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How Fishermen Respond Threat of Climate Change: Empirical Evidence in East Java

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ABSTRACT

This research investigated how shrimp farmers perceive climate change and what factors influence their decision to implement adaptation strategies. Surveys were conducted with 150 households in Tambakan, Kalianyar, Raci 1, and Raci 2. Over the past five years, information about climate change has primarily reached farmers through radio and television (54%). The majority (96.21%) perceived climate change as manifested by altered rainfall patterns, rising pond water temperatures (98.71%), declining production yields (95.41%), and an increase in shrimp pests and diseases (96.23%). The researchers classified climate change adaptation strategies into four categories and used logit regression analysis to identify factors influencing their adoption. They found that the determinants of adoption varied across these categories. Based on these findings, the study concludes that raising awareness about the impact of climate change on shrimp farming is crucial for farmers to choose suitable adaptation strategies. Additionally, strengthening institutional support through improved access to association borrowing, markets, extension services, farm group activities, and use of climate-resistant shrimp varieties can contribute to increased farm production.

Keywords: Adaptation Strategies, climate change, households, logit regression.

INTRODUCTION

As a coastal archipelagic country, Indonesia is a strategic area (Sabet et al., 2022) negatively affected by climate change and threatening the livelihoods of the fisheries sector (Jaaffar, et al., 2018). So far, Indonesia's fish resource potential is estimated to reach 12.54 million tons per year and until December 2020 reach USD 5.20 billion. This achievement is equivalent to the 2020 target, which is 84.28% (USD 6.17 billion). When compared to the target in 2019 (USD 4.94 billion), this achievement increased by 5.26%. The value of fish exports in 2020 was dominated by shrimp with a contribution of 39.68% (USD 2.06 billion). Based on export destination countries, the United States (US) became the largest market with a contribution of 40.30% (USD 2.1 billion). Of this value, as much as USD 1.45 billion was generated from shrimp exports (Widyastuti, 2023). However, this potential has decreased due to climate change, increasing the risk of floods, droughts, and extreme weather can disrupt fisheries supply and cause price instability (Tresnati, J.., et al., 2023). The price reduction is not only felt by shrimp pond cultivation business actors, but in general for aquaculture production business actors (Ahmed et al. 2021; Nadarajah & Eide, 2020; Oparinde, 2021).

The fact that shrimp farmers are vulnerable to climate events, such as typhoons, sea level rise, temperature, salinity, rainfall, floods and droughts (Do

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and Ho 2022). Increased temperatures and unusual rainfall patterns in recent years, affecting shrimp production with more diseases and damaging the environment, clear examples of this are pollution and water quality (Islam et al. 2019). This condition emphasizes the fisheries sector to be one of the sectors considered risky (Joffre, et al., 2018), thus providing new challenges for pond business actors to quickly adapt, and maintain the quality and stability of shrimp production, one of which is improving aquaculture infrastructure facilities (Nadarajah & Eide, 2020).

Realizing the economic potential of shrimp bididaya, the Indonesian government pays serious attention to the issue of climate change which can be the impact of changing precipitation and evaporation patterns (Ahmed et al. 2021; Galappaththi et al. 2020). The vulnerability of climate change risks, the emergence of very significant negative influences on fisheries (Oparinde, 2021), many scientists pay attention through their research and find that climate change adaptation strategies are categorized into three levels, namely mitigation options at the local level, multi-level adaptive strategies, and approaches at the community level known as multilevel adaptive strategies. There are adaptation countermeasures at the farmer household level, namely increasing the depth of the pond, repairing dikes around the pond, lining shrimp ponds using plastic sheets, and improving water quality using settling ponds (Islam et al. 2019; Hukom et al. 2020). The application of adaptation strategies varies greatly between regions, even between households in one region due to socioeconomic factors.

Some scientific literature finds the impact of climate change on ecosystems (Perisha et al., 2022), fisheries productivity (Illahi et al. 2023), and food security (Rahman et al., 2022), but researchers still rarely make observations related to 1) How perceptions, forms, and factors of adaptation strategies carried out by shrimp farmers in dealing with climate change. Considering the contribution of research can be used as a reference for the government to formulate policies and strategies to deal with climate change issues, especially for traditional shrimp pond business actors. So, researchers are also interested in doing research on this topic.

The issue of climate change is the condition of several climatic elements whose intensity tends to change or deviate from the dynamics and average conditions towards a certain direction (increasing and decreasing). Climate change also causes an increase in the frequency of extreme climate events (climate anomaly) such as El Niño and La Nina phenomena, IOD (Indian Ocean Dipole), decrease or increase in air temperature extremely, shifts and precipitation and erratic seasons (Basuki et al., 2022). Following up on this issue, the first action that needs to be taken in dealing with climate change is to implement adaptation strategies in order to reduce and stabilize the concentration of greenhouse gases in the atmosphere. Furthermore, Orazalin et al., (2024) argue that climate change adaptation is an effort to reduce the level of vulnerability to the impacts of climate change by building economic, social resilience, diversifying the livelihoods of people who are less sensitive to climate change, improving spatial planning and ecosystem management. Adaptation programs and actions that are immediately directed at areas where the current level of climate risk is high and the future is expected to remain high or likely to increase. While the long-term nature is directed at areas that are currently low and the future remains low or will increase.

With regard to this view, adaptation is changing everyday social and economic realities around the world.

Adaptation is defined as the process of adjusting to actual or expected climate change and its impacts (IPCC, AR5, 2020), climate change has a broad impact on changes in human and natural systems. The International Panel on Climate Change (IPCC) definition is not limited to the planning and policy levels, but in practice, the term adaptation is more widely used to refer to planned interventions to adapt to climate change. Based on this view, planned adaptation is based on conversations about the impacts of climate change on individuals and households by considering the adaptive capacity of communities and involving local institutions in adaptation plans (Patnaik & McPeak, 2023; Scobie et al., 2023; Visconti, 2023: Ramalho et al., 2022; Nightingale et al., 2020).

RESEARCH METHODS

Observational Study Area

This research focuses on four shrimp-producing areas in Bangil District, East Java, chosen as the intervention site due to their high vulnerability to climate change and designation as one of the hottest and driest regions in the province.



Figure 1. Map of Research Location (Source: Weatherbase)

The researchers' initial observations obtained information that shrimp farmers experienced extraordinary changes in rainfall patterns that caused a decrease in production quality. High rainfall, flooding, pests and diseases that attack shrimp are carried away through flood currents and enter the pond, making it difficult to overcome and in the end they experience crop failure. Lack of modern adaptation technology because the shrimp pond cultivation business carried out is still traditional, so it is vulnerable to pest and disease attacks and difficulty regulating water temperature in the pond.

Sampling, Questionnaire, and Data Collection

The data used in the study was taken through a survey of shrimp farmer households in 2023. The sampling technique uses a multistage method to select the area first, then the village or kelurahan and households from each village/kelurahan. In the first phase, four areas (Tambakan, Kalianyar, Raci 1 and Raci 2) were deliberately selected to conduct surveys based on shrimp production intensity, accessibility, and safety. Furthermore, from 15 regions in Bangil sub-district, 4 regions (Tambakan,

Kalianyar, Raci 1 and Raci 2) were chosen as intervention locations.

The final stage of household selection is carried out randomly. Households were selected from 150 intervention villages and interviewed were conducted. The samples were evenly distributed throughout the intervention area, so that the number of samples per area for the intervention villages used as samples was 38 households each for Tambakan and Kalianyar villages, and 37 households for Raci 1 and Raci 2 villages.

Structured questionnaires are used as the main instrument of data collection. The questionnaires were crafted in Indonesian to ensure cultural relevance and validated by seasoned professionals with expertise in fishery farming. During the interview process, researchers used translators in the local language (Javanese). The translator method is used so that question information from the questionnaire can be conveyed to respondents and information from respondents can be understood.

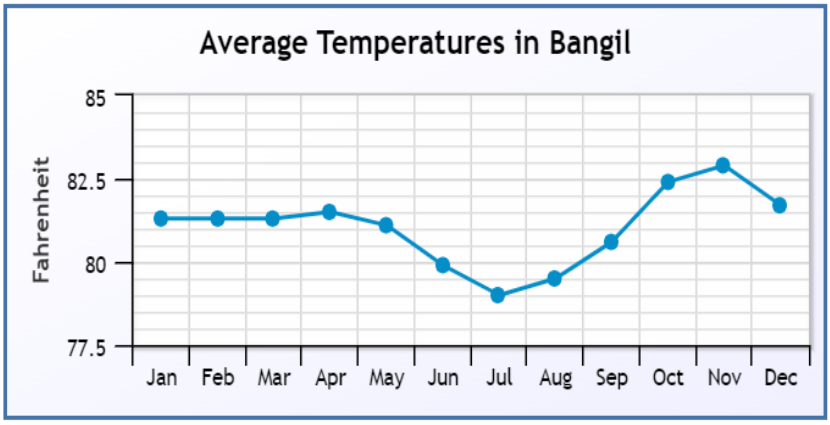


Figure 2. Average Temperature in Bangil District (2019-2023); (Source: Weatherbase**)**

Conceptual Framework

Factors Influencing Climate Change Adaptation Strategies

Rural households are facing the challenges of climate change and are actively engaged in adapting through adaptive strategies (Ramadhani & Hubeis, 2020; Maliga, et al., 2022). The strategy aims to minimize the negative impacts of climate variability and increase resilience. There are various approaches, including adjusting planting times and patterns, utilizing local wisdom (Hilman, Suciantini, and Rosliani 2019), and adoption of weather-resistant plant varieties (Aziz, S., et al., 2024). The choice of strategy can be influenced by the desire to obtain optimal benefits in addition to risk mitigation in the face of climate change (Funk et al. 2020). Researchers have categorized adaptation strategies into four distinct groups (Table 1) and used a binary logit model to identify key factors influencing the adoption of each category in specific contexts, such as shrimp farming (Tesfaye, 2016; Atube et al. 2021; Ahmed et al. 2021).

The logit function of the likelihood of farmers adopting climate adaptation strategies can be detailed as follows:

$$\text{Log } (P) = \log\left(\frac{p}{1-p}\right) \quad \text{.....(1)}$$

$$\text{Example } Pi = Pr\left(\frac{Y=1}{X=x\,i}\right) \text{.....(2)}$$

Then the model combines the formula above, it can be written as follows:

$$Pr\ (y = \tfrac{1}{x}) = \text{Logit}\left(\frac{e\ xp^{xb}}{1-e^{xb}}\right)\left(\frac{P}{1-P}\right)(P\ i) = \beta\ 0 + \text{.....} + \beta\ i\ x\ i \text{ .....(3)}$$

Wherein, *Pi* represents the probability of adopting an adaptation strategy (response variable), *xi*'s is the explanatory variable, *β 0* is the interseo and *β i the* regression coefficient of the socioeconomic variable.

Table 1.
Climate Change Adaptation Strategy Category by Shrimp Farmers

Categories Adaptation Strategy	Adapter (%)
Perform periodic water changes	31.57
Changing fry stocking and harvesting time	50.01
Replacing shrimp fry varieties	12.27
Creating additional embankments	6.15
Total	100

RESULTS AND DISCUSSION

Table 3 provides a summary of the variables employed in the analysis, encompassing characteristics of household demographics (e.g., age, educational attainment, family dependents, farmer experience, and asset ownership), factors related to institutional access (e.g., Access to ssociation borrowing, members in organizations, Coaching opportunities, weather information access, awareness of advanced fry varieties and seasonal shifts, and market proximity), and additional influencing factors such as droughts and floods.

Shrimp Farmer Climate Change Resources

Shrimp farmers' access to climate change information will offer enormous potential, allowing farmers to decide to adapt, manage risks well, turn the threat of changing climate conditions into potential that can be utilized, and innovate climate change adaptation to increase shrimp pond production yields. The study found that among shrimp farmers surveyed, 62% received information about temperature and rainfall via radio/TV (54%) and friends (16.7%). Governments and non-governmental organizations were underutilized resources, with only 7.3% and 8% of respondents, respectively.

This research report is in accordance with the results of research conducted by Popoola et al., (2020) which explains that Radio / TV is a potential source in transferring climate change information and is the most potential and easy to obtain information center. In addition, the implication is that television plays a more significant role in disseminating climate change information than extension services. The media is also a force to encourage and bring change to various societies and the world in general by creating awareness about certain things, thus shaping public interest, opinion, and ultimately government regulation (Zakari et al., 2022; Matere et al., 2023: Manteaw et al., 2022).

Through the report of the results of the research presented in table 4 also shows that Non-Governmental Organizations (NGOs) and the Government occupy the last cake as a climate change information center service. This is a valid and concrete source of scientific information in accordance with field conditions, where NGOs and farmer group services are not so massive in providing services, both as climate change information centers, integrated field schools (Coaching), and as other services as a function that should

be. Because with farmers obtaining information through the media and Radio / TV alone is not enough, there needs to be direction as a form of follow-up, as well as an effective communication process and coaching in understanding and using information is a strong and potential driver.

Table 2.
Definition of Variables and Descriptive Statistics

Variable	Information	Mean	Std. Dev.
Household characteristics			
Gender	Dummy = 1 if the head of the household is male	0,74	0,48
Age	Age of the head of household	49,19	13,83
Duration of education	Number of years of education	10,99	6,32
Family dependents	Number of dependents in one family	5,14	5,89
Farmer experience	Number of years of shrimp pond farming	27,00	14,63
Household assets	Total amount of household assets	0,49	1,66
Variable	**Information**	**Mean**	**Std. Dev.**
Institutional Factors			
Association Borrowing	Dummy = 1 if the household has access to Association Borrowing	0,41	0,56
Members	Dummy = 1 if the head of the household is a member of an organization or association	0,04	0,18
Coaching	Dummy = 1 if one (at least) household member attends Coaching	0,18	0,46
Weather information	Dummy = 1 if households obtain and collect weather and temperature information	0,74	0,56
Awareness of high-yielding varieties of fry	Dummy = 1 if the household is aware of the presence of high-yielding varieties of fry	0,30	0,45
Variable	**Information**	**Mean**	**Std. Dev.**
Institutional Factors			
Awareness of seasonal shifts	Dummy = 1 if the household is aware of the proper change in fry stocking season	0,22	0,41
Market access	Distance to nearest main road (in kiloometers)	21,42	18,46
Variable	**Information**	**Mean**	**Std. Dev.**
Other			
Swamped	Dummy = 1 if it has been flooded in the last five years	0,39	0,48

Table 3.
Shrimp Farmer Climate Information Source (N=150)

Receive temperature and precipitation information (N=150)	Frequency	Percentage (%)
Not	57	38
Yes	93	62
Climate resources (n=150)	**Frequency**	**Percentage (%)**
Government	11	7.3
Radio/TV	81	54
Fellow farmers	21	14
Friends/relatives/neighbors	25	16.7
Non-governmental organizations	12	8

Farmer Perceptions of Climate Change

Knowledge of shrimp farmers about climate change and its risks is very important and has the potential to be a factor in making decisions, as well as plans for agricultural and fisheries development (Mahmood et al., 2020; Mekonnen et al., 2021; Ogunpaimo et al., 2021; Atube et al., 2021; Zhu et al., 2021). Considering the perceptions of farmer households in designing adaptation policies, it will produce a useful adaptation response and potentially minimize the risk of climate change in a sustainable manner (Ali et al. 2021; Addis and Abirdew 2021; Nkuba et al., 2021)

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Table 4.
Farmer Perceptions of Climate Change (N=150)

Farmer perceptions of climate change	Response: Yes (%)
Increase rainfall	96.21
Lowering rainfall	59.71
Increase the temperature of the pond water	98.71
Declining production	95.41
Increase pests and diseases in ponds and shrimp	96.23
Long duration of hot and cold periods	57.21
Flood	73.77
Changes in the amount of rain	91.25
Increased intensity of heat and cold	66.8
High daytime temperatures	72.68
Changes in rainfall intensity	81.82
Changes in rainfall patterns	93.21
Drought frequency	57

This study has designed the questions presented in the questionnaire and asked during the interview process (See items in table 5), the results obtained from respondents' answers that they pay attention to rainfall variability by paying attention to increased rainfall (96.21%), decreased rainfall (59.71%), increased pond water temperature (98.71%), decreased production yield (95.41%), increased pests and diseases in ponds and shrimp (96.23%), Long duration of hot and cold periods (57.21%), Floods (73.77%). Changes in the amount of rain (91.25%), Increase in heat and cold intensity (66.8%), High daytime

temperature (72.68%), Change in rainfall intensity (81.82%), Changes in rainfall patterns (93.21%), Frequency of drought (57%).

Impact of Climate Change on Shrimp Farming Activities

The growing economic and social significance of shrimp farming in the region under investigation is increasingly faced with critical challenges due to the growing consequences of climate change. This growing threat has the potential to wreak havoc on local economies, as evidenced by a growing body of scientific literature (Jayasinghe, et al., 2019; Radhakrishnan et al., 2022; Yuniartik et al., 2022; Le & Armstrong, 2023).

The results of this study obtained several variations in the impact of climate change (See Table 6) on shrimp farmers, including increasing shrimp farming costs (93.52%), decreasing production yields (96.71%), decreasing profits (86.15%), increasing pest and disease attacks (94.36%), slowing shrimp growth process (85.09%), damaging pond infrastructure (64.67%), crop failure (97.56%). This research report was obtained based on answers to questionnaire questions given to respondents. The information indicates that the impact of climate change on shrimp farmers is very large. If the right adaptation strategy is planned as a measure to minimize the impact and risk of climate change, it is likely that in the next few years respondents will shift their profession to other fields outside the farm.

Table 5.
Impact of Climate Change on Shrimp Farming Activities

Impact of Climate Change on Shrimp Farming Activities	Agree (%)
Increase shrimp farming costs	93,52
Declining production	96,71
Declining profits	86,15
Increased pest and disease attacks	94,36
The process of shrimp growth slows down	85,09
Damaging Farm Infrastructure	64,67
Crop failure	97,56

Adaptive Strategies for Shrimp Farmer Households

Climate change necessitates adaptation by shrimp farmers for enhanced production and income. The efficacy of adaptation strategies varies under differing climatic conditions, farming practices, and regional contexts (Bernzen et al. 2023; Jamal et al. 2023; Pham & Saizen, 2023. As shown in Table 7, diverse adaptation strategies are employed by shrimp farmers. Notably, frequent pond water replacement (96.71%), adjustments in fry stocking timing (93.21%), co-culturing shrimp with other fish species (92.74%), and utilization of weather-resistant fry varieties (89.41%) emerge as predominant strategies at the research site. These findings align with existing research (Do & Ho, 2022; Nguyen et al., 2023) highlighting modifications in stocking periods, polyculture practices, and adoption of high-yielding climate-tolerant varieties as key adaptation tactics for fishponds.

Among a variety of adaptation strategies employed by shrimp farming households, the most frequent (67.97%) involve income diversification through sources unrelated to shrimp ponds. This often manifests as seeking off-farm employment (21.37%), suggesting reliance on alternative income streams for

financial stability rather than reinvestment in pond operations. Additionally, 55.24% of surveyed households reported utilizing alternative fry varieties for stocking, potentially reflecting an attempt to mitigate risks associated with specific species or market fluctuations. Furthermore, substantial emphasis is placed on enhancing pond infrastructure (31.01%) and water management (88.34%). This includes strengthening dams and barriers, improving water circulation, and investing in better filter systems at water inlets (24.31% each). Notably, practices like increasing waterwheel usage (4.31%) or incorporating concrete/plastic materials (24.31%) are less prevalent. As Kundu et al., (2024) explain, the limited timeframe for fry stocking in traditional "penan" systems often necessitates job diversification as a primary coping strategy for economic security, rather than an avenue for accumulating additional capital specifically for pond aquaculture.

Table 6.
Household Adaptation Strategies to Climate Change (150)

Household Adaptation Strategy	Adapter (%)
Mixing shrimp fry with other types of fish in one pond field	92.74
Diversification of fry	70.44
Income diversification (non-farm sources of income)	67.97
Using other varieties of fry	55,24
Change fry stocking time	93.21
Using weather-resistant varieties of fry	89.31
Plant trees for shade and protection	45.7
Replacing pond water with routine	96.71
Improves water circulation	88.34
Strengthening pond infrastructure (dams, barriers, etc.)	31.01
Finding work outside the fisheries sector	21.37
Changing types of fish	64.74
Conduct regular water quality checks	4.31
Increase the number of waterwheels	4.31
Using concrete/plastic in ponds	4.31
Improve filter quality at water inlets	4.31

Climate Change Adaptation Strategy Determinants of Shrimp Farmer Households

To determine the factors influencing the implementation of climate change adaptation strategies by shrimp farmers, researchers categorized various adaptation approaches into four key groups (Table 7). This includes utilizing high-yielding shrimp fry varieties, adjusting seed stocking periods, implementing regular water changes, maintaining and repairing pond embankments. This characteristic is recognized as a variable that is vulnerable to diverse impacts on decisions related to climate change adaptation (Islam et al. 2019; Karki et al., 2020; Poelma et al., 2021). This study used logit regression analysis to identify the influence of sociodemographic and economic features of households on climate change adaptation practices adopted by shrimp farmers. The results of the logit model were then applied to analyze the four categories of adaptations outlined in Table 7.

Table 7.
Factors for Farmers Decisions in Implementing Adaptation Strategies (logit analysis)

Climate Change Adaptation Strategy of Shirmp Farmer Households				
Explanatory Variables	**Vaietas Benur Superior**	**Stocking Time Changes**	**Regular water changes**	**Pond Embankment Repair**
Gender	-1.062***	0.810***	0.430**	-529***
Age	0.002	0.030***	-0.004	-0.020***
Education	-0.051***	-0.040***	-0.0011	-0.041***
Family dependents	0.033*	-0.033***	-0.0361***	0.015
Farmer experience	0.064	-0.009	-0.031	0.307***
Household assets	-0.056	-0.288***	0.060***	-0.112**
Association	0.894***	-0.625***	0.0004	0.836***
Borrowing				
Coaching	-0.459**	-0.131	-0.477***	-0.104
Weather information	0.547***	0.672***	0.160	-0.378***
High-yielding varieties of fry	0.052	0.117	-0.721***	-0.408***
Market access	0.020**	-0.067***	-0.032***	0.077***
Flood experience	-0.343**	-0.254*	0.423***	0.359**
constant	-1.511***	-1.128***	-1.396***	-1.463***
Numb. of observations	150	150	150	150
LR chi2(17)	108.14	207.56	160.66	232.99
Loglikelihood	-792.69298	-1093.2825	1242.6506	-851.81315
Prob>chi2	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.0639	0.0867	0.0607	0.1203

*Description: *p<0.1, **p<0.05, ***p<0.01 indicates the degree of significance.*The results of logit regression analysis presented in table 7 show that;

Vaietas Benur Superior

The main purpose of implementing weather-resistant superior seed varieties is to increase productivity amid the emergence of climate change and pest diseases in ponds. Adaptation to climate change requires farmers to adopt weather-resistant seed varieties to minimize climate risks. Farmers need to adopt varieties according to the water conditions in the pond and the weather around their environment. The results of logit regression show that access to association borrowing and markets, as well as obtaining climate information, are positively related to farmers' decisions to adopt weather-resistant seed varieties. This indicates that farmers who have access to ssociation borrowing are more likely to adopt high-yielding varieties compared to other farmers.

This is in line with research conducted by Ojo & Baiyegunhi, (2020); Ojo et al., (2021), explained that association aorrowing and market access are determining factors for farmers in implementing climate change adaptation, the indication is because access to association borrowing can increase capital costs to reach superior varieties, while close market access will be easy for farmers to get superior varieties. The fact that many poor farmers in the countryside cannot afford varieties buys high-endurance high-yielding varieties. Therefore access to association borrowing can be a factor adding to the cost of obtaining better varieties.

Stocking Time Changes

One of the impacts of climate change is the change in the time of the rainy season to the dry season. At the study site, the dry season usually occurs from February to April, but changes to August to November. Therefore, an alternative step for farmers to adjust to changes in masuim is to apply an adaptation strategy by changing the time of fry stocking and harvesting. The results of logit analysis showed that the acquisition of weather information, gender, age had a positive effect on farmers' decisions to change the stocking time of shrimp fry. Jamal et al., (2023) research highlights how information that changes in fry stocking time is influenced by the acquisition of weather information obtained by farmers, male gender (head of family) is a decision-making factor in a household, and maturity should be an indication of farmers to decide and be wise in taking steps to implement climate change adaptation strategies.

Regular Water Changes

Increasing water temperature in ponds can be a factor in the loss of shrimp farmers. This is because it triggers the growth of pathogenic bacteria and parasites in shrimp, and reduces the oxygen content in the water. Meanwhile, unexpected rainfall intensity is also a trigger for changes in pond water temperature (Atube et al. 2021). Following up on this, farmers at the research site continue to strive for climate change adaptation strategies. Based on the results of logit regression analysis (Table 7) shows that gender, farmer experience, household assets, flood experience are factors that positively influence farmers to make decisions to implement climate change adaptation strategies by replacing water in ponds regularly. This is in accordance with research conducted by Zakari et al., (2022); Matere et al., 2023 who explained that flooding is a factor in the presence of pests and diseases in ponds, causing a decrease in shrimp quality, reducing production yields and crop failure.

Pond Embankment Repair

The findings of the logit analysis presented in Table 7 indicate that several factors positively influence shrimp farmers' decision to adopt dike repair as a climate change adaptation strategy. These factors include having dependent children outside the household, access to association borrowing, access to markets, and prior experience with floods. Mai et al., (2023) explained that with the experience of flooding, farmers feel worried about damage to pond dikes due to frequent floods and cause damage to pond dikes. Access to association borrowing as a facilitator to increase repair costs, access to market reach makes it easier for farmers to buy equipment for pond embankment repair, and the number of family dependents to ease the work of repairing pond dikes.

CONCLUSION

This research shows that climate change has had a negative impact on the livelihoods of shrimp farmers in Bangil District. Increased rainfall, changes in rainfall patterns, and increases in pond water temperature were identified as major factors associated with decreased yields and increased shrimp disease pests. On the other hand, access to information on climate change still needs to be improved so that it does not become an obstacle in adaptation and mitigation efforts. Logit regression analysis reveals that climate change adaptation decisions require careful consideration of a wide array of spatially and temporally varying factors. This knowledge contributes to the development of targeted interventions aimed at mitigating the negative impacts of climate change on shrimp farmers in Bangil District. The study recommends

strengthening institutional support elements such as access to association loans, extension services, and pond group members as well as the utilization of climate-resilient shrimp fry to increase yields, household income, and overall well-being. Therefore, the implementation of appropriate adaptation strategies is important to maintain the quality, profitability, and sustainability of shrimp production in the face of climate vulnerability. In addition, shrimp farmers in Bangil District need to get education from various parties as an effort to raise awareness and provide the right information to farmers.

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