Disaster Impact on Supply Chain Management of Agricultural Products in Dacope, Khulna

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Abstract - Bangladesh's southwest coastal zone is prone to several natural disasters due to global climate changes, its low elevation, and its geographical position. This study was conducted to analyze the effects of natural disasters on the supply chain management of agricultural products and to identify the existing supply chain management at two Unions Pankhali and Tildanga of Dacope Upazila in Khulna district of Bangladesh. These areas are highly affected by devastating cyclones such as Aila (2009), Bulbul (2019), and Sitrang (2022). There are thirty farmers were randomly selected for the survey. Focus group discussions were also conducted with local businessmen, wage laborers and drivers. A Key Informant Interviews were conducted with the Dacope Upazila Agriculture Officer. The collected data was analyzed which was shown that the majority of the respondents belonged to the low-income group. Their average monthly incomes were 9,000 to 15,000 BDT. The main agricultural crops were watermelon, rice, sesame, sunflower, potato and vegetables. The total amount of produced crops in the area is 56,294 metric tons. During the summer, villagers suffered water scarcity, cyclones and excessive salinity and severe drought. In the monsoon period, villagers get exposed to excessive rainfall which causes floods. These natural disasters caused damage to crops, animals, poultry, trees, residences, roads and bodies of natural water. One single ferry system in the road network at Chalna Ghat can lead to delays in transporting agricultural goods to the central market. As well as supply chain management of local agricultural products was affected by the road transportation system. There was a lack of storage facilities that could lead to significant losses and waste of agricultural production, exacerbating the impact of the disaster on food supply chains. From the study, it is depicted that effective supply chain management helps to improve the agribusiness organization's competitiveness and efficiency. Developing road networks and River

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Bridge in the study area is crucial to improving transportation and accessibility for farmers to distribute their agricultural goods. The infrastructure development of storage facilities also enhances connectivity with markets, reducing post-harvest losses and promoting economic growth in the region.

Keywords: Supply chain management, agricultural goods, disaster, transportation, farmers

1 Introduction

Bangladesh is globally recognized as one of the world's most disaster prone countries to the effects of climate change. Climate changes are increasing the vulnerability of huge populations in Bangladesh's coastal areas that rely on natural resources for a living. The southwestern region of Bangladesh is located in the coastal area of the Bay of Bengal and is affected by storms, floods, droughts, salinity intrusion, and river erosion every year. These natural disasters pose significant challenges to the region's agricultural productivity and the livelihoods of the local communities and millions of dollars in damages [1].

Bangladesh's economy is based on agriculture. The majority of Bangladeshis (84%) lives in rural areas and work in agriculture-related activities such as farming, production, and business. Agricultural employs around 40.6% of all workers [2]. Bangladesh's agricultural GDP increased to 10739.10 BDT Million in 2019 from 10468.80 BDT Million in 2018 [3]. Through production and growth, agriculture plays a vital role in creating employment opportunities for the large population. The country's agriculture sector which includes crops, fish, animals, and forests contributes significantly to the nation's GDP, employs approximately half of the labor force, and provides raw materials for the agricultural industry [4]. The challenge comes from the basic problems of the agricultural industry in Bangladesh, via the supply chain of different agricultural products. The supply chain encompasses all of the operations that take products from the raw materials stage to the final consumer [5]. These processes include production, post-harvesting, transportation, and distribution. Supply chain management in all these areas is greatly affected by natural disasters. Natural disasters disrupt transportation routes, damage storage facilities, and cause widespread crop destruction [6].

Perdana et al., [7] suggest that supply chain management is faced with two kinds of reasons one is humanitarian and the other is natural or man-made disasters. These factors can disrupt the movement of goods and services within a supply chain network. Humanitarian reasons include conflicts, commissioning agents, political instability, and social unrest, while natural or man-made disasters encompass events such as earthquakes, floods, fires, and pandemics. Kibria et al., [6] have analyzed effective supply chain management is crucial in ensuring that food reaches those who need it most, especially during times of crisis. By implementing strategies such as efficient transportation and storage systems, as well as establishing strong partnerships with suppliers and distributors, food supply chains can become more resilient and responsive to changing circumstances.

Supply chain management in agriculture refers to the management of the relationship between the businesses responsible for efficient delivery from the farm level to fulfill the

needs of customers in terms of quantity and supply of commodities and prices in Bangladesh. It frequently involves linkages and procedures between horizontal and vertical alliances and entities in practice [8]. Agricultural supply chains are economic entities in which individuals share benefits and risks. The supply chain for fresh agricultural products is a dynamic and open network comprised of farmers, wholesalers, distribution centers and retailers. This network is essential for ensuring the timely and efficient delivery of fresh produce to consumers. However, disruptions in the supply chain, such as natural disasters or transportation issues, can greatly impact the availability and quality of these products [9]. Finally, supply chains are the collection of information and resources connected to the flow of goods and information across supply chain member organizations, the conversion of substances into products, and the delivery of those products to end customers [10].

In this study the primary objective was to assess the existing supply chain of agricultural products in the study area. The study was also to analyze the impact of the disaster on the existing supply chains of the study area.

2 Methodology

To achieve the specific objectives of the study. Primary data were collected by using qualitative and quantitative questionnaires. Data have been collected from different groups of people. Secondary data was collected from scientific journals, thesis papers and government reports.

2.1 Brief Description of Study Area

The study area is situated in Dacope Upazila of Khulna district, which is located in the southwestern zone of Bangladesh. Its geographical coordinates are 22° 39’ 30” North, 89° 30’ 0” East. The study area is adjacent to the mangrove forest, the Sundarbans, and the Bay of Bengal. Dacope is prone to natural disasters such as cyclones, floods, and tidal surges due to its coastal location. These disasters have a significant impact on the local community, making effective disaster management and supply chain management operations crucial for the area’s resilience and recovery. Pankhali and Tildanga is two of the Union of Dacope Upazila. In this study, data have been observed in Pankhali and Tildanga Union. Both Union, Pankhali and Tildanga is situated along the banks of the Pasur and Jhaki Rivers. The population density of this area is 159 people per square kilometer [11]. Map of the study area shows in the Fig. 1.

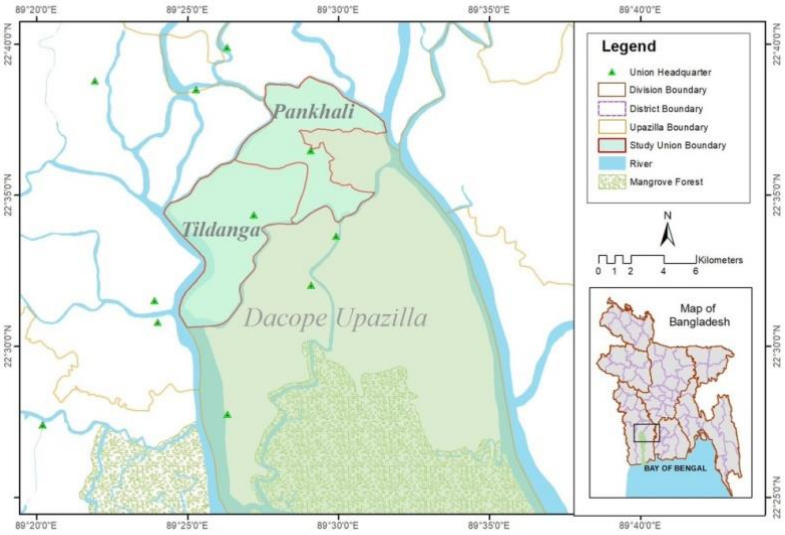

Fig. 1. Map of the study area

2.2 Data Collection

Survey. There are thirty farmers were randomly selected for the survey. The field survey was conducted with farmers in the study areas to gather valuable information and local farmers' opinions regarding the primary agricultural products, including rice, watermelon, sunflower, and vegetables. Subsequently, data on the impact of disasters on agriculture and the supply chain were documented. Using this collected information, a supply chain model for these products was developed. Such models will help to understand the overall existing supply chain of the study areas.

Focus Group Discussion. Three focus groups were conducted with farmers, fishermen, business owners, wage laborers, and drivers. These groups included both men and women. Through focus group discussions with various groups, significant qualitative and quantitative data regarding the effects of disasters on agricultural goods in the study area has been collected. Relevant data were collected from two field visits to the two polders and to relevant governmental and non-governmental organizations.

Key Informant Interview. A Key Informant Interviews were conducted with the Dacope Upazila Agriculture Officer. These interviews provided valuable information on the

current practices, issues, and potential solutions within the supply chain. The perspectives of the Dacope Upazila Agriculture Officer helped to identify areas for improvement and possible interventions to enhance the efficiency and effectiveness as well as adaptation and mitigation of the supply chain in the study areas.

2.3 Data Collection

In this study, data was analyzed by using Microsoft Excel. The software allows for the organization and manipulation of the data easily, making different data tables regarding population, education, and occupation with the aspect of collected data from the study areas. The use of Microsoft Excel played a crucial role in the successful analysis of the study's data.

3 Results and Discussion

3.1 Socioeconomic Status of the Study Area

Education. A comprehensive analysis of the collected data gives fascinating knowledge regarding the educational distribution of the respondents. Among the respondents, 10 % of respondents had no education, 16.66 % of respondents had only Primary education. The highest proportion 36.66 % of respondents had Secondary and under Secondary education. 26.67 % of respondents achieved Higher Secondary education. 10 percent of respondents had completed their higher education. Table 1 shows the educational status of the study area.

Table 1. Educational Status in the Study Area

Number of Respondents	Educational Level	Percentage
3	Illiterate (no education)	10
5	Primary Level (class 1 to 5)	16
11	Secondary level (class 6 to 10)	36.67
8	Higher Secondary level (class 12)	26.67
3	Higher Education (Honors & Masters)	10

Age. Among the respondents, 23 % were under the age of 35 is known as young, compared to 70 % who were between the age of 37 and 55 years is known as middle age. The remaining 6.67 % of respondents were from the old, aged group i.e., having ages of more than 56 years. The oldest person recorded was 72 years old, and the youngest was 24 years old. According to data on respondents' age, the majority of the respondents were middle-aged which was followed by the young. Table 2 shows the population stages of the study area.

Table 2. Population Stages of the Study Area

Number of Respondents	Age Level	Percentage
7	Young (Age from 25 to 35)	23
21	Middle (Age from 36 to 55)	70
2	Old (Age up to 56)	6.67

Occupation. The average monthly income in the study area was significantly lower, ranging from 9,000 to 30,000 BDT. The majority of the respondents were low-income, with average monthly income ranging from 9,000 to 15,000 BDT. None of the participants were from wealthy family. Table 3 shows the occupation and income levels of the people in the study area.

Table 3. Occupation and Income Levels of the people in the Study Area

Occupation	Number of the respondents	Average monthly income range (Tk)	Percentage
Farmers	25	9,000/- to 30,000/-	83.33
Farmer & Business	3	20,000/- to 26,000/-	10
Farmer & Driver	2	18,000/- to 26,000/-	6.67

3.2 Agricultural Activities and Major Agricultural Crops in the Study Areas

The people of Dacope emphasized on methods of sustainable farming practices as a result of the increasing demand for ensuring all year round agriculture through crop diversification. The study found that a majority of the respondents (100%) identified themselves as farmers, indicating that agriculture played a significant role in their livelihoods. A small number of the respondents (6.67%) also reported being both farmers and drivers, suggesting they have engaged in multiple occupations to increase their income. It was observed that a specific group of respondents (10%) identified themselves as businessmen, highlighting their creative efforts along with their agricultural activities. These additional income-generating activities provide farmers with a different source of income and help them mitigate the risks associated with disaster impacts on agriculture. By participating in non-agricultural activities, farmers are able to gain access to different markets and take advantage of opportunities beyond their fields, contributing to their overall financial stability. Tildanga Union has a total area of cultivable land of 2273 hectares and produces 25037 metric tons of crops. On the other side, the entire quantity of cultivable land in Pankhali Union is 2329 hectares, and the total amount of crops produced is 31257 metric tons. Table 4 shows the percentage of main agricultural

crop cultivation based on a field survey in the studied areas. Farmers in this area grow a variety of crops [10].

The majority of the respondents preferred Ropa Aman cultivation. Ropa Aman paddy is a popular choice among farmers due to its ability to tolerate tidal salt in the soil. This makes it suitable for cultivation during the rainy season in the study areas when there is normally an abundance of water available for irrigation. Rice cultivation provides an important source of income for farmers, contributing to their overall livelihoods and economic stability. First of all, farmers try to fulfill their own demand by using the rice, and if an excess amount remains, they sell it in the market to earn money. Watermelons are typically grown in warm, temperate climates. The region of Dacope experiences warm and sunny weather, making it an ideal location for watermelon cultivation. Watermelon cultivation in Dacope has been shown to be a profitable activity for farmers, as the demand for this fruit remains high in the local and regional markets. According to Uttam Kumar Roy (Sub-Assistant Agriculture Officer, Dacope Agriculture Office) "Cultivating watermelon in one bigha of land can yield a profit of 50,000 to 70,000 Taka". The success of watermelon farming has encouraged many farmers in the study area to focus on its cultivation as a primary source of income. Farmers in these areas rely on traditional farming methods and have limited access to modern agricultural technologies. After the cultivation of Ropa Aman and watermelon, most of the farmers grow tomatoes, pumpkins, garlic, sunflowers and potatoes in their suitable season. These crops are chosen by farmers because they require less water and can withstand the dry conditions of the season. Livestock farming is considered profitable by most respondents due to its potential for high profits and regular demand in the market. This diversification strategy allows farmers to maximize their income and reduce their dependence on crop production, ensuring a more secure financial future for themselves and their families.

Table 4. Major Agricultural Crops Cultivation Regarding Field Survey in the Study Areas

Name of cultivated crops	Number of the respondents	Percentage
Rice	30	100
Watermelon	15	50
Tomato	7	23.3
Pumpkin	9	30
Garlic	3	10
Sunflower	7	23.3
Potato	5	16.6
Livestock	14	46.6
Fish	13	43.3

3.3 Major Natural Disaster in the Study Area

Due to its geography and low-lying topography, Bangladesh is recognized as one of the world's most sensitive to climate and other environmental events. All the respondents in the study areas faced several types of disasters like cyclones, coastal floods, storm surges, droughts, and salinity intrusion. However, all of the respondents suffered water logging as a result of river embankment failure. During the rainy season, they faced flooding due to heavy rainfall. As it is adjacent to the Bay of Bengal, all respondents were affected by high salinity and severe drought. A cyclone is the most devastating natural disaster in these areas. Due to this catastrophic cyclone, most of the respondents reported the loss of their homes and belongings. The cyclone caused widespread destruction, leaving many people without shelter and basic necessities. The respondents also mentioned the loss of livelihoods as their agricultural fields, roads, and shops were destroyed. As well as the emotional trauma they experienced as a result of the cyclone's impact.

3.4 Transportation Systems of Agricultural Goods in the Study Area

In this study, two areas Pankhali and Tildanga Union were selected for data collection. According to the respondents, the transportation mode was chosen based on some factors such as distance, road conditions, and the availability of vehicles. The respondents also mentioned that after primary storage of the agricultural crops, the farmers used two kinds of vehicles for transportation, one is on-road vehicles like trucks, pickups, and mini-pickups and the other is non-road vehicles like barges, engine boats and launches. The respondents in Pankhali Union used only on-road vehicles like trucks, pickups, and mini-pickups for transporting their agricultural goods into the central market (Kadamtala, Khulna). The respondents in Tildanga Union used both on-road and non-road (water vehicles) vehicles like barges, engine boats, pickups, and mini-pickups for transporting their agricultural goods into the central market (Kadamtala, Khulna). They used mini-pickups, nosimons (big shallow engine vans), and motor vans to shift agricultural goods from the primary storage center to the local market. Fig 2 and 3 shows the transporting mode in the study areas.

Fig. 2. Transporting Watermelon by using Truck

Fig. 3. Transporting Rice by using an Engine boat

3.5 Existing Supply Chain

The existing supply chain in the study area involves farmers, who act as producers and are responsible for the primary storage of their agricultural products. Then they engage with commissioning agents to sell their products.

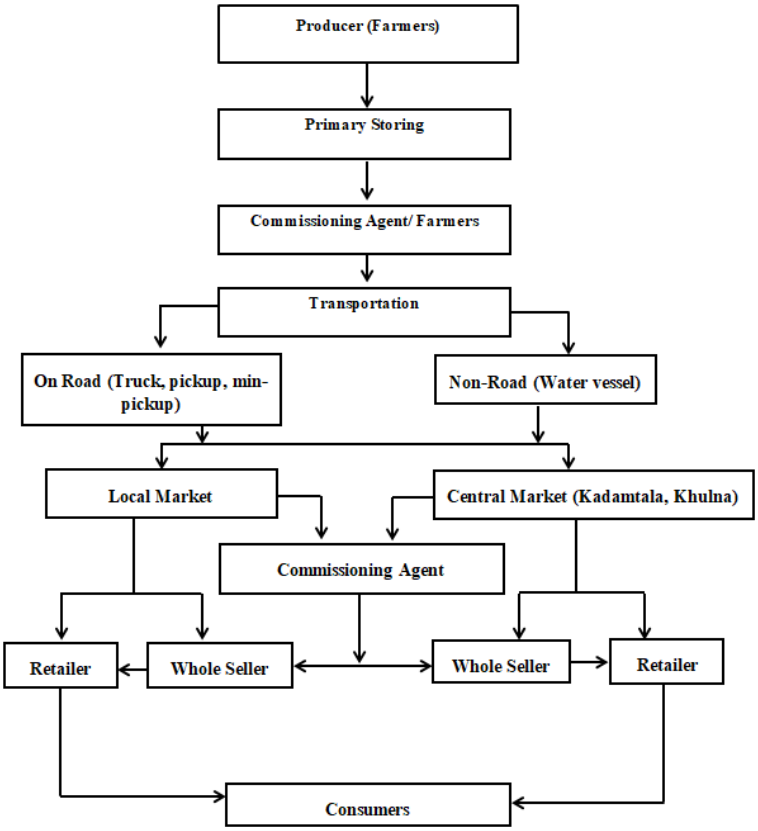

Fig. 4. Existing Supply Chain in the study area

Commissioning agents can have both positive and negative impacts on the sale of agricultural goods. Transportation plays an important role in the supply chain of agricultural goods. In the study area transportation of agricultural goods from primary storage to the local or central market is reached by using two processes, one is on the road using trucks, pickups, or mini-pickups or non-road using water vessels like engine boats, burgs etc. Efficient transportation ensures that agricultural products reach their destination in a timely manner, preserving their freshness and quality. Furthermore, it allows for wider market access, enabling farmers to sell their goods to a larger customer base and potentially increase their profits.

3.6 Impact of Disaster on Supply Chain Management in the Study Areas

Impact on Transporting Agricultural Products. In the Pankhali Union, agricultural goods were transported to the central market near Khulna and other districts via narrow roads using on-road vehicles. These narrow roads were not designed to handle heavy traffic. As a result, there are created in frequent vehicle congestion and delays in transporting goods. According to Idris Mollah 29 July 2023(Truck Driver in the study area) "During the harvesting period of the Watermelon Khulna-Chalna main road, local people faced heavy traffic due to narrow roads and big vehicles (trucks)." Farmers often had to pay additional costs for their vehicles due to the poor road and heavy traffic conditions and they faced probable losses and decreased market value. According to Md. Shofiqul Islam (Agriculture Officer, Dacope Agriculture Office), "Narrow roads and the ferry system for communication with this area often result in a significant delay in the transportation of agricultural goods into the central market. Consequently, the quality of the products is often compromised and that's why the farmers did not get fair prices". The lack of a proper road transportation system has increased the challenges faced by farmers in transporting their produce efficiently. The delays in transporting goods to the central market led to the spoilage of fresh agricultural products, causing significant financial losses for the farmers and producing huge agricultural waste. The inadequate investment in the transport system also disrupted the growth of the agricultural sector and limited the potential for increased productivity and profitability in the study areas. In the Tildanga Union, waterways (non-road) are used by farmers as an alternative mode of transportation to the road. This mode of transportation helps to reduce the risk of spoilage and financial losses caused by delays in transporting agricultural goods to the central market. In these areas, there is no adequate infrastructure for the loading and unloading of agricultural goods onto water vessels. This lack of proper landing space for water vessels poses a significant challenge for farmers who rely on waterways as a mode of transportation. Without proper facilities, the process of loading and unloading agricultural goods becomes risky for porters in the vessels ghat and also time-consuming, and inefficient, potentially negating the benefits of using waterways. Another limitation of these areas is the tidal condition of the river. After loading the agricultural goods truck drivers had to suffer for the time of tide because there was a single ferry system in the road network at Chalna ghat. Generally, river tide comes approximately after six to seven hours. There are most of the agricultural goods loaded vehicles waited at the ghat for the time of tide. Agriculture loaded trucks have to wait for six to more hours for the next tide, if truck drivers miss the timing of the tide. This limitation not only impacts the timely delivery of agricultural goods but also increases the risk of spoilage due to longer travel times.

Disaster Impacts on Agricultural Production. The Dacope Upazila is adjacent to the border of the Sundarbans and the Bay of Bengal, almost every year, the area is affected by devastating cyclones. The total area of Dacope Upazila is 99,157 hectares. In which, the total cultivated land in Tildanga and Pankhali Unions is 4,572 hectares. The total 22,757 hectares area of Dacope is affected by high salinity. In which a total of 2,100 hectares of land in Tildanga and Pankhali Unions are affected by salinity. The highest recorded soil

salinity levels reached 49.33 DS/m. In these highly saline areas, agricultural productivity during the Rabi and Kharip-1 seasons is severely constrained. Approximately 80% of the land here is under single-crop cultivation, with around 32% dedicated to local crop varieties and 20% under irrigation facilities. This area produced 56,294 metric tons of agricultural goods [10]. According to Uttam Kumar Roy (SAAO, Dacope Agricultural Office), this amount is significantly less than the total cultivated land. Farmers in this area are disinterested in agricultural activity. Because natural disasters such as cyclones, saline water, unplanned shrimp aquaculture, destruction of polders, and the inability to use groundwater irrigation are major obstacles to agricultural development. However, if these problems are resolved, the Upazila total agricultural output could be increased. Improvement of polders, building sluice gates and ensuring proper use of sluice gates and management of saline water can be achieved by creating fresh water streams. It will be possible to convert single-crop land into double and triple-crop land and ensure food security by increasing agricultural product production.

Disaster Impacts on the Agricultural Supply Chain in the Study Area. Natural calamities damaged the agricultural crops, animals, poultry, trees, buildings, roads, polders almost everything of farmers although the degree of damage varied depending on the type of disasters they faced. The destruction of road networking systems made it difficult for farmers to transport their goods to market, and increasing their economic challenges. They highlighted the importance of timely transportation to ensure the freshness and quality of agricultural crops during market distribution. During cyclones hit the study area, roads side trees fell on the roads, as a result the vehicles cannot move to their destination in time and the agricultural goods get spoiled due to time consumption. Fig 5 and 6 shows the disaster impacts on water vessels ghat and road network.

ig. 5. Water Vessels Ghat of Tildanga Union

Fig. 6. River Bank Erosion

Impact on the Pricing of the Agricultural Products. In the study area commissioning agents play an adverse role in the buying and selling of agricultural goods. They are motivated by earning their own profit, which could lead to a conflict of interest. This can

potentially lead to lower profits for farmers or producers, as they buy agricultural goods from the farmers at a low price, subsequently reselling these products within both local and central markets at a high price. This practice can result in unfair profits for the agents. All these occur with the farmers because they lack access to information about market prices and are therefore unable to negotiate fair prices for their goods. But particular farmers bring their agricultural products to the local and central markets. This allows them to directly interact with buyers and negotiate prices, ensuring that they receive a fair price for their hard work. Additionally, this can be beneficial for central markets, which often have a higher demand for agricultural products.

4 Conclusion

The study found an overview of disaster impact on supply chain management in the Pankhali and Tildanga Union which is located in the southwestern region of Bangladesh. Agriculture is the main income generating source of this area and the total amount of produced crops in these areas is 56,294 metric tons. The study area is affected by storms, floods, droughts, salinity intrusion, and river erosion every year. From the study the fallowing conclusions are made:

The majorities of people in the areas are affected by the cyclone due to damaged housing, destroyed agricultural crops, a damaged road network, and reduced livelihood options. Disaster damage of road network and transportation systems makes it difficult to transport agricultural goods into the central market.

Due to the lack of proper storage facilities for agricultural goods, farmers are forced to sell them immediately at lower prices to avoid spoilage. Farmers used waterways as an alternative transportation method to reduce spoilage and financial losses. Its single ferry system at Chalna ghat, created high traffic jams and delays for the timely delivery of agricultural goods to its destination.

The findings of this study emphasize the critical need for improved disaster resilience and infrastructure development in the study area's agricultural supply chain. Investment in road network resilience, storage facilities, efficient transportation methods, particularly for waterways is paramount to mitigate economic losses, reduce spoilage and enhance the overall well-being of the affected communities.

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