

Article

Benefit Distribution of Community-Based Infrastructure: Agricultural Roads in Indonesia

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Received: 6 February 2020; Accepted: 5 March 2020; Published: 8 March 2020



Abstract: Infrastructure development is believed to provide economic benefits, but the distribution of these benefits is still a subject of discussion. Previous studies generally discussed the distribution of benefits of large-scale and top-down infrastructure. In contrast, this paper aims to explore the existence and distribution of the benefits of community-based infrastructure development. This study uses a case study approach with quantitative and qualitative methods. The study reveals that agricultural roads provide time saving and cost reduction. However, the benefits obtained by farmers vary depending on the location of agricultural land in relation to the road. Although the distribution of benefits differs, farmers do not perceive this as an injustice since the route of the road is determined by the farmer group. Moreover, the greater benefits received have to be compensated by certain amounts of contributions by each farmer in terms of land release. This study also reveals that the physical-environmental conditions of the road contribute to the variation of benefits. The results of this study provide an insight into the benefit distribution from small-scale and community-based infrastructure. Such community-based infrastructure development has been proven to be effective as a model for investing in local infrastructure development.

Keywords: benefit distribution; community-based infrastructure; agricultural road

1. Introduction

Agricultural roads in Indonesia are special road under the responsibility of the Ministry of Agriculture. Besides this special road, there are other public roads with varying government levels tasked with their investment and maintenance. The national government has the authority for managing national roads, the provincial government manages provincial roads, and the city and district governments manage their respective roads [1]. Agricultural roads are production roads or farm roads which constitute transportation infrastructure in agricultural areas (horticulture, plantations, and smallholder farms) to facilitate the mobility of agricultural machinery, transport production facilities to agricultural land and agricultural products from the land to the storage, processing or market place [2].

Agricultural roads in Indonesia are developed under the concept of collaboration between the government and the community or farmer groups, while the maintenance and management of roads are carried out independently by the community or farmer groups. The funding for agricultural road development is allocated based on proposals submitted by the community or farmer groups. The central government provides seed money of US\$ 7300 to US\$ 9500 for each approved proposal for the construction of the road sourced from Special Allocation Fund for Agriculture Sector. Special Allocation Fund for Agriculture Sector is fund allocated in the State Budget to certain regions focusing on agricultural infrastructure development. In addition to the Special Allocation Fund, funding for the construction of agricultural roads also comes from Revenue Sharing Fund of Tobacco Product.

Roads that are built must meet the criteria for 2.5 to 3 m width, can be passed by three-wheeled and four-wheeled vehicles, and the material is concrete or stone. These roads network are focused on serving agricultural land. There are several criteria that must be fulfilled by the farmer group to get the funding, including the willingness of farmers to work in groups, to release parts of their land without compensation, to carry out maintenance, and the minimum size of the agricultural area is 250.000 m² [2].

Agricultural road development is an intervention to alleviate poverty, which is an important issue in rural areas [3]. In 2015, around 736 million people in rural areas lived in conditions of extreme poverty globally [4]. Like in other developing countries, the majority of poor people in Indonesia live in rural areas. In 2018, 13.2% of the rural population could be classified as poor, whereas only 7% of the urban population was poor [5]. The rural poor generally carry out low productivity work in the agriculture sector [6].

Transportation infrastructure plays an important role in economic growth [7–13]. Economic growth can be achieved due to increased access [14], reduced costs in the manufacturing industry, the increased productivity of resources [15,16], and employment opportunities [17,18]. In addition to economic benefits, investment in infrastructure is important in creating sustainable and resilient societies [19].

Apart from the role of infrastructure in contributing to economic growth, several studies question the distribution of these benefits. Benefit distribution equity (also called justice and fairness) refers to the equal distribution of impacts and benefits [20]. Several studies have found that there are inequalities in the distribution of benefits of infrastructure provision. For instance, Andani stated toll road development in Indonesia unevenly distributes benefits between regions and community groups [21]. Rammelt and Leung also revealed the uneven distribution of benefits in the case of rural road development in Ethiopia [22,23]. Van Dijk et al. found that the accessibility effects of toll road construction and the application of toll tariffs in the Cape Town Metropolitan Area differ based on income levels [24]. Lastly, Khandker and Koolwal also found inequality in the distribution of benefits from rural road construction in Bangladesh. Specifically, low-income groups obtain fewer benefits from the construction of roads [25].

Related to the distribution of the benefits from the construction of roads, Rammelt stated that the road network is a catalyst for economic growth [22]. However, the catalyst function of the road network will vary greatly depending on the region. Notably, the catalyst effect is strongly influenced by the presence of promoters and inhibitors [22]. Promoters can accelerate the expected effects of economic growth, while inhibitors can hinder the expected effects. In the case of road construction in rural Ethiopia, vehicle ownership is a promoter while limited land resources are the inhibitors.

This study aims to explore the distribution of the benefits of community-based road infrastructure development by exploring agricultural roads in Garut District, Indonesia. The distribution of benefits of local and community-based road infrastructure, to the authors' knowledge, has never been explored. Previous studies have generally focused on large-scale and top-down road infrastructure [21–25]. The purpose of this study is to identify critical issues in community-based road development, including agricultural road in order to get optimal benefits. This study elaborates on the following questions: (1) What are the economic benefits of agricultural road development? and (2) how are the benefits distributed? The hypothesis related to the first research question is that agricultural road development has positive impacts on farmers, whereas the hypothesis for the second research question is the distribution of benefits varies based on the distance between farmland and agricultural road as well as other physical-environmental conditions of the road. The case study approach is utilized with quantitative and qualitative methods. The method used in the quantitative approach is descriptive statistics analysis, and the method for qualitative approach is content analysis. This study is useful in the formulation of policies in order to achieve an equitable distribution of benefits in infrastructure development.

2. Materials and Methods

This study used a case study approach with quantitative and qualitative research methods. The case study approach is an in-depth exploration of complex issues in a real setting [26]. The cases were agricultural roads in (1) Padaawas Village, (2) Bayongbong Village, (3) Panjiwangi Village, and (4) Pamulihan Village. All villages are in Garut District, Indonesia which is one of the biggest contributors to the agriculture sector in Indonesia. The analysis technique for the quantitative method was descriptive statistics analysis. Descriptive statistics analysis in the form of range, mean, and standard deviation of variables were used to compare the cases. The analysis technique for the qualitative method is content analysis. Figure 1 shows the location of Garut District as well as the four cases.

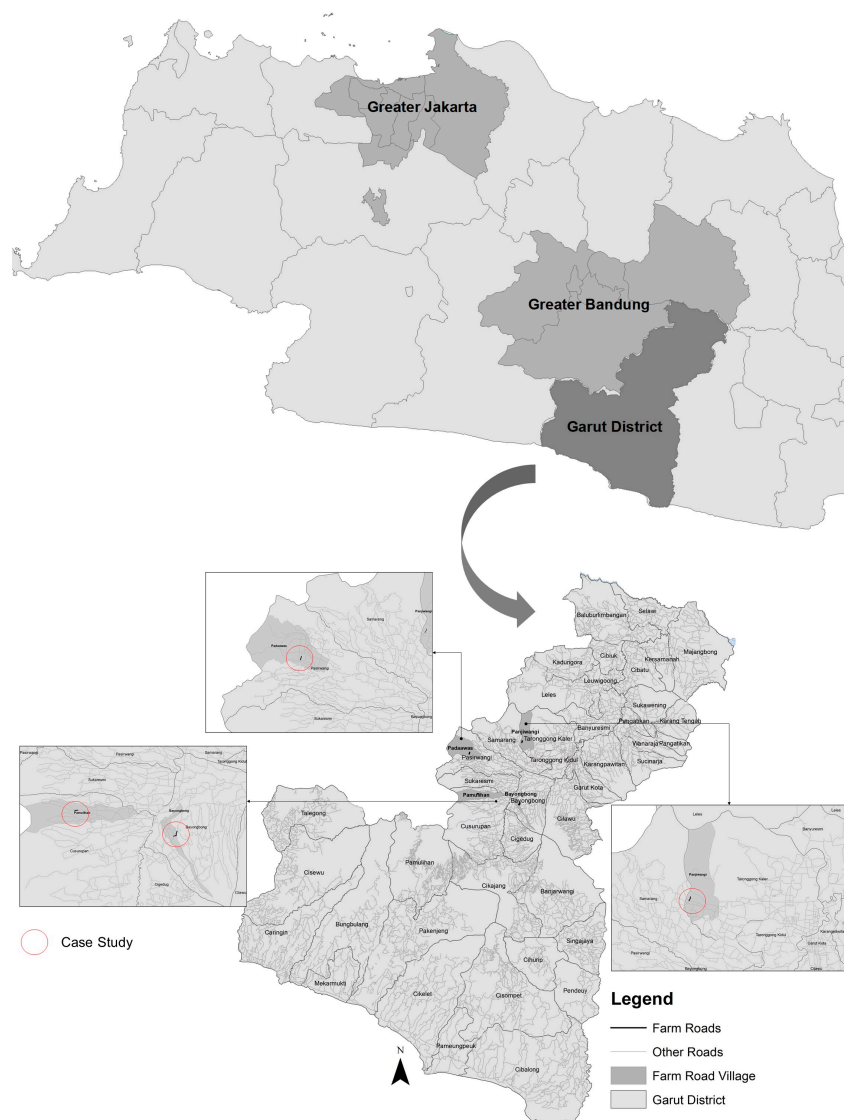


Figure 1. Garut District and the location of cases.

The study of the distribution of benefits in infrastructure development is generally approached using the concept of equity. Ciommo and Shiftan stated that there are three components of equity in transportation, namely (1) benefits and costs to be distributed, (2) groups of people who will receive benefits and incur costs, (3) distributive principles that examine whether the distribution of benefits is morally appropriate and socially accepted [27]. This research examines these three components for the construction of agricultural roads which are represented in two research questions mentioned above.

Referring to Litman, this study uses the principle of horizontal equity, which is the distribution of benefits over the people in the same class or level, in this case, farmers [20].

Data collection in this study included primary and secondary data collection. Primary data were obtained through interviews with government agencies and four farmer groups that construct and manage the agricultural roads in the cases. The government agencies interviewed comprised Garut District Agriculture Agency, Garut District Development and Planning Agency, and Garut District Trade and Commerce Agency. The questions for government agencies were related to policies on agricultural roads, while the questions posed to farmers were related to the benefits of agricultural roads and their distribution to the farmers, farmers' perception of the benefit distribution, and future preferences. The questions can be viewed in Table A1 (Appendix A). The study also comprised observations of the physical condition and route of the road network. Secondary data collected includes documents from the Ministry of Agriculture, Republic of Indonesia, Garut District Agriculture Agency, Garut District Development and Planning Agency, and other statistical publications. The entire process of data collection was conducted from June to August 2019.

The first research question was answered by identifying the benefits of road construction based on previous studies. These previous studies found several positive impacts of the construction of roads, i.e., time-saving [28,29], cost reduction [30–32], diversification [32–34], and added value of the agriculture sector [33]. This study examines time-saving, cost reduction, diversification, and added value from road construction. The extent of positive or negative impacts was measured through a comparison of the conditions before and after the construction of agricultural roads.

Time-Saving

Time-saving is an indicator that is widely used to measure the benefits of the existence of roads. Metz stated that a good road network allows travelers to reach the destination faster. In the context of rural roads, road construction has opened and improved access and mobility [35], which reduces the time needed to reach destinations.

Cost Reduction

Cost reduction occurs due to several reasons. One reason is that the road network has reduced transportation costs because it brings farmers closer to the market. Tarigan and Syumanjaya explained that agricultural roads allow farmers to bring agricultural products to the market directly and quickly, without going through middlemen. Thus, the profits obtained by farmers will be greater [32].

Diversification

Diversification can be defined as a shift from growing less remunerative crops to more remunerative ones [36]. Crop diversification is an option to ensure the resiliency of the agricultural system [37]. It gives farmers more choices to plant and process various crops, whereas the provision of rural roads leads to crop diversification [37,38]. In India, farmers have started to cultivate non-cereal hybrid crops in addition to staple grains once the rural roads were developed [38]. This was possible because the construction of rural roads has opened access to the wider market.

Added Value

Added value is the process of transforming raw agricultural products into a new form through a process [39]. Added value in the agriculture sector occurs because roads have opened access to wider markets that cater to various demands [40]. This encourages farmers to meet the demand by not only selling raw agricultural products but also by providing agricultural processed products.

The second question in this study is answered by considering the variations in benefits and costs received and paid by the farmers, whether greater sacrifice will lead to greater benefits. In this part, the role of the physical-environmental conditions of the road, such as distance from farmland to the

agricultural road, road surface, slope, topography, and altitude, to the distribution of benefits are examined. The framework of analysis can be seen in Figure 2.

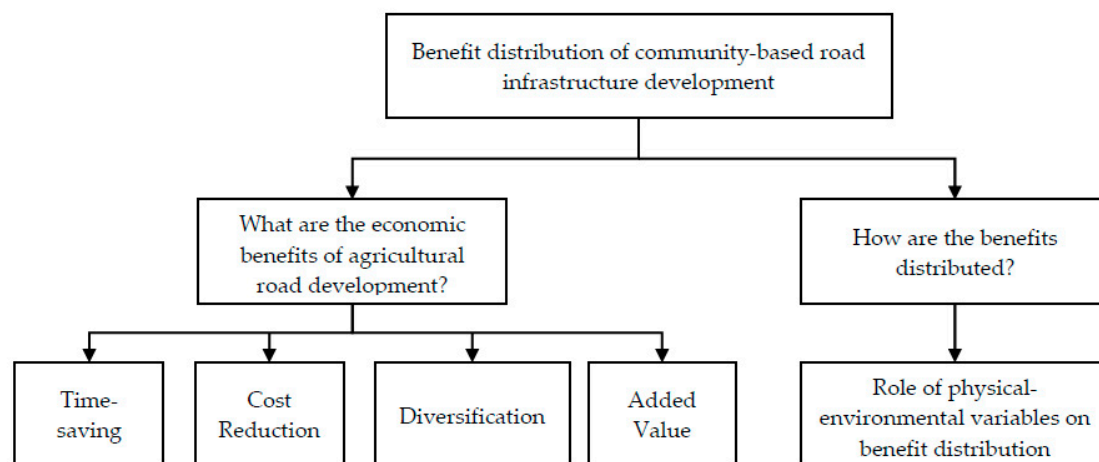


Figure 2. Framework of analysis.

3. Results

3.1. Overview of the Cases

3.1.1. Padaawas Village

The development of an agricultural road in Padaawas Village was proposed by the Sawargi Farmer Group. This proposal was approved for funding from the Ministry of Agriculture which provided around US\$ 9500. The fund was managed by the village head. The land used for the road is village-owned (customary land). Hence, there were no obstacles in land acquisition for road construction. Customary land is village land which is owned by the village government as a source of village income and can be used for social purposes. The customary land originally appeared during the colonial era. It consisted of several hectares of land under the supervision of the village government. Based on Law No. 6 of 2014 concerning Village, villages have the authority to manage their assets, including customary land, for the prosperity of the village community [41]. It can be used by the most vulnerable groups in the village. Furthermore, the Ministry of Home Affairs establishes three formats for the use of customary land: Lease, profit sharing, and built-used-transfer, or built-transfer-used [42]. In Garut District, the format for using customary land is not too rigid, as stated in Law No. 6 of 2014 concerning Village [41]. Farmers may use customary land for agricultural land. In return, farmers are requested to contribute to village social activities.

The farmers independently built the road through a community-based scheme. The Sawargi Farmer Group primarily relied on its members to construct the road rather than on third parties. During the construction phase, some experts who were appointed by the Garut District Agriculture Agency monitored the construction process. Before the road was constructed, farmers had built a low-quality pathway. Therefore, the farmers proposed the improvement of the pathway. To avoid future land disputes, the Agriculture Agency conducted a preliminary survey of the availability of land and other technical requirements to guarantee the availability of the land needed to build the road. The road maintenance is carried out by the farmers without any engineering procedures. All payments for maintenance are made through active and/or passive participation from the farmers in terms of manpower as well as contribution fees for the materials such as sand and cement.

The road is located in the middle of 300,000 m² horticulture farmland in an undulating area with an average altitude of 1400 m above sea level (masl) and a slope of 5%–15% [43,44]. The whole area of Garut District, including Padaawas Village, has a rainfall ranges from 5000–7500 mm/year and a humid tropical climate with Af (tropical rainforest climate)-Am (tropical monsoon climate) type (Köppen

Climate Classification), and the type of soil is mainly andosol [43,44]. There are around 20 farmers as landowners and 50 farmers as smallholders. Landowners are farmers who own farmland, while smallholders are farmers who cultivate farmland but do not own the land. Profit-sharing between the owner and the smallholders is based on an agreement between the two parties. Landowners can also cultivate their land by themselves. In addition to the two types of farmers described above, there are also tenant farmers. Tenant farmers are farmers who do not have land and are renting land to grow agricultural products. Tenant farmers pay land rent to the landowner. In the study area in Padaawas Village, there are only landowners and smallholders.

The agricultural road in Padaawas Village, which has a width of 2.5 m and a length of 285 m, is strategically located. It is approximately in the center of the farmland. The farmers decided on the location of the road considering the connectivity, accessibility, and physical safety, as well as the coverage of farmland. They also built a parking area of 10 m × 10 m, which is designated for crop-transporting vehicles. The road may be used by anyone, not only farmers but also traders and all inhabitants of the village. The farm road in Padaawas Village is connected to a project road built by a private company which, in turn, is connected to the village road. The condition of the agricultural road can be seen in Figure 3.



Figure 3. Agricultural road in Padaawas village.

3.1.2. Bayongbong Village

The development of the agricultural road in Bayongbong Village engaged 25 farmers with a labor-intensive system. The road construction involved a collaboration between third parties (25%) and local communities (75%). The source of funding for construction was the Special Allocation Fund for Agriculture Sector and the Revenue Sharing Fund of Tobacco Products. The land which the road was built on is owned by 213 tobacco farmers. As such, this development required compliance from the farmers to provide land. The community carries out the maintenance of the road independently with a self-funding mechanism.

The development of the road commenced in 2006 and has produced 1650 m of road. This road has connected two villages, namely Kampung Cigembor and Kampung Werkip. The agricultural road in Bayongbong Village can be seen in Figure 4. The road is located on the steep of the Cikuray Mountains with an average altitude of 650 masl and a land slope of 5%–15% [44,45]. Its development was inspired by the personal motivation of the head of the village and the limited access to other villages. In the

early stage of development, farmers funded the construction of the road. After that, the farmers received financial assistance from the national government under the Special Allocation Fund of US\$ 7300 and US\$ 9500, which was provided in 2012 and 2019, respectively. The construction of the road has not run smoothly as there was a farmer who disagreed to share his land for road development in the middle of the development process. Another issue was the funding for subsequent development and maintenance. Farmer groups planned to expand agricultural land that can be reached by roads. Currently, there has been no definite source of funding for road maintenance. Communities collect funds voluntarily if there is a need for road maintenance.



Figure 4. Agricultural road in Bayongbong village.

3.1.3. Panjiwangi Village

Agricultural road in Panjiwangi Village serves around 1,000,000 m² of farmland in a flat area with an average altitude of 850 masl and a slope of 5%–15% [44,46]. There are approximately 90% of farmers in the village who plant tobacco. The farmers also implement an intercropping system with other commodities, e.g., chili, leek, celery, corn, peanuts, soybeans, mustard greens, and other horticultural crops. Since most of the land is cultivated for tobacco plants, the source of funds for the construction of agricultural roads comes from the Revenue Sharing Fund of Tobacco Products, which provided US\$ 7300. There are approximately 15 landowners and 1500 smallholders in the area. The status of the land is mainly customary land, whereas, very little farmland is privately owned. Land acquisition for road construction, particularly for privately owned farmland, was quite a challenge because some landowners were unwilling to release the land. Nevertheless, this problem could be overcome with good communication.

The construction of the agricultural road in Panjiwangi Village commenced in 2015. The construction of the road was managed by a third party appointed by the Agriculture Agency. However, its construction involved a labor-intensive scheme by the members of the Surya Panji Farmer Group, chaired by a former Head of Panjiwangi Village. The involvement of the former Head of Panjiwangi Village was a vast opportunity to integrate the agricultural and village road development to address the isolation of some areas in the village. The road development from the initiation stage in 2015 to 2019 involved approximately 1000 farmers who took turns in constructing and maintaining the roads. The length of the road depends on the availability of funds provided while taking into account the technical requirements. Since 2015, 250 m of road has been built with a width of 2.5 m and a thickness of 15–20 cm. The condition of the road in Panjiwangi Village before and after the construction can be seen in Figure 5.



Figure 5. Agricultural road in Panjiwangi village.

3.1.4. Pamulihan Village

The funding for agricultural road construction in Pamulihan Village was obtained from the Special Allocation Fund as much as US\$ 7300. The land used for road construction was private-owned, so voluntarily land acquisition was needed. The road was constructed by the farmers and is maintained and managed independently by the community, especially the farmers. Pamulihan Village plans to improve road quality in 2020. The road is planned to be concreted and increased in thickness over 12 cm so that trucks can pass.

The road in Pamulihan Village built since 2011 has reached approximately 200 m and is connected to the village road. This road's beneficiaries include around 25 landowners and 1500 smallholders. The road serves farmland that is mainly planted with potato, carrot, and cabbage, which are the primary commodities of Pamulihan Village. It is located on a steep area with an average altitude of 1300 masl and a slope of 15%–40% [44,47]. The quality of the road is low, its surface is slippery and steep. Thus, the road is only traversed by motorbikes and motorcycle taxis (*ojek*). At least 100 motorcycle taxis provide transportation services for crops. The condition of the road is shown in Figure 6.



Figure 6. Agricultural road in Pamulihan village.

The condition of the roads in the case study can be viewed in Table 1.

Table 1. Overview of agricultural road condition.

Case Study	Amount of Fund (US\$)	Land Ownership	Construction	Road Length (m)	Number of Beneficiaries	Served Farmland (m ²)
Padaawas	9500	Village land	Community-based	285	±20 landowners, ±50 smallholders	300,000
Bayongbong	7300 (2012) 9500 (2019)	Private land	Community-based, with the assistant of third party	1650	213 landowners	910,000
Panjiwangi	7300	Mixed village and private land	Community-based, with the assistant of third party	250	±15 landowners, ±1500 smallholders	1,000,000
Pamulihan	7300	Private land	Community-based	200	±25 landowners, ±1500 smallholders	More than 1,000,000

3.2. Benefits of Agricultural Road Development

It is necessary to understand the marketing practices of agricultural products that are commonly found in Indonesia, before discussing the benefits of agricultural roads in the cases. The marketing of agricultural products in Indonesia can be classified based on the studies conducted by Andri and Tumbuan with cases in Bojonegara and Soka et al. with cases in Bogor City [48,49]. Farmers sell products to collectors or middlemen who bring the products to a local market, wholesale market, supermarket, or a factory. Collectors generally collect the products straight from the farmers using private or rented vehicles. If collectors come to the farmers, the collectors bear the transportation costs. Farmers can also bring their crops to the collector. In this case, the farmers bear the transportation costs. The combination of the two practices commonly occurs in rural areas in the Garut District. The farmers bring their products to collection points, and the middleman collects agricultural products from farmers at the points. This collection point must be passable by four-wheeled vehicles.

3.2.1. Padaawas Village

The road used to transport raw materials and agricultural products in Padaawas Village was originally a stone road. With the construction of agricultural road, the quality of the road has been upgraded to become a concrete road that can be passed by four-wheeled vehicles. Transporting crops from agricultural land to the collection point, which is located at an agricultural road, still uses human labor. The agricultural land served by the agricultural road in Padaawas Village is not too large compared to the land in Panjiwangi and Pamulihan Village. The longest distance of agricultural land served from the agricultural road is approximately 500 m.

Farmers acknowledge that the agricultural road significantly facilitates the transportation of fertilizers and crops to and from the farms. The farm road reduced transportation costs by 60%–70%. Another benefit is time-saving. Before the agricultural road was constructed, it needed two to three hours to transport 1000 kg of crop yields, while now only one hour is needed. The harvest is transported directly by collectors from collection point to the wholesale market located in some large cities.

Farmers in Padaawas Village grow vegetables with potato, cabbage, tomato, pumpkin, and chili as the main commodities. There is no change in planted products before and after the construction of agricultural road since the product planted by farmers at this time are high-value agricultural products. Farmers sell their crops directly without any processing. There is no difference in the value-added process before and after the construction of agricultural road. Therefore, diversification and the value-added process because of road construction do not occur in Padaawas Village. However, the existence of agricultural road can maintain the quality of the crop because it can be quickly sold.

For products that do not rot quickly, farmers plan to build a warehouse as temporary storage for keeping the harvest, as well as it could also be a collection point for the trucks to pick-up the products.

Presently, the harvest is only placed in the agricultural area before being transported. This condition causes a decrease in product quality. The Sawargi Farmer Group has submitted a proposal for the procurement of a storage warehouse, but the government has not yet responded. In addition to the construction of the warehouse, farmers hope that agricultural road can be extended in the future.

3.2.2. Bayongbong Village

The agricultural road in Bayongbong Village can be traversed by a four-wheel vehicle. The type of surface of the agricultural road is concrete. Previously, the road was a stone road. Not all agricultural land in Bayongbong village is served by agricultural road. This includes agricultural land that only uses stone roads, dirt roads, or just land openings. Therefore, the community hopes that in the future agricultural road can be extended and equipped with parking facilities. The agricultural road is also expected to connect isolated villages, so they can be more easily accessed.

The agricultural land served by the agricultural road in Bayongbong Village is broader than in Padaawas Village. The existing agricultural road is the longest in the four cases. The farthest agricultural land is located approximately 200 m from the agricultural road. Road construction has been carried out since 2012, and there has been progress in the construction of agricultural roads since that year. The village received funding for the construction of agricultural roads in 2012, 2015, and 2019.

Bayongbong Village is the largest tobacco-producing village in West Java Province. Around 90% of farmers in this village are tobacco farmers. The road provides access for these tobacco farmers. The main benefit of road development is 70%–80% reduction in transportation costs, equal to US\$ 0.011–US\$ 0.037. Before the road was constructed, the farmers had to pay porters to carry crops from farmland to the collection point with higher wage. After road construction, besides cost reduction, the frequency of transporting yields has also increased from three times to 10–12 times a day. There is time-saving from three to four times faster. Another benefit is the increased connectivity with Sukasari Village and Sukahejo Village.

Some farmers diversify their products by growing vegetables between tobacco-growing periods. However, this practice has been carried out before the construction of agricultural road. Most tobacco farmers in Bayongbong Village processed tobacco leaves by drying them before they are sold. This shows an effort to increase the value of the crop. However, the same as diversification, these efforts were made before the construction of agricultural road.

3.2.3. Panjiwangi Village

The agricultural road in Panjiwangi Village is a concrete road that can be passed by four-wheeled vehicles. Previously, the road in this area was a stone road. The land served by the agricultural road in Panjiwangi Village is the largest land in the cases, while the existing road is 250 m. As an implication, there are agricultural lands which are located up to 2000 m from the agricultural road. In the future farmers hope that agricultural road can be extended and improved in quality. The community also hopes that the village fund can be contributed to the construction of agricultural road, so the community does not only rely on the fund from the central government.

The construction of the agricultural road has had an impact on tobacco farmers in the form of reduced transportation costs, crop transportation frequency, and time-saving. Transportation costs savings are 30%–40%. In one day, 17,000–15,000 kgs of agricultural commodities can be transported with a load capacity per truck of around 3500–4000 kgs. Thus, at least four trucks cross the road daily. Farmers also experience six times faster in terms of time efficiency in transporting products. Before the road was constructed, farmers needed two hours to transport agricultural products from the farmland to the nearest collection point, yet currently, it only takes 15 to 20 min. Another impact of road construction is an increase in land value with the value of land near of the road increased three-fold.

Some farmers diversify products and plant them between the tobacco growing periods. The products planted are vegetables. There are also farmers who dry tobacco leaves before they are sold, although not as many as in Bayongbong Village. The practice of diversifying and increasing the

value of products was carried out before the agricultural road was constructed, therefore the existence of agricultural road does not have an impact on diversification and increase in added value.

3.2.4. Pamulihan Village

The agricultural road in Pamulihan Village is a stone road that can only be passed by two-wheeled vehicles. Previously the road was a dirt road. Farmers choose road with stone surface over concrete with consideration of the lower unit cost in terms of construction. The agricultural road was built since 2011, and since then, there has been no effort to improve the road conditions. Besides, Pamulihan Village is located at a slope of 16%–40% making it difficult to pass this road. In the future, the community hopes that the quality of the road can be upgraded to become concrete, and the agricultural road can be extended.

The agricultural land served by this road is more than 1,000,000 m². With the rather short length of the road (200 m), the distance from the road to the farthest agricultural land is up to 5000 m. With these conditions, the existing agricultural road has not provided great benefits for farmers. Time-saving is only 1.1 to 1.2 times faster, while in terms of cost reduction, there are savings of 30% to 40%. Farmers do not diversify products before and after the construction of agricultural road, as well as increasing value added. The benefits of the agricultural roads in the four villages are shown in Table 2.

Table 2. Benefits of agricultural road development.

Case Study	Connecting Access	Connectivity	Time-Saving	Cost Reduction	Diversification	Added Value
Padaawas	Accessed from Private Company project road	Connecting only farmland	2–3 times faster	60%–70%	No Diversification	No Added Value
Bayongbong	Village road	Connecting farmland and two villages	3–4 times faster	70%–80%	Diversification exists before and after road construction	Adding value to the product is done before and after road construction
Panjiwangi	Village road	Connecting only farmland	6–8 times faster	30%–40%	Diversification exists before and after road construction	Adding value to the product is done before and after road construction
Pamulihan	Village road	Connecting only farmland	1.1 to 1.2 times faster	30%–40%	No Diversification	No Added Value

The benefits received by farmers include time-saving and reduced cost. These benefits exist in all villages. Diversification and added value due to road construction are not found in this study because there have been no process changes in product diversification and product value improvement carried out before and after the road construction. Product diversification and product value enhancement were found in the Bayongbong and Panjiwangi, which are tobacco producer villages. Not many farmers diversified their products in the two villages. In contrast to diversification, quite a number of farmers increase the value of products by drying tobacco leaves. In Bayongbong Village, most farmers do the drying, while the proportion of farmers who do the drying in Panjiwangi Village is not as big as in Bayongbong Village.

3.3. Benefit Distribution of Agricultural Road Development

The amount of benefits obtained by the farmers varies in each village. The farther the farmland from the road, the less the benefit obtained. The average time-saving in the four locations ranges from 1.13 to 7.06 times faster, and 33.33% to 70% for the average cost reduction. Interestingly, this study finds that although the distribution of benefits obtained by farmers in each village varies by distance, most respondents stated that the principle of benefit distribution on agricultural roads is fair.

In terms of cost savings, Bayongbong Village is the village with the largest cost reduction, while Pamulihan Village is the smallest. Cost, in this case, is harvesting cost. Harvesting cost consists of the cost of harvesting and transportation cost from the farm to the point of harvest collection. The existence of an agricultural road affects the transportation cost.

Besides the variations of benefits in each village, there are also variations between villages. The physical-environmental conditions of each village contribute to the variations between villages (see Table 3). The village with the highest time-saving is Panjiwangi Village, nevertheless, it is not the village with the closest average distance. Bayongbong Village is the village with the highest cost reduction and the closest average distance. The village with the lowest time-saving as well as cost reduction and the farthest average distance is Pamulihan Village (see Table 3). It is also the only village that has an agricultural road with a stone surface.

Table 3. Physical-environmental condition, time-saving, and cost reduction by village.

Village	Distance * (m)	Road Surface	Slope (%)	Topography	Altitude (masl)	Time-Saving * (Times Faster)	Cost Reduction * (%)
Padaawas	228.59 ^a	Concrete	5–15	Undulating	1400	2.71 ^a	66.43 ^a
	157.71 ^b					0.39 ^b	3.78 ^b
Bayongbong	136.44 ^a	Concrete	5–15	Steep	650	3.36 ^a	70.00 ^a
	67.96 ^b					0.38 ^b	7.07 ^b
Panjiwangi	1288.9 ^a	Concrete	5–15	Flat	850	7.06 ^a	34.44 ^a
	683.16 ^b					0.77 ^b	3.91 ^b
Pamulihan	3222.22 ^a	Stone	16–40	Steep	1300	1.13 ^a	33.33 ^a
	1641.48 ^b					0.05 ^b	4.33 ^b

Note: a: Mean, b: Standard deviation, * Padaawas: n = 7, Bayongbong: n = 7, Panjiwangi: n = 9, Pamulihan: n = 9.

Slope in the four villages varies. Padaawas, Bayongbong, and Panjiwangi Villages are in the slope of 5%–15%, while Pamulihan Village is situated in the slope of 16%–40%. The villages with the highest time-saving and cost reduction are located in the slope of 5%–15%. On the other hand, the village with the lowest time-saving and cost reduction is in the slope of 16%–40%. In terms of topography, Padaawas Village is located in an undulating area, Panjiwangi Village is in a flat area, while Bayongbong and Pamulihan Villages are located in a steep area. The village with the highest time-saving is located in a flat area, while the village with the highest cost reduction is located in a steep area. The village with the lowest time-saving and cost reduction is located in a steep area. In terms of altitude, the four villages are located at 650 masl to 1400 masl. The village with the highest time-saving is situated at 850 masl, while the village with the highest cost reduction is located at 650 masl. The village with the lowest time-saving and cost reduction is located at 1300 masl.

Physical-environmental conditions in the village with the highest time-saving are as follows, an average distance of 1288.9 m, stone road surface, located on the slope of 5%–15%, flat area, and located at 850 masl. Before the construction of an agricultural road in Panjiwangi, the harvesting collection point was far from the farmland. To reach this collection point took a maximum of about two hours. After the construction of the agricultural road, the harvesting collection point became closer. This is caused by trucks carrying agricultural products that can pass through the agricultural road and approach the stretch of farmland. Besides the existence of the agricultural road, this condition is supported by topography that is in a flat area. After the construction of the road, the maximum time needed to reach the collection point is 20 min.

Physical-environmental conditions in villages with the highest cost reduction are as follows, the average distance of 136.44 m, the road surface is concrete, located in a steep area, with a slope of 5%–15% and altitude of 650 masl. The average distance of farmland from agricultural road is the shortest in Bayongbong Village. The road that has been built in this area is long enough, so the distance between farmland and the road is not far. The close distance between farmland and the road in Bayongbong, supported by good location in the low slope and good road surface, makes these villages have better cost reduction.

The village with the lowest time-saving and cost reduction has the characteristics as follows, the average distance of 3222.22 m, stone surface, located on a steep area with a slope of 16%–40%, and an altitude of 1300 masl. The average distance from the farmland to the agricultural road in this village is the highest. This condition is exacerbated by the stone road surface. Moreover, this village is in an unfavorable area in terms of other physical-environmental conditions. Under these conditions, the harvest collection trucks cannot enter the agricultural road. The position of the collection point of agricultural products has not changed before and after the agricultural road construction. Collecting trucks cannot pass the agricultural road since it can be only passed by two-wheeled vehicles. However, the existence of the agricultural road still contributes to reducing travel time to the collection point, although it is not significant.

4. Discussion

In general, the construction of agricultural roads in cases observed has benefited farmers. These benefits include time-saving and cost reduction. The findings in this study are in line with previous studies related to time-saving [28,29], as well as cost reduction [30–32]. Although these benefits are the same in this study and in previous studies, there are fundamental differences in the way these benefits are generated.

Before the construction of agricultural roads, the collection points of agricultural products were far from the farmlands. Farmers must hire porters to transport agricultural products to the collection points. After the construction of agricultural roads, transport vehicles may reach closer to farmland. As such, labor costs may be reduced because the distance is closer. In addition, the frequency of transportation can be increased. Cost reduction, in this case, is related to the transportation cost of agricultural products from farmland to collection point. The reason for the existence of time-saving is almost the same as the cost reduction. Before the construction of agricultural roads, agricultural products must be transported by porters manually from the land to the vehicle, whereas agricultural roads allow transport vehicles to come closer to the farm.

In contrast to previous research, which stated that rural road construction provides added value for the agriculture sector [33] and diversification [30,33,34], this study did not find such benefits in all cases. In Padaawas and Pamulihan Village, farmers sell their crops directly without any processing. This condition is related to the marketing system as the crops are directly collected by collectors from collection point and brought the crops to the market. In Padaawas and Pamulihan Village, the farmers do not practice any intercropping process. They cultivate the same products before and after road construction. This is because income per m² for the commodity in these two villages is relatively higher compared to others [50]. The main commodity in Bayongbong and Panjiwangi Village is tobacco. Some farmers in Bayongbong and Panjiwangi practice intercropping system and drying the tobacco leaves. Drying tobacco leaves can increase the product value. Nevertheless, these practices have been carried out before the roads were constructed until the present time. Thus, there are no benefits of diversification and added value generated by agricultural road development.

The benefits received by farmers in four cases explored vary greatly. The benefits received by farmers in the same village depend on the distance from the farmland to the road. The farmers who own land on the side of the road benefit most from the construction of agricultural road. The need for porters can be reduced significantly when farmland is situated on the roadside. Although these farmers benefit from the closeness to the road, they must contribute land for the construction of the road. Thus, in the case of agricultural roads in Garut District, the sacrifice of land from farmer whose land is traversed by the road network is offset by the benefits of improved access. This study also uncovers that other physical-environmental conditions contribute to the magnitude of benefits received by farmers in various locations.

Vehicle ownership is not a limiting factor in the distribution of benefits in the case of agricultural roads in Garut District. This finding is different from the results of a study in Ethiopia [22]. In four villages observed, farmers have not used private vehicles to transport agricultural products. Instead,

the middlemen gather agricultural products from the collection points and distribute them to the big cities near Garut District, such as Jakarta and Bandung or to cigarette factories.

An interesting finding of this study is that agricultural roads in Garut District are developed through a community-based concept. Notably, farmer groups determine the routes of farm roads. They plan these routes to cross the middle of farmland to provide equitable access to the road. Farmers whose land is traversed by agricultural roads must sacrifice their land for the common good. However, these farmers benefit most from the close proximity to agricultural roads. On the other hand, farmers whose land is far from an agricultural road do not feel unfair because they do not have to sacrifice land for road construction, even though, access to the road is not particularly close.

5. Conclusions

The construction of agricultural roads—a community-based infrastructure—provides the benefits of time-saving and cost reduction. The benefits of diversification and added value are not found in the case of agricultural road development in Garut District, since the farmers do not change their behavior in diversifying and/or adding value of their products before and after the road construction. Furthermore, the amount of benefits received by farmers varies. Benefit distribution of agricultural road in the same village depending on the position of the agricultural land towards the road. Farmers with the land close to the road receive greater time-saving and cost reduction compared to farmers with the land farther from the road. Although the benefits received by farmers vary, this is not a problem for them. The route of the road is determined together and aimed to cross the middle of farmlands. Whilst farmers with the best access must sacrifice land for the construction of the road.

The benefit distribution between villages is also varied. The physical-environmental conditions of the road contribute to the variations. The characteristics of the village with the lowest time-saving and cost reduction are the farthest average distance between farmland and agricultural road, stone surface of the road, and other unfavorable physical and environmental conditions.

The findings of this study provide new insights related to the distribution of benefits in community-based road infrastructure development. Community-based infrastructure development can be used as a model of local infrastructure development oriented to equally distributed benefits. To optimize the benefits derived from the construction of agricultural roads, several important issues must be considered. Firstly, the importance of determining the optimal route of the road network, so that the average distance from the farmland to the agricultural road is the smallest. Secondly, the amount of effort, so as agricultural roads become more accessible to all agricultural land. This can be done by extending the length of the road and adding the new route. This point certainly has implications for the needs of large funding. The village fund may be used as a primary source of funding. Thirdly, the types of surface of the agricultural road should be concrete with a certain thickness so that it can be passed by a four-wheeled vehicle. Technical assistance in road construction is needed even though the process is carried out by the community. Lastly, most physical-environmental conditions are difficult to intervene. Besides ensuring a good surface type in road construction at high slope locations, agricultural road construction needs to be combined with innovation on harvest transport vehicles that can pass small roads in high slope areas. Future research could compare the distribution of benefits of local-scale community-based infrastructure development and top-down local-scale infrastructure, as well as the implications of interventions on critical issues of agricultural road development.

Author Contributions: Conceptualization, S.M. and T.F.; methodology, S.M. and T.F.; formal analysis, S.M.; investigation, A.N.S.H. and Y.T.F.; writing-original draft preparation, S.M., A.N.S.H. and Y.T.F.; writing-review and editing, S.M., A.N.S.H. and Y.T.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Research Centre for Infrastructure and Regional Development, Institut Teknologi Bandung, Indonesia, FY 2019.

Acknowledgments: The authors would like to thank Department of Agriculture, Garut District, for valuable support during data collection.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Appendix A

Table A1. List of questions in interview.

No	Information Needed	Questions	Interviewees
1	The role of local government in developing agricultural road	<ul style="list-style-type: none"> • How is the implementation of the agricultural road development plan? • What are the roles of the local government in agricultural road development? • What are the roles of the local government in agricultural road operation, maintenance, and rehabilitation? • What are the roles of the local government in the improvement of agricultural roads? 	Garut District Agriculture Agency, Garut District Development and Planning Agency, and Garut District Trade and Commerce Agency
2	The role of farmer groups in developing agricultural road	<ul style="list-style-type: none"> • How many farmers, landowners, and smallholders in the Farmer Group? • What are the roles of farmer group in agricultural road development? • What are the roles of farmer group in agricultural road rehabilitation? • What are the roles of farmer group in the improvement of agricultural road? • What are the roles of farmer group in agricultural road maintenance? • What are the roles of farmer group in agricultural road funding? • What are the problems found in road development? • How is the marketing mechanism of agricultural products? 	The Head of Farmer Group
3	Impacts of agricultural road	<ul style="list-style-type: none"> • How is the distance between farmland and agricultural road? • How far is the distance from farmland to the collection point before and after road construction? • How much time is needed to transport the crops from farmland to the collection point before and after road construction? • How is the frequency of transporting crops from farmland to the collection point before and after road construction? • How much is the cost of transporting crops from farmland to the collection point before and after road construction? What kind of costs? • What kind of commodities planted in the farmland before and after road construction? • Do the farmers implement intercropping system before and after road construction? • Do the farmers enhance the value of crops before and after road construction? What are the kinds of enhancements? • How much are the wages for labor or porter? • Do the farmers feel that benefits are equally distributed? • What are the preferences of the farmers for the future concerning road development? • What are the benefits perceived from agricultural road development? • What problems arise from agricultural road development? 	Farmers

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