

# Assessing Farmers' Flood Vulnerability and Institutional Role in Mitigating Its Impacts in District Jamshoro, Sindh

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## Abstract

Floods in Pakistan are a constant and destructive phenomenon that causes significant economic and social losses. Therefore, this study aimed to assess farmers' flood vulnerability and institutional role in mitigating its impacts in district Jamshoro, Sindh. To collect samples, 150 individuals living in the Jamshoro district, the area most badly damaged by floods, were chosen randomly and non-probabilistically to gather primary data. Questionnaires were administered, and interviews were conducted with respondents. In addition, relevant technical reports, policy documents, and research papers related to flood management studies were reviewed as secondary data. Statistical analysis of the collected data was undertaken using *t*-tests. The results revealed that economic impacts were severe, with 82% of farmers reporting crop damage or destruction and 75% reporting reduced yield. Moreover, most farmers (57%) reported a more than 50% decrease in income. The floods also had significant social impacts, with 98% of respondents reporting damage or destruction of homes and 95% reporting displacement of families. The analysis also showed that farmers in the study area were very vulnerable to flooding, where livestock damage was reported by 37.3% of the respondents, crop loss by 28%, and housing devastation by 14.6%. The findings revealed that institutions were moderately successful in reducing the effects of floods, with an average efficiency rating of 3.5. This study also highlighted that access to information and involvement in decision-making were the most significant factors affecting institutions' effectiveness, with 70% and 60% of the respondents reporting these factors.

**Keywords:** Farmers, Flood Vulnerability, Institutional Role, Mitigation, District Jamshoro

## Introduction

Floods are recurring natural phenomena in rivers and streams. The impact of flooding has become increasingly important in recent years as more and more people are exposed to the adverse effects of flooding.

Populations around the world are vulnerable to natural disasters. In most cases, flood is defined in terms of statistical frequency (Akhtar S., 2011). A "100-year flood" or "100-year flood-plain" is an event or location with a 1% chance that a specific flood will occur in a particular year. Hazards are becoming more prevalent and more intense everywhere. According to the Intergovernmental Panel on Climate Change (IPCC, 2004), floods are one of the leading causes of disaster-related fatalities and economic losses. In the future, flood frequency and

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intensity are expected to rise. Trends indicate that while the number of people killed by flooding is declining, the financial cost is rising (EM-DAT, 2011). However, not everyone will be equally affected, as the magnitude of mortality risks may rely on their intrinsic vulnerability to flooding. Disaster managers must comprehend the social and ecological variables influencing vulnerability to create effective policies and procedures to increase resilience. (Thomalla *et al.*, 2006). Vulnerabilities are reflected in indicators. The Asia and The Pacific region is also vulnerable, with floods affecting the economy and regional stability of different countries; floods have hit India, Pakistan, South Korea, China, and Bangladesh, affecting thousands of people and destroying agricultural and residential land, namely life and food (Balica, 2012).

In Pakistan, flooding is the most frequent and expensive natural disaster, and it is anticipated that it will worsen due to climate change (Khan *et al.*, 2021). Planning can reduce flood risks and lessen their effects, even while it cannot prevent floods and the effects that follow. The effects of flooding are unevenly distributed among different groups of people. This is because they have different exposures and socioeconomic characteristics. Socially vulnerable people may be more vulnerable to floods due to poor socioeconomic conditions (e.g., financial problems, inadequate housing, and social isolation) and, therefore, experience more significant impacts and losses more likely. Social vulnerability analysis is a popular tool for assessing this (Cutter *et al.*, 2003).

It is about identifying the vulnerabilities or vulnerabilities of people at risk and understanding where they are most in need, such as before, during, and after a disaster, thus reducing the impact of natural disasters (Fuchs *et al.*, 2012). Similar to this, spatially variable flood exposure with maps can assist community planners in making resource allocation decisions that are both efficient and well-informed, as well as give emergency management agencies more knowledge and context before they decide on priorities or take action. Social vulnerability can take several forms: The state of the system prior to the occurrence, the likelihood of outcomes in terms of economic loss and loss of life, and the inability to face and recovering rapidly from a disaster are only a few examples of social vulnerability (Dwyer *et al.*, 2004).

This research study aims to classify vulnerable populations, assess their protective strategies in disaster risk Management, and formulate a theoretical framework with indicators aimed at vulnerable groups, which can be helpful in the future and make it easy for stakeholders to make quick decisions during disasters and flooding situations.

## Review of Literature

Natural disasters, particularly floods, can severely impact communities, which are often highly vulnerable to these hazards. Therefore, assessing community vulnerability is paramount in understanding community preparedness and resilience against floods. Among the most vulnerable groups are farmers, whose livelihoods depend on the environmental factors that influence their crops and well-being. Thus, assessing the flood vulnerability of farmers is highly crucial (Rahman *et al.*, 2019; Senaratne *et al.*, 2021). One of the significant factors that exacerbates farmers' vulnerability to flood hazards is the lack of institutional support and intervention (Saleem *et al.*, 2019; Kale *et al.*, 2020). Institutions are crucial in mitigating the impacts of floods by providing risk reduction measures, including early warning systems and emergency response

plans (Lesk, 2020). However, the effectiveness of institutional interventions in reducing vulnerability is influenced by various factors, including community participation in the planning process and trust between farmers and institutions (Saleem *et al.*, 2020; Rashid *et al.*, 2019). In addition, access to information, finance, and infrastructure is critical in reducing farmers' vulnerability to flood hazards (Ahmed *et al.*, 2020; Ibrahim *et*

*al.*, 2019). Understanding local perceptions and knowledge is also essential in assessing farmers' flood vulnerability (Hossain *et al.*, 2020).

Farmers often have traditional methods and strategies for dealing with flooding developed over generations, often resulting from experience and learning from previous disasters. Such knowledge and coping strategies can contribute significantly to farmers' resilience against flood hazards (Mahmood *et al.*, 2021). The assessment of farmers' flood vulnerability and the institutional roles in mitigating its effects have been the subject of many studies. For example, Saleem *et al.* (2020) investigated farmers' perceptions of flood risks and institutional preparedness in Pakistan, concluding that farmers needed higher perceptions of risk, better trust in institutions, and a need for more institutional preparedness. Another study by Kale *et al.* (2020) attempted to understand the vulnerability and adaptation of farmers to floods in Maharashtra, India, finding that farmers' vulnerability depended on many factors, including education level, income, land ownership, and access to institutional support.

Similarly, Ahmed *et al.* (2020) reported that Bangladeshi farmers exposed to floods need more institutional support, such as early warning and emergency response systems, results in high vulnerability. Furthermore, Ibrahim *et al.* (2019) assessed flood vulnerability and coping capacity among smallholder farmers in Kelantan, Malaysia, finding that farmers' vulnerability and coping strategies were influenced by institutional support and access to resources, such as finance, information, and infrastructure. Community participation in flood preparedness and resilience has also been investigated in several studies. For instance, Rashid *et al.* (2019) assessed flood disaster management policies in Pakistan and concluded that policies that included the participation of communities in planning and implementation were the most effective. Mahmood *et al.* (2021) investigated the perceptions and decisions of farmers toward flood risk in coastal Bangladesh, finding that farmers who participated in flood preparedness and mitigation programs were more resilient against flood hazards. In conclusion, assessing farmers' flood vulnerability and the institutional role in mitigating its impacts is critical to community resilience against flood hazards. By understanding the challenges and opportunities in improving farmers' resilience against flood hazards, policymakers and practitioners can develop appropriate strategies and policies for disaster risk reduction. The literature review highlights that institutional support and intervention, access to resources, and community participation are essential factors in reducing farmers' vulnerability to flood hazards. With these factors in mind, future research can focus on developing context-specific strategies to enhance farmers' resilience to flood hazards in District Jamshoro, Sindh, and other similar communities.

## Materials and Methods

Recent research has focused on socioeconomic vulnerability and vulnerability to disasters, but less attention has been paid to group classification. In particular, farmers' vulnerability comprehensively addresses specific issues and concerns in households, housing, and agriculture.

This research contributes to the climate-changing literature in many ways, i.e., in the context of Pakistan, there are insights into the diverse socioeconomic vulnerabilities of ethnic groups to climate change. It paints a picture not only of the changes brought about by the floods in Pakistan but also of farmers and other groups coping with the challenges associated with natural disasters. From this point of view, with the help of national and international organizations, it explores the future ambitions of local experiences and communities and ultimately contributes to developing socio-environmental vulnerability assessments. Detailed information can be reflected for future disaster decision-makers.

### Research Design

The current research survey applies qualitative research methodology appropriate for this research study. To gather data on the flood disaster via category, age, and gender perspective, it is essential to systematically understand the phenomenon by the perception of community people via participating. Thus, qualitative research methodology was applicable here because these are used culturally and socially to discover people's life experiences. Similarly, qualitative research methodology is applied to quarry the local informers' viewpoint about the 2022 flood experiences. Data was also collected about living conditions and conditions earlier and after the disaster, explicitly focusing on farmers.

### Sampling Design

The Jamshoro district of Sindh was chosen for sampling using a simple random method in which each respondent from the population has an equal chance of being chosen. One hundred fifty people made up the sample size for this study.

### Study Area Selection

Due to the following reasons, the Sindh province's Jamshoro district was the focus of the sample.

1. The Jamshoro district is one of the Sindh province's most often flooded regions. Following the 2010 disaster, this area was hit by four further floods, which caused extensive damage.
2. Due to the influx of relief workers from public and private organizations after the 2010 flood, this region was a good choice for research on the role of such institutions in flood management in flood-prone areas.

### Study Area Background

Jamshoro district is situated on the Indus River's west bank. District Jamshoro borders from the north with district Dadu, south with district Thatta, and southwest with Karachi. The district Jamshoro has four talukas: Sehwan, Thana Bula Khan Manjhand, and Kotri. District Jamshoro was separated from District Dadu in December 2004.

### Climate

In Jamshoro, the summer is muggy, sweltering, windy, and arid; the winter season is comfortable, short, dry, and primarily clear around the year. Throughout the year, the temperature usually varies from  $53^{\circ}F$  to  $105^{\circ}F$  and is hardly below  $47^{\circ}F$  or above  $111^{\circ}F$ .

### Land Utilization

The district Jamshoro is rich in marble, gravel, and limestone minerals. The Rabi crops are oil seeds, pulses, gram, wheat, and barley. The Kharif crops harvested in the district are maize, bara, sugarcane, cotton, and rice. Alongside the river, the Katcha Indus is the main agricultural production area where vegetables are mostly grown. Dadu Canal irrigates some of the regions in Taluka Sehwan. In this district, indigenous poultry, mules, horses, camels, goats, sheep, buffalo, and cattle are mostly kept as domestic animals.

### Study Variables

The information relevant to various elements of flooding. Moreover, community and farmers' risk was presented as graphs and tables. In order to accomplish the goals of the current study, the following elements/variables were incorporated.

- Impact of recent floods-2022 on the farming community.
- Farmers' vulnerability to floods in the study area.

- Role of institutions in mitigating flood-induced impacts on farmers in the study area.
- Vulnerability of Farmers to Flood-Induced Impacts
- Effectiveness of Institutions in Mitigating Flood-Induced Impacts

### ***Units of Analysis***

The basic random analysis units were:

- Household leaders, farmers, and the general public comprises local units.
- Governmental and nongovernmental organizations (NGOs) are organizational units.
- Union Council, Tehsil, District and Provincial Administration

### **Data Collection**

The informants were selected based on the requirement of the research topic, and purposive sampling techniques were applied. The informants selected were adult men, women, and senior citizens. The sources were selected for the group discussion or interview by visiting door-to-door. Moreover, the researcher asked for their participation.

### **Tools for Data Collection**

Data was collected by using both primary and secondary data and the below-given tools will be used for primary data collection:

- Questionnaire survey
- Group discussions
- Semi-structured interview
- Non-participant and Preliminary observation

### **Secondary Data**

Secondary data includes reports on flood victims, books, journals, articles, and governmental websites on disaster management, Newsletters by NGOs and damage available on the internet.

### **Group Discussions**

The number of group discussions was 150, 60 with women, 30 with senior citizens and 60 with men. Each group discussion was comprised of 5-6 informants. The group interview was a beneficial method that created a valuable background to explore the problems at hand, like gender relations in a chauvinistic culture and the living issues of flood victims. To understand the viewpoint of senior citizen informers on a particular issue during senior citizen group discussions, the questions were asked individually to each informant.

### **Semi-Structured Interviews**

Semi-structured interviews were implemented as another tool for data collection as they allowed informers to convey their viewpoints about the topic thoroughly. Moreover, it provided opportunities to form helpful relationships with the informers via face-to-face communication. Thus, semi-structured individual interviews were selected as an alternative to the group interviews.

### **Observations**

During this research study, non-participant observations were applied to supplement the interview data. Observations were made in natural settings, and no plans were made to conduct the observations. However, the observations were made from various viewpoints, mainly investigating senior citizens' access to private and public places.



### **Data Analysis**

The data was recognized by assigning an artificial name to each participant instead of mentioning the actual name and age. This data was distributed into various thematic sections to discuss and describe the main sections of the survey individually. Finally, data analysis was based on the subjects and was interpreted accordingly.

### **Respondents Demographic Profiles**

Farmers were divided based on farm size, land ownership position, annual income, education level, and flood and heavy rainfall risk perception.

#### **Farmers Distribution**

The study categorized farmers based on farm size holdings and created three categories: small, medium, and prominent. The ownership position of farmers revealed that 15% of small farmers were owners, 72% were tenants, and 13% were tenant cum owners. Large farmers had the highest proportion of ownership, at 82%.

#### **Farmers Income**

Most small farmers (49%) earned less than PKR 220,000, while most middle farmers (37%) earned between PKR 220,001-450,000. Large farmers had the highest average revenue of PKR 650,000 and above.

#### **Farmer Education**

Education is essential to boost agricultural output and innovation. The study divided sample respondents into six illiterate to bachelor-level groups. Illiterate farmers had the highest proportion at 34%, while 18% held a middle-level education. The proportion of farmers with a bachelor's degree was the lowest among all categories.

#### **Flood and Heavy Rains Risk Perception**

More than half (60%) of all farmers viewed floods as a significant risk, with small farmers (74%) having the highest perception of floods, while medium farmers (64%) believed it was a low-risk event. Most farmers (68%) had a high-risk perception of heavy rainfall, with small farmers (82%) expressing the highest perception of heavy rainfall risk.

### **Results**

The 2022 floods disproportionately devastated Sindh, causing substantial damage to residences, transportation, agricultural, irrigation, and communication infrastructure. Millions of people remain in need of assistance. The 2022 floods destroyed the agriculture and food sectors, driving up food prices, causing food shortages, and hurting employment and lifestyles. Over 4.4 million acres of agricultural land have been destroyed. Structured questionnaires were provided to 150 respondents, including 60 males, sixty females and 30 senior citizens. This survey study examined the influence of floods on the socioeconomic situations of farmers in the area.

#### **Economic Impacts**

The economic impacts of the 2022 flood are detailed in Table 1. Crop damage or destruction was observed in 123 cases, representing 82% of the total. Such damage can lead to significant losses for farmers and food supply disruption. Yield reduction was reported in 113 cases, representing 75% of the total can adversely affect farmers' income and overall food supply. An income decrease of more than 50% was noted in 86 cases, representing 57% of the total. These figures indicate the long-term adverse economic effects of flooding on local communities.

Costs have risen in 144 cases, representing 96% of the total, including expenses for repairing damaged structures, evacuation, and insurance premiums. The findings demonstrate that flooding can have various negative economic impacts, particularly on agriculture and the local economy.

**Table 1: Economic Impacts of Current Floods**

Economic Impacts	Frequency	Percentage
Crop damage or destruction	123	82%
Reduction in yield	113	75%
Decrease in income by more than 50%	86	57%
Increased costs	144	96%

### Social Impacts

The social impacts of the 2022 flood are detailed in Table 2. House damage or destruction was observed in 147 cases, representing 98% of the total. Flooding can severely impact homes, leaving people homeless and without essential resources. Displacement of families has occurred in 143 cases, representing 95% of the total. Flooding can force families to evacuate their homes, resulting in distress and compromising their safety. The impact on health services was noted in 98 cases, representing 65%. Flooding can affect access to health services and cause health issues such as water contamination and the spread of diseases. Education services were affected in 120 cases, representing 80% of the total. Flooding can affect access to education services, such as schools, hindering the education of young people. Services were compromised in 141 cases, representing 94% of the total. Flooding can compromise essential services such as electricity, water supply, and transportation. Overall, the data suggests that flooding can have significant social impacts on homes, families, and essential services.

**Table 2: Flooding Social Impacts**

Social Impacts	Frequency	Percentage
Houses damaged or destroyed	147	98%
Displacement of families	143	95%
Impact on health services	98	65%
Impact on education services	120	80%
Compromised services	141	94%

### Additional explored impacts

Additionally, the explored impacts of the 2022 flood are detailed in Table 3. Reduced market access was observed in 136 cases, representing 91%. Flooding can disrupt transportation, leading to reduced market access and economic setbacks. The impact on mental health and well-being was noted in 114 cases, representing 76%. The flood can have long-term adverse psychological effects on individuals and communities. Delays in planting crops occurred in 147 cases, representing 98% of the total. The flood can delay planting seasons, significantly affecting crop yield and quality. A decrease in livestock production was observed in 110 cases, representing 73% of the total. Flooding can cause significant livestock losses and limit agricultural productivity in the long run. Overall, these additional impacts further illustrate the diverse and far-reaching effects of flooding on communities and natural systems.

**Table 3: Additional Explored Impacts**

Additional Explored Impacts	Frequency	Percentage
Reduced access to markets	136	91%
Impact on mental health and well-being	114	76%
Delay in planting crops	147	98%
Decrease in livestock production	110	73%

### Farmers' vulnerability to recent floods

Table 4 details farmers' vulnerability to the recent floods in 2022. Crop loss was reported by 42 farmers, representing 28% of the total, highlighting the economic implications for farmers who rely on their harvests for livelihood. Food insecurity was experienced by ten farmers, representing 6.7% of the total, underscoring the risk of hunger and malnutrition for vulnerable populations. Temporary displacement was reported by 20 farmers, representing 13.3% of the total, causing disruptions to their livelihoods and social and economic networks. Destruction of homes was reported by 22 farmers, representing 14.6% of the total, resulting in significant loss of personal possessions and the need to rebuild homes. Livestock damage was reported by 56 farmers, representing 37.3% of the total, affecting the livestock industry and supply chains. The overall impact of flooding on farmers underlines the significant losses of crops, livestock, and homes with potential long-term implications.

**Table 4: Flood Vulnerability**

Factors	Frequency	Percentage
Crop loss	42	28%
Food insecurity	10	6.7%
Temporary displacement	20	13.3%
Destruction of homes	22	14.6%
Livestock damage	56	37.3%

### Role of institutions in mitigating flood-induced impacts on farmers

The study's objectives were to ascertain the degree of susceptibility of farmers to the effects of floods, evaluate the efficiency with which institutions mitigated these effects, and pinpoint the variables affecting this efficiency.

### Vulnerability of Farmers to Flood-Induced Impacts

The vulnerability of farmers to flood-induced impacts is shown in Table 5. The vulnerability of farmers to flood-induced impacts is influenced by age. The Vulnerability Index (VI) was used to gauge a farmer's ability to deal with flood-related effects, with a range between 0 and 1, where 0 means "not vulnerable" and one means "highly vulnerable." The data shows that farmers aged below 60 years old had a VI of 0.40, indicating a moderate level of vulnerability to flood-induced impacts. On the other hand, farmers aged 60 years or older had a VI of 0.60, indicating a higher level of vulnerability to flood-induced impacts.

**Table 5: Vulnerability Index per Age Group**

Age Group	Vulnerability Index
<60 years old	0.40
≥60 years old	0.60



### Effectiveness of Institutions in Mitigating Flood-Induced Impacts

The effectiveness of institutions in mitigating flood-induced impacts is shown in Table 6. The effectiveness of institutions was evaluated using a scale of 1 to 5, with one being "very ineffective" and five being "very effective." The data shows that farmers aged below 60 years old gave an effectiveness rating of 3.7, suggesting that they perceived institutions to be moderately effective in mitigating flood-induced impacts. On the other hand, farmers aged 60 years or older gave an effectiveness rating of 3.1, indicating a lower perception of effectiveness in institutions' efforts to mitigate the impacts of floods.

**Table 6: Effectiveness Rating of Institutions per Age Group**

Age Group	Effectiveness Rating
<60 years old	3.7
≥60 years old	3.1

### Factors that Influence the Effectiveness of Institutions

Factors that influence the effectiveness of institutions are shown in Table 7. The results show that access to information is the more influential factor, with a percentage of 70%. It suggests that institutions need to ensure that information related to flood management and mitigation strategies is readily available and easily accessible to the public, especially farmers who are at high risk of flood-induced impacts. The second factor is the level of participation in decision-making, with a percentage of 60%. It highlights the importance of involving the public, including farmers, in flood management and mitigation strategies decision-making.

**Table 7: Factors that Influence the Effectiveness of Institutions**

Factors	Percentage
Access to Information	70%
Level of Participation in Decision-making	60%

### Discussions

The research results provide essential insights into the demographic profiles of farmers in Jamshoro district, Sindh, as well as the impacts of floods on their livelihoods, vulnerability to floods, and the role of institutions in mitigating flood-induced impacts. The study reveals that small farmers perceive floods as a significant risk, while large farmers have the highest proportion of ownership. Moreover, education is essential to boost agricultural output and innovation, but the proportion of farmers with a bachelor's degree was the lowest among all categories.

This study also highlights the significant economic impacts of floods on the agricultural economy, with most farmers reporting crop damage and reduced revenue. Input costs had also increased following the floods, indicating long-term impacts on farmers' livelihoods. On a social level, the floods damaged or destroyed the farmers' homes, impacting their health and education systems. Additionally, the floods significantly affected the farmers' mental health and general well-being. This research also indicated that farmers' vulnerability to floods is highly influenced by their income and education levels, with most respondents reporting no help from the government or NGOs to handle the effects of floods. Livestock damage, crop loss, and housing devastation were the most commonly reported factors affecting farmers' vulnerability, highlighting the need for policies and plans to reduce the harm caused by floods. The results revealed the role of institutions in mitigating flood-induced impacts on farmers and suggest that institutions are moderately efficient in reducing the effects of floods. Moreover,

factors such as information access and the degree of decision-making involvement significantly impact institutions' efficacy in reducing the effects of floods.

Overall, this study provides comprehensive insights into farmers' demographic profiles, the impacts of floods on their livelihoods, vulnerability to floods, and the role of institutions in mitigating flood-induced impacts. The study highlights the need for policies and plans to reduce the harm caused by floods, focusing on providing extra assistance to elderly farmers during floods. Finally, the study presents several recommendations to reduce the negative impacts of floods on farmers' livelihoods and improve their resilience to future floods.

## Conclusion

Risk perception is a critical component influencing farmers' risk management decisions. The majority of small farmers perceived significant flood and rain hazards. The findings of farmers' risk attitude reveal that most of the small farmers were risk-averse. The field survey's main findings are that agriculture employs around 80% of the surveyed area's population, directly or indirectly. Landowners in the area are limited, with most farmers owning less than 4 acres of land. Farming is mainly done by young people (more than 60%) aged between 21 to 40 years. In terms of experience, all of the farmers in the research area had an average of 21 years of practice. The area's education levels are considered poor, with the average educational level at the primary levels. Farmers' average agricultural revenue is reported to be PKR 350000 per year. Per month income was Rs. 28000, whereas the Pakistani minimum pay is Rs. 25000. (GOP, 2022 Budget). Flood risk perception was positively linked with consumption reduction in the study region.

Similarly, risk perception concerning severe rainfall was related to adopting this method. The ownership of land was related to diversification. The implementation of diversity was favorably linked with risk assignment from severe rainfall in the research region. As a result, this study showed how severely floods affected the agricultural community in Sindh's Jamshoro area. Floods damaged crops, reduced yields, uprooted families, and destroyed houses, among other economic and social harms. This research also emphasized the need for aid from governmental and non-governmental organizations and farmers' susceptibility to the effects of floods. Additionally, the efficiency of institutions in reducing flood-related effects was evaluated, and it was discovered that elements like information access and the level of decision-making engagement impacted their efficacy. These findings present significant data that policymakers and institutions may use to create efficient flood mitigation plans for the study area's farming community.

The majority of farmers in the survey district were small. Their risk perceptions were higher, and they were risk averse. The PDMA should assist these small farmers during disaster so that they may manage their risk effectively. Farmers used informal risk management measures and government should assist these farmers with crops and soil preparation so that they are less dependent on traditional techniques for sustainable societies.

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