribution apparatuses into the hands of the rural community.

Beyond financial dimensions, welfare must also be interpreted through multidimensional quality of life improvements, including the mitigation of disproportionate physical workloads. For decades, farmers and agricultural laborers were compelled to carry burdens or pedal bicycles across slippery embankments for hours to evacuate their grain. The advent of road access for motorized vehicles has eradicated this form of excessive physical exertion. The ensuing conservation of energy and time

yields crucial impacts on long-term health improvements and the availability of leisure time that can be allocated for other productive activities or social interactions within the community. The alleviation of this extreme workload directly contributes to mitigating the risks of musculoskeletal disorders and chronic fatigue that frequently afflict the productive age group of agrarian workers. From a social security perspective, this enhancement in occupational health and safety will subsequently suppress household out-of-pocket expenditures for medical treatments. The newly generated leisure time can now be converted into social capital, affording farmers greater opportunities to participate actively in village deliberation forums. This heightened civic participation is vital for fostering the institutionalization of a more democratic, transparent, and inclusive village-level governance.

Furthermore, infrastructural improvements precipitate a multiplier effect for the rural microeconomy. Fluid mobility stimulates the emergence of ancillary enterprises around agricultural zones, such as local transport service providers, agricultural machinery workshops, and stalls supplying daily necessities for farm laborers. The diversification of income sources beyond the core cultivation sector constitutes a crucial economic cushion for farming households, functioning to preserve family financial stability when agricultural commodities encounter price fluctuation cycles. This nascent entrepreneurial ecosystem absorbs local labor that may not be optimally accommodated within the primary cultivation sector, thereby minimizing the rate of disguised unemployment. Robust connectivity also incentivizes the inception of household-scale circular economy initiatives, such as the utilization of husk and straw waste—which can now be easily transported—to be processed into commercially viable bio-briquettes or organic fertilizers. This diversification progressively shifts the rural paradigm from merely a raw commodity extraction zone to a center of high value-added circular economic growth. This bottom-up communal financial resilience serves as a foundational pillar in realizing regional economic stability that is impervious to global crisis shocks.

Moreover, analyzed through the lens of social justice, the improvement of farm roads concurrently propels economic inclusivity by facilitating the roles of more marginalized actors,

notably women farmer groups. With a more accessible distribution terrain, rural women are presented with greater opportunities to engage directly in micro-logistics management and small-scale post-harvest marketing. This spatial empowerment is a fundamental step in narrowing the rural gender gap, ensuring that the dividends of infrastructural development are experienced equitably by all social entities within the village. The integration of a gender perspective in this development aligns with the social pillar within the Environmental, Social, and Governance (ESG) framework, which demands equitable access to public policy instruments. The active involvement of women in the downstream supply chain frequently correlates positively with increased income allocation for fulfilling nutritional needs and children's educational access at the household level. Ultimately, the transformation of this physical space provides a platform for women farmer groups to initiate independent and innovative local food processing ventures. Thus, infrastructural development does not merely facilitate the movement of goods; it reweaves the fabric of social cohesion and positions women as central agents of change within the regional food security architecture.

Challenges Encountered

From a social perspective, farm roads also facilitate community mobility in accessing educational, health, and economic services. However, several constraints persist, such as uneven road quality and suboptimal infrastructure maintenance. Furthermore, central government policies significantly impact regional development, notably the mandate requiring local governments to allocate 30% of their Regional Revenue and Expenditure Budget (APBD) toward infrastructure to accelerate regional progress. This obligatory allocation quota frequently precipitates a dilemma for regional administrations, forcing them to navigate between fulfilling physical project quantity targets and ensuring the qualitative sustainability of said infrastructure. An analogous structural challenge has fundamentally emerged as a crucial discourse in the surrounding regional vicinities, encompassing Gresik, Bojonegoro, and Tuban, which are currently striving to reconcile the acceleration of development with their agrarian carrying capacity.

One of the most pressing structural constraints is the absence of a

systematic, post-construction maintenance institution at the village level. Development projects frequently culminate merely at the stage of physical handover, devoid of any accompanying budgeting schemes for periodic maintenance. As the primary beneficiaries, farmer groups generally lack both the managerial literacy and independent operational funds requisite for addressing minor damages. Consequently, physical road degradation—such as surface cracking or shoulder landslides—is often neglected until it reaches a state of severe deterioration that once again impedes mobility. This inability to maintain public assets glaringly illustrates the prevailing weakness of governance at the grassroots level. Therefore, it is imperative to establish a policy framework that explicitly binds commitments to continuous mentoring, thereby fostering an ecosystem of autonomous and empowered village institutions.

From an environmental dimension, infrastructure planning that insufficiently considers micro-scale Environmental Impact Assessments (AMDAL) frequently engenders derivative complications. Road construction that intersects the natural contours of the land is often implemented without adequate drainage systems (culverts). During the rainy season, the absence of these drainage channels transforms the roads into artificial dams that obstruct water runoff, triggering inundations that submerge rice fields and accelerating both soil erosion and the degradation of the road materials themselves. The disregard for Environmental, Social, and Governance (ESG) principles during this physical design phase ultimately precipitates long-term ecological and economic detriments for the farming community. Simultaneously, this case underscores the critical importance of a political ecology approach to prevent physical state interventions from inadvertently disrupting the local hydro-orological equilibrium.

Furthermore, regional government policy interventions are frequently stymied by limited fiscal space, wherein mandatory spending consumes the majority of the Regional Revenue and Expenditure Budget (APBD) structure. The political tug-of-war in determining development priorities often relegates specific agricultural infrastructure to a subordinate position compared to inter-subdistrict highways, which are deemed

more electorally populist. This allocative disparity elucidates why the quality and volume of farm roads across different areas within Lamongan Regency remain largely uneven. Such budgetary political hegemony indicates that the rationality of sectoral economic development is frequently eclipsed by short-term electoral pragmatism. Consequently, primary food production centers are recurrently marginalized from the equitable distribution of inclusive regional development dividends.

The paradox inherent in this enhanced accessibility is the emergent threat of productive land conversion. Increased accessibility automatically inflates the valuation of land adjacent to farm roads. Unless accompanied by stringent regional spatial planning regulations (such as the designation of Sustainable Food Agricultural Land or LP2B), this logistical facilitation paradoxically induces a temptation among farmers to sell their land or convert it into commercial buildings or small-scale industrial facilities. If left unchecked, this phenomenon will prove counter-productive to the initial objective of road construction, which is to safeguard regional food security. The pressure of uncontrolled spatial expansion can potentially plunge the agrarian landscape into a trap of spatial exploitation. Therefore, the rigorous enforcement of spatial laws serves as the ultimate bulwark to ensure that farmers' land sovereignty is not eroded by the relentless tide of land capitalization.

Conclusion

The development of farm road infrastructure in Lamongan Regency has proven to be a highly effective policy intervention in enhancing both agricultural productivity and farmer welfare. By providing ease of access and significant production cost efficiency, these physical infrastructures have empowered farmers to optimize land management and minimize logistical barriers. Furthermore, the ensuing cost efficiency functions as a crucial economic cushion that elevates the Farmers' Terms of Trade (NTP), thereby breaking the oligopsonistic chains of local middlemen. Ultimately, this spatial democratization not only bolsters regional food security but also transforms subsistence farming into a more resilient and commercially viable agribusiness sector.

However, to ensure that the benefits of this infrastructure are felt optimally, critical improvements are required in the aspects of equitable development and long-term maintenance. The current trajectory is

impeded by structural challenges, notably the absence of systematic post-construction maintenance programs and uneven road quality across the region. Additionally, inadequate environmental planning threatens to precipitate premature physical degradation and unintended ecological disruptions. The allocation of regional budgets often reflects short-term electoral pragmatism, which further exacerbates the disparities in infrastructure quality. Concurrently, the paradox of increased accessibility has escalated the risk of productive land capitalization, posing a severe threat to agrarian spatial sovereignty if left unregulated.

To navigate these complexities and safeguard the sustainability of rural infrastructure, the government must prioritize enhancing the quality of farm road construction and establishing continuous maintenance programs. It is equally imperative to foster active community participation in the management of these agricultural infrastructures. By embedding Environmental, Social, and Governance (ESG) principles into rural development strategies, policymakers can ensure that farm roads serve not merely as logistical conduits, but as catalysts for equitable agrarian progress. Moving forward, a synergized, cross-sectoral commitment—coupled with stringent spatial planning regulations—is vital to fortify Lamongan's position as a robust and sustainable food granary.

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