IMPACT ASSESSMENT OF RURAL DEVELOPMENT AND AGRICULTURAL INFRASTRUCTURE SUSTAINABILITY THROUGH FARM-TO-MARKET ROADS IN AGUSAN DEL SUR

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Abstract: *This study investigates the social, economic, physical, and environmental impacts of Farm-to-Market Roads (FMRs) on rural development in Agusan del Sur, Philippines. Employing a mixed-methods approach, including household surveys, key informant interviews, focus group discussions, and field assessments, the research examines how improved road infrastructure influences agricultural productivity, access to public facilities, and overall social well-being. Findings indicate that FMRs enhance market accessibility, reduce travel times, and contribute to increased agricultural output and income generation. Physical assessments reveal varying road conditions with maintenance challenges in upland areas. Environmental impacts include improved waste management alongside concerns about soil erosion and water quality. The study recommends providing complementary facilities, such as post-harvest and storage infrastructure, and enhancing accessibility to maximize the socio-economic benefits of FMRs. These insights aim to guide policy and infrastructure planning for sustainable rural development in the region.*

Keywords: Farm-to-Market Roads, Rural Development, Agricultural Sustainability, Infrastructure Assessment

1. INTRODUCTION

Rural infrastructure plays a crucial role in improving livelihoods, health, productivity, and reducing poverty. Access to essential facilities such as transportation, water supply, and sanitation is strongly related to the well-being of the general population [1].

Among various rural infrastructure components, road networks, especially Farm-to-Market Roads (FMRs)—are vital for enhancing market access, reducing transportation costs, and boosting economic well-being [2] . FMRs are particularly significant in agricultural economies as they facilitate the efficient movement of farm inputs and outputs, supporting productivity and sustainable rural development [3].

The Philippines, a predominantly agricultural country, relies on farming as a primary livelihood for millions of Filipinos [4] . As a leading exporter of agricultural products in Southeast Asia, the country's economic growth is driven by urbanization, a growing middle class, and a young population, supported by strong consumer demand and remittances [5]. However, many rural areas still face limited access to efficient transport infrastructure, hindering rural development. This underscores the importance of Farm-to-Market Roads (FMRs), which are a key priority in the Philippines' rural development strategy to improve accessibility and strengthen agricultural economies [5].

These national challenges are reflected in regions such as Caraga, where the dependence on agriculture, forestry, and fishing is pronounced. Specifically, Agusan del Sur produces rice, bananas, palm oil, coconuts, corn, rubber, and other commodities [6]. The province has seen significant agricultural expansion, with 76,000 farms spanning 200,500 hectares [7] . Despite this growth, inadequate infrastructure accessibility continues to limit farmers' efficient transport of produce. Strategic investments in Farm-to-Market Roads remain critical in such regions to enhance connectivity and stimulate economic opportunities.

While impact assessments of FMRs have been conducted in various regions, there is still a need for deeper understanding of their local implications. This study will assess the socio-economic, physical, and environmental impacts of FMRs in Agusan del Sur, focusing on how these roads drive rural development and agricultural sustainability. The insights gained will inform policy-making and infrastructure planning, ultimately contributing to the goal of fostering sustainable rural development in the Philippines.

2. METHODOLOGY

2.1 Research Design

This study employed a mixed-methods research design integrating both quantitative and qualitative approaches to comprehensively evaluate the social, economic, physical, and environmental impacts of Farm-to-Market Roads (FMRs) in Agusan del Sur. Quantitative data were collected using structured surveys administered to households and farmers in the study area, while qualitative data were gathered through key informant interviews and Focus Group Discussions (FGDs)

involving community members and local officials. This mixed approach allowed for a comprehensive analysis combining measurable data with contextual and experiential insights, aligning with established mixed-method frameworks [8] [9].

2.2 Sampling and Site Selection

Survey sites were selected using stratified random sampling to ensure representation across Agusan del Sur's municipalities with FMR projects completed between 2016 and 2020. Presented in Table 1 are the number of FMRs per municipality and the single FMR sample selected from each, prioritizing geographic coverage over proportionality. This approach ensures all areas impacted by FMRs are represented, providing meaningful insights despite varying population sizes [10].

Table 1. Population and Sample Sizes for Stratified Random Sampling.

Municipality/City	Population Size	Sample Size
Bayugan City	2	1
Bunawan	1	1
La Paz	1	1
Properidad	2	1
San Francisco	3	1
San Luis	3	1
Talacogon	3	1
Veruela	3	1
Total	17	8

Within these sites, systematic sampling was applied to select household respondents, choosing three individuals per municipality from areas near the start, middle, and end points of each FMR segment. This was further extended to include residents living within a two-kilometer radius to better capture the wider community impact [11] . Purposive and convenience sampling were employed to select key informants such as barangay officials and farmers actively engaged in agricultural activities along the FMR corridors, ensuring the relevance and accessibility of qualitative data [12].

2.3 Data Collection Instruments

Four customized instruments were developed to assess the impacts of Farm-to-Market Roads (FMRs) in Agusan del Sur: (1) FMR Field Assessment Survey for road condition; (2) Household Survey Questionnaire for social, economic, and environmental effects; (3) Focus Group Discussion (FGD) Guide for farmer and stakeholder perceptions; and (4) LGU Consultation Questionnaire for technical insights from local officials. These tools captured both pre- and post-FMR conditions.

Following mixed-methods best practices (Creswell, 2014), data triangulation from multiple levels ensured a comprehensive evaluation. Participatory approaches like FGDs helped identify community-level changes and validate survey results [9]. The context-sensitive design ensured relevance to Agusan del Sur, supporting comprehensive impact assessment and practical recommendations.

2.4 Data Gathering Procedure

Data collection was conducted through face-to-face interviews and direct observations during the study period. Informed consent was obtained from all participants after explaining the study's objectives and ensuring confidentiality. Participants were informed that their involvement was voluntary and that they could withdraw at any time without consequence. Audio recordings were used to supplement note-taking, thereby improving the accuracy of qualitative data. The researchers collaborated with barangay officials who facilitated community access and assisted with participant recruitment, consistent with community-based participatory research methodologies. Focus Group Discussions (FGDs) were conducted with carefully selected groups of 4 to 10 participants each to maintain group cohesion and maximize discussion quality [9].

2.5 Data Analysis

Quantitative data from household surveys and structured questionnaires were analyzed using descriptive and inferential statistics via the JASP software, which enabled the identification of trends, patterns, and statistically significant differences pre- and post-FMR construction [13]. Qualitative data obtained from FGDs and interviews were transcribed verbatim and subjected to thematic analysis following Braun and Clarke's guidelines, which involve identifying, analyzing, and reporting themes within the data to provide explanatory narratives [14] . The integration of quantitative and qualitative findings through triangulation enhanced the validity and comprehensiveness of the research outcomes [8].

2.6 Ethical Considerations

Ethical standards were rigorously upheld throughout the research process. Participants' anonymity and confidentiality were safeguarded by excluding identifying information from all reports and publications. The study adhered to the Philippine Data Privacy Act of 2012 and complied with standard social science research ethics protocols, ensuring respect for participants' rights and welfare. Participation was entirely voluntary, with respondents free to decline or withdraw without penalty at any stage of the study. All data were securely stored and managed in accordance with ethical guidelines to maintain integrity and protect participant information.

3. RESULTS AND DISCUSSION

3.1 Respondents' Profile

A total of 21 respondents participated, predominantly middle-aged (47.6% aged 51–65) and mostly male (57.1%). Most were married (71.4%) and headed households averaging 3–5 members, indicating stable family structures [15]. Over half (52.4%) have lived in their communities for more than 20 years, providing valuable long-term perspective [16].

Economically, 81% earned below 10,000 Php monthly, underscoring rural livelihood challenges. Agriculture dominates the local economy, with 66.7% of respondents engaged in farming, primarily crop farming. Among these farmers, 86% focus exclusively on crops such as rice, coconut, and banana, as illustrated in Figure 1.

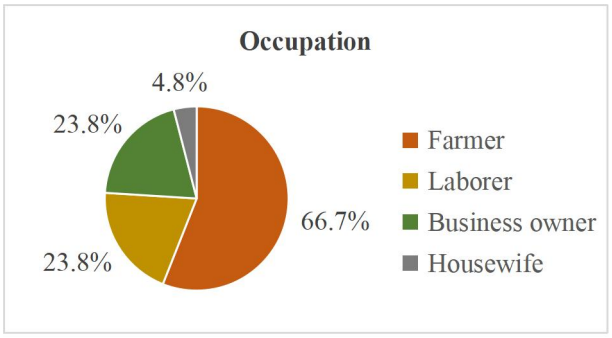


Fig. 1. Socio-demographic profile of the respondents in terms of occupation.

Farm sizes are generally small, with 78.6% cultivating 1–3 hectares. Following the construction of FMRs, significant improvements in production levels were reported, with 71.4% of respondents indicating high or very high output compared to pre-FMR conditions (Figure 2). This underscores the critical role of improved infrastructure in enhancing market access and productivity [2].

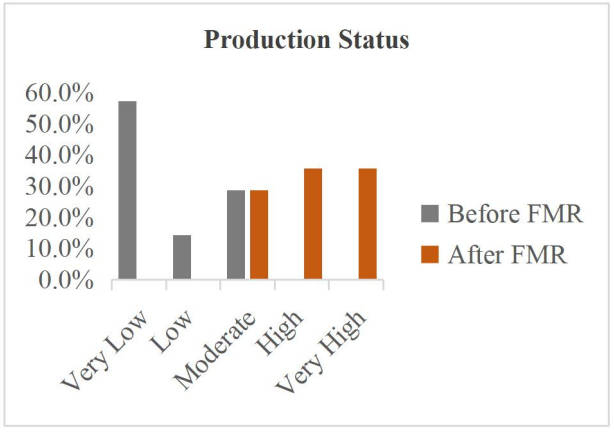


Fig. 2. Production status before and after FMR.

3.2 Impact Assessment Result

3.2.1 Social Impact

The implementation of Farm-to-Market Roads (FMRs) has greatly improved transportation accessibility and social well-being in rural communities. All respondents (100%) reported easier access to markets, schools, healthcare, and employment, with travel times to key services reduced by over 60% in some cases (Figure 3). Focus Group Discussions confirmed better access to agricultural inputs and markets, although some logistical challenges remain in certain areas. Most respondents (57.1%) noted strengthened social connections and greater community engagement, while a small portion (9.5%) experienced decreased in-person interaction due to increased digital communication [17] [18].

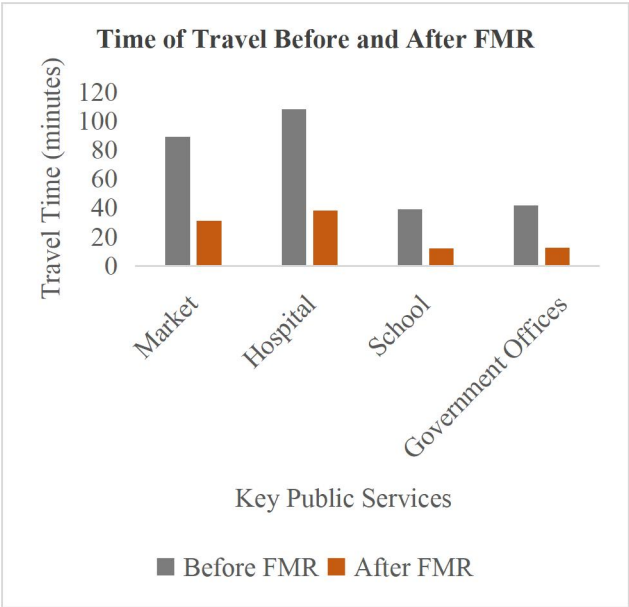


Fig. 3. Time of travel on selected municipalities in Agusan del Sur to key public services before and after FMR.

FMRs have also enhanced access to education and public services, facilitating better school attendance and healthcare access for all participants [19]. Community development benefits include the emergence of new establishments (52.4%) and increased participation in agricultural training (80%) due to improved mobility [20]. Safety perceptions were generally positive, although some concerns persist in hazardous road sections. Access to basic resources such as water, electricity, and stores significantly improved post-FMR, but rising costs and economic disparities may limit full inclusion of low-income groups [21].

Despite these benefits, increased migration linked to improved infrastructure has led to higher conversion of agricultural lands into residential and commercial use, posing challenges for rural livelihoods and land availability. This trend threatens to reduce the area available for farming and may require more strategic use of FMRs to balance infrastructure development with agricultural sustainability [22]. Thus, while FMRs have boosted connectivity and access, careful planning is needed to mitigate potential negative effects of land use change driven by population shifts.

3.2.2 Economic Impact

The implementation of Farm-to-Market Roads (FMRs) has significantly enhanced rural economic activities by improving market access and household incomes. Most respondents (85.7%) reported better access to markets, with 90.5% indicating increased income—mostly ranging from less than 1,000 to 5,000 Php monthly. Improved roads also facilitated new employment opportunities for some, though many continue relying on farming [20]. Access to financial services and credit loans improved, enabling investments in livelihoods and small businesses [23].

Marketing practices improved with increased trader activity and higher commodity prices in several areas, boosting revenues [24]. Transportation became more efficient with the use of motorized vehicles, though these may introduce higher costs that could burden small-scale farmers [25]. Production yields remained largely stable, and post-harvest losses persisted due to limited storage and processing infrastructure, indicating that roads alone cannot resolve all agricultural challenges [25].

Despite these benefits, economic disparities and inflation pose significant barriers. Rising operational costs—including wages, inputs, and transportation fees—limit the full advantage of improved infrastructure for many smallholders and micro-businesses [26]. Increased commodity prices and competition may reduce affordability for low-income consumers and widen inequalities, limiting equitable economic gains from FMRs [27]. These challenges underscore the need for complementary policies and support systems alongside infrastructure improvements to ensure inclusive and sustainable rural economic development.

3.2.3 Physical Impact

Farm-to-Market Roads (FMRs) in Agusan del Sur face significant physical deterioration due to a combination of tropical climate stress, heavy usage, and limited maintenance. Visible cracks, potholes, uneven surfaces (Figure 4), and erosion are widespread across most roads, accelerated by extreme heat, heavy rains, and typhoons [28]. Technical factors such as underdesign, pavement age, and weak subgrade further contribute to rapid wear [28].

Fig. 4. Observed road damages in various barangays: (a) crack in Brgy. Poblacion, San Luis; (b) potholes in Brgy. Bunawan Brook, Bunawan; and (c) uneven road surface in Brgy. Del Monte, Veruela.

Traffic loads vary, with highly trafficked roads in La Paz, San Francisco, and San Luis exceeding design capacities and experiencing more severe degradation. None of the roads have proper shoulders, increasing safety risks and drainage problems. Only one road features drainage infrastructure, leaving others vulnerable to water damage and erosion, highlighting urgent maintenance needs [29].

Despite these challenges, FMRs remain vital connectors supporting diverse vehicle use for agricultural and residential transport. Roads with higher traffic volumes serve as main arteries linking markets and communities, while lower-traffic roads primarily support local agricultural operations. Increasing residential and commercial development along FMR corridors reflects infrastructure's role in spurring local growth but also raises environmental concerns such as soil compaction and water pollution [30]. These findings underscore the necessity of integrated planning and sustainable maintenance to balance infrastructure benefits with ecological protection.

3.2.4 Environmental Impact

Farm-to-Market Roads (FMRs) have improved waste management practices and facility access for most communities, leading to cleaner environments and greater community participation in sustainable disposal methods [31] [32]. While flooding decreased in some areas due to better drainage, other municipalities still experience waterlogging during heavy rains, and soil erosion, especially in sloped areas like Talacogon, remains a challenge, highlighting the need for erosion control and proper maintenance [33]. Concerns about water quality from road runoff have arisen where drainage is inadequate, risking contamination of irrigation and drinking sources. However, most respondents observed no significant changes in local climate patterns, suggesting that current FMR construction has minimal impact on microclimates or environmental degradation. These findings emphasize the importance of integrating effective drainage and erosion mitigation to ensure that FMRs support sustainable rural development without compromising environmental health [33].

3.3 Generated Map for the selected FMR to its connectivity to key public facilities

The spatial analysis of the eight selected Farm-to-Market Roads (FMRs) in Agusan del Sur illustrates their critical role in linking rural communities to essential public services such as schools, health facilities, markets, and government offices [34]. These routes not only support agricultural productivity but also serve as vital conduits for social services.

As shown in Figure 5, the FMR in Marcelina, Bayugan City demonstrates a well-established connection to various key public facilities, including schools, markets, and government offices. This accessibility significantly reduces travel time and cost for residents, improving their quality of life and economic participation.

In Figures 6a and 6b, the FMRs in Bunawan and Veruela reveal more limited connectivity. These routes primarily link to schools, government offices, and markets; however, there is a noticeable absence of nearby hospitals within these municipalities. This gap forces residents to travel farther for healthcare, indicating a critical area for infrastructure or service investment.

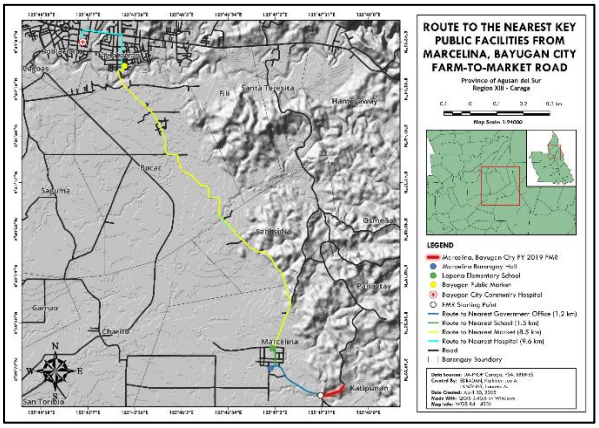
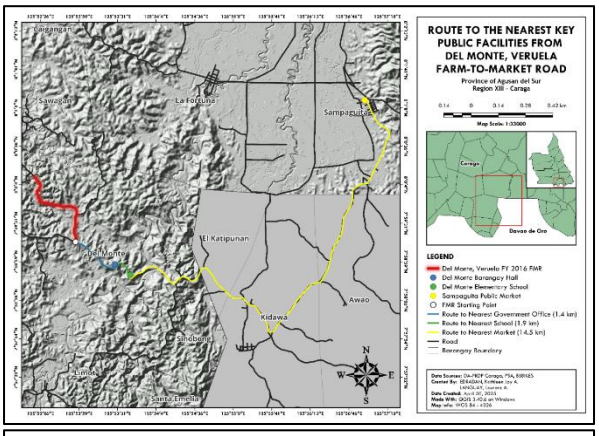


Fig. 5. Map Showing the Route to Nearest Key Public Facilities via the FMR in Marcelina, Bayugan City.



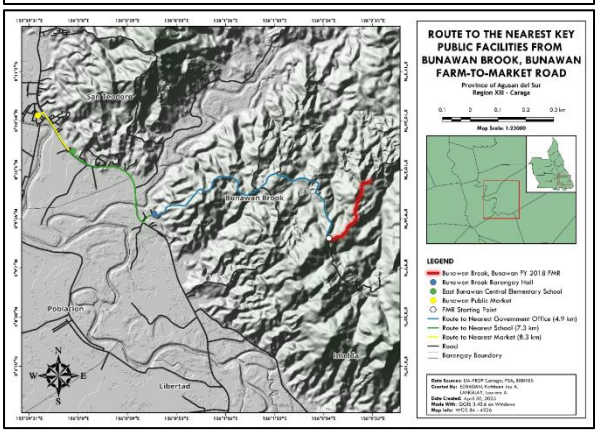


Fig 6. Map Showing only the School, Government Office, and Market as Nearest Key Public Facilities via the FMR in (a) Bunawan and (b) Veruela.

The FMR in Panagangan, La Paz, presented in Figure 7, exemplifies strong integration with essential services. The route offers direct and efficient access to barangay halls and schools, highlighting the potential of well-placed FMRs to minimize travel burdens and enhance service delivery in remote areas.

Similarly, Figure 8 illustrates the FMR in Lucena, Prosperidad, which facilitates convenient access to public facilities. Its proximity to schools, markets, and health centers emphasizes the role of strategic planning in improving rural connectivity and welfare.

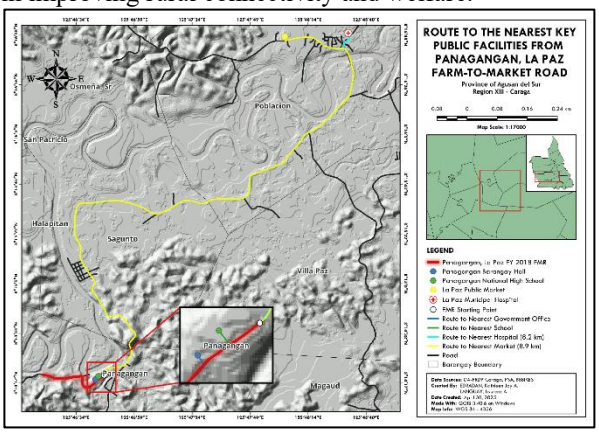


Fig 7. Map Showing the Route to Nearest Key Public Facilities via the FMR in Panagangan, La Paz.

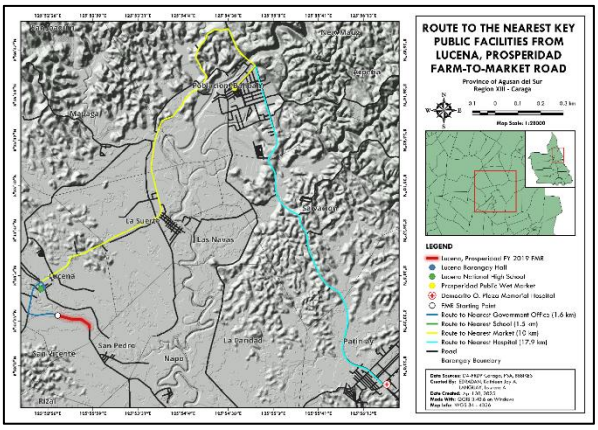


Fig. 8. Map Showing the Route to Nearest Key Public Facilities via the FMR in Lucena, Prosperidad.

In Figure 9, the FMR in Karaos, San Francisco connects to several services, though the distances vary, particularly in accessing healthcare. This disparity indicates the uneven distribution of key facilities across the province.

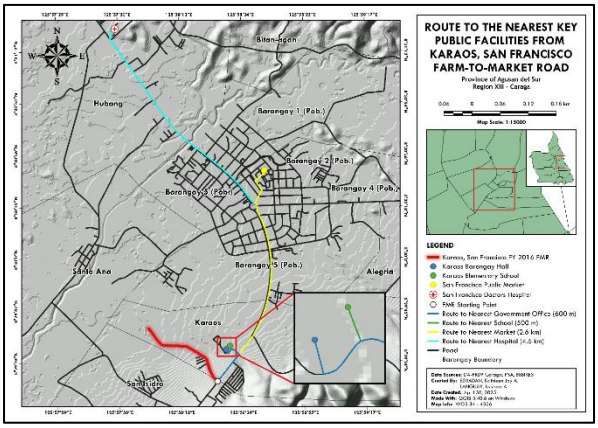


Fig. 9. Map Showing the Route to Nearest Key Public Facilities via the FMR in Karaos, San Francisco.

Lastly, the FMR in Del Monte, Talacogon (Figure 10) shows relatively good connectivity to markets and schools, yet similar to other areas, it lacks immediate access to healthcare services. This pattern underscores a broader trend observed across the region.

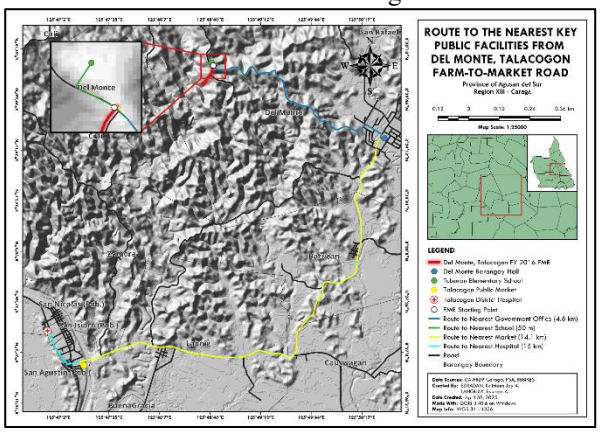


Fig. 10. Map Showing the Route to Nearest Key Public Facilities via the FMR in Del Monte, Talacogon.

These maps collectively reveal that while FMR placement has generally enhanced connectivity to education and government services, gaps remain—especially in healthcare and market accessibility. The distance patterns suggest the need for more strategic infrastructure planning to maximize the social and economic benefits of FMRs. Overall, the spatial data confirm that FMRs substantially contribute to rural development by fostering access and economic opportunities, while also highlighting areas that require complementary investments to close service accessibility gaps [35].

3.4 Policy Recommendations

To sustain and amplify the positive impacts of Farm-to-Market Roads (FMRs), it is essential to extend their reach to enhance rural accessibility. Moreover, complementary infrastructure and services must be developed alongside roads to fully maximize benefits for agricultural productivity and community development.

Furthermore, ongoing maintenance and resilient design are critical to preserve road quality amid increasing usage and climate-related challenges. Additionally, policies should promote inclusive access, actively engage local communities in decision-making, and secure long-term funding to support the continuous improvement and adaptation of FMR infrastructure.

4. CONCLUSION

The impact assessment shows that Farm-to-Market Roads (FMRs) play a crucial role in rural development in Agusan del Sur by improving accessibility and expanding socio-economic opportunities for farming communities. Despite challenges like road deterioration and environmental issues, enhanced connectivity has led to better access to markets, services, and resources, positively affecting livelihoods and community well-being. To sustain these gains, continued maintenance, strategic expansion, and policies addressing economic and environmental concerns are essential. With complementary facilities and active local involvement, future FMR investments can support more equitable and resilient rural growth, turning infrastructure improvements into lasting benefits for agriculture and quality of life.

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