Indonesian Journal of Agricultural, Resource and Environmental Economics

Volume 4 Issue 1 Year 2025
Pages 27-39 EISSN 2962-2328

Impact of Weather Variability on the Income of Salt Farmers (Case Study: Rawa Urip Village, Pangenan District, Cirebon Regency)

Heni Wahyuni Ayuningsih[1], Nia Kurniawati Hidayat[2], Nuva[2]

[1]Corinthian Industries Indonesia
[2]Department of Resource and Environmental Economics, Faculty of Economics and Management, IPB University, Indonesia

***Correspondence to**: heniwahyuni2234@gmail.com

Abstrak: Variabilitas cuaca telah memberikan pengaruh negatif terhadap sektor pertanian dan kelautan. Kejadian cuaca ekstrim berupa curah hujan tinggi yang melanda Kabupaten Cirebon terutama di Desa Rawa Urip merupakan wujud dari adanya variabilitas cuaca. Variabilitas cuaca yang terjadi diduga berdampak pada proses produksi garam karena garam merupakan komoditas yang sangat tergantung terhadap kondisi cuaca. Produksi garam menurun karena variabilitas cuaca yang berimbas pada penurunan pendapatan usaha tambak garam. Variabilitas cuaca juga mendorong petani garam untuk mampu beradaptasi. Adaptasi yang dilakukan petani garam bervariasi dan kemampuan adaptasi tersebut berpengaruh terhadap keberlanjutan penghidupan petani garam. Metode yang digunakan dalam penelitian ini yaitu analisis pendapatan, uji t berpasangan, serta analisis deskriptif kuantitatif. Hasil penelitian menunjukkan bahwa terdapat perbedaan pendapatan petani garam saat kondisi normal dan saat kondisi variabilitas cuaca. Adaptasi yang banyak dilakukan petani garam dalam menghadapi variabilitas cuaca berupa adaptasi sosial dengan mengandalkan pinjaman kepada kerabat, mengandalkan kiriman keluarga, meminjam uang ke anggota kelompok tani, serta mengandalkan pinjaman ke tetangga.

Kata Kunci: penghidupan, strategi adaptasi, uji t berpasangan, usahatani garam

Abstract: *Weather variability has adversely impacted the agricultural and marine sectors. In Cirebon Regency, especially Rawa Urip Village, extreme rainfall illustrates this variability and is suspected to reduce salt production, which heavily depends on weather conditions. Consequently, salt production and business revenues have declined, prompting farmers to adapt. Data were collected through purposive interviews with 52 smallholder salt farmers meeting predefined criteria. The study applied income analysis, paired t-tests, and quantitative descriptive analysis. Results showed significant differences in farmers' income between normal and variable weather conditions. The most common adaptation strategies involved social coping mechanisms, including borrowing from relatives, receiving remittances, and taking loans from neighbours and farmer group members.*

Keywords: adaptation strategies, livelihoods, paired t-test, salt farming

Citation: Heni, W.A., Hidayat, N.K., Nuva (2025). Dampak Variabilitas Cuaca terhadap Pendapatan Petani Garam Rakyat di Desa Rawa Urip, Kabupaten Cirebon. *Indonesian Journal of Agricultural, Resource and Environmental Economics*, 4(1), 27-39.

DOI: https://doi.org/10.29244/ijaree.v4i1.58075

INTRODUCTION

Weather variability is a natural phenomenon that can occur on a short-term scale, with narrow area coverage and recurring events (Meteorology, Climatology, Geophysics Agency, 2022). Weather variability is also one of the indicators or symptoms that can be observed as a result of climate change (Purboningtyas et al., 2019). It can be characterized by changes in rainfall patterns, an increase in global air temperature, and erratic and unpredictable seasonal shifts (Sinurat, 2016). Several factors, including both natural and human factors, can contribute to weather variability. Natural factors occur due to natural processes felt in a climate and weather system. In contrast, human factors arise due to anthropogenic behaviors, which stem from the nature of human greed in utilizing and implementing development (Faqih and Listyarini 2021).

The salt commodity is one of the agricultural and marine sub-sectors whose Production depends on weather conditions. From an economic perspective, salt is a strategic commodity that can improve the national economy. Salt production in Indonesia is utilized in various sectors, including industry, consumption, pharmaceuticals, and other non-food fields, which require salt as a raw material for product manufacturing (Sinaga et al. 2020). Apart from being a strategic commodity, salt is also a political commodity because it is closely tied to a nation's interests. Apart from being a strategic commodity, salt is also a political commodity because it is associated with a nation's interests. It is also stated in Presidential Regulation 71 of 2015, concerning the determination and storage of necessities and essential goods, which stipulates that salt is a staple for daily needs, thereby regulating the storage of this commodity.

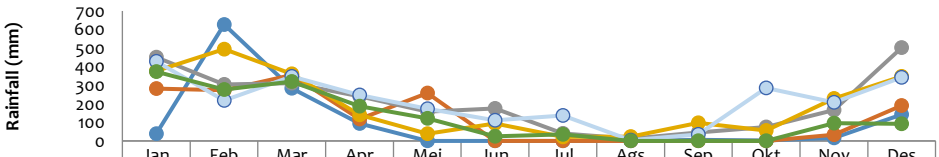
Cirebon Regency is one of the major salt production centers in West Java Province. This regency occupies the second most prominent position in West Java after the Indramayu Regency (West Java Marine and Fisheries Service 2020). The contribution of salt production to each district in West Java for Indramayu Regency is 80,391 million rupiahs, with an average salt production of 173,534 tons per year. Cirebon Regency's contribution is 49,186 million rupiahs, with an average annual salt production of 169,332 tons (Widjaja et al., 2021). Cirebon Regency is an area with potential for developing a salt production center. The Cirebon Regency Marine and Fisheries Service (2020) reported that they have spread alt production across several sub-districts, including the Pangean sub-district (800 ha), the Kapetakan sub-district (288 ha), the Gebang sub-district (136 ha), and the Suranenggala sub-district (120 ha). Then, the amount of salt production in each sub-district fluctuates and varies depending on the ponds available in the area. Table 3 shows the salt production data in each sub-district in Cirebon Regency.

Table 1. Salt production in each sub-district in Cirebon Regency in 2018-2022

No	Sub District	Salt Production (Ton/year)					
		2018	2019	2020	2021	2022	2023
1	Kapetakan	1.726	9.916	65	18	122	5.127
2	Suranenggala	626	1.664	206	113	10	4.116
3	Gunung Jati	128	207	104	26	4	465
4	Astanajapura	-	3.122	752	160	14	1.521
5	Mundu	4.819	2.298	166	80	64	2.653
6	Losari	30.523	11.021	313	57	95	7.619
7	**Pangenan**	**332.940**	**92.282**	**155**	**510**	**400**	**45.724**
8	Gebang	53.856	16.185	910	240	12	6.200

Source: Cirebon Regency Food Security and Fisheries Office (2024)

Pangenan District is a sub-district with the largest harvest area and the most significant salt producer in Cirebon Regency, compared to other sub-districts. The average salt production in the Pangenan District can reach 18 million tons per hectare per year (DKPP Cirebon Regency, 2023). According to data from the Cirebon Regency Food Security and Fisheries Office, salt production in Pangenan District has been decreasing. Salt production in this area experienced a drastic decline from 2020 to 2022. This decrease is suspected to have occurred because it is related to weather variability marked by extreme weather that hit the region.



	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Ags	Sep	Okt	Nov	Des
2018	39	627	283	94	0	0	0	0	5	2	16	142
2019	281	273	355	118	258	0	0	0	0	0	33	191
2020	451	305	311	241	158	174	40	12	45	74	167	502
2021	377	494,5	361	140,5	39	93	22	23	97	56	229	346,5
2022	428	218	348	247,5	173	111	137,5	4	35	285	207	342
2023	373	276	320	187,5	121	25	35	0	0	0	96	92

Figure 1. Rainfall statistics of Pangenan District, Cirebon Regency in 2018-2023 (Meteorology, Climatology and Geophysics Agency 2023)

The existence of weather variability with indications of changes in rainfall patterns disrupts salt production. Rainfall is a crucial factor that impacts people's salt production. The rainfall in Pangenan District in 2022 has increased compared to 2023. The increase in rainfall occurs during the salt harvest season, so the salt ready to be harvested fails due to extreme rainfall. This condition also results in approximately 45% of the salt pond land in this sub-district being unusable for salt production (DKPP Regency Cirebon, 2022). Rainfall fluctuations in the Pangenan District over the last five years are shown in Figure 1.

The optimal rainfall for salt commodities is 1000-1300 mm per year or less than 100 mm per month. The character of the salt commodity is that its Production can fluctuate because it depends on weather and climatic conditions, one of which is yearly rainfall—based on data from the Meteorology, Climatology, and Geophysics Agency (BMKG) (2023), rainfall in Pangenan District fluctuated every year from 2018 to 2023. The highest rainfall occurred in 2022, at 2,536 mm per year. In 2022, rainfall is expected to increase during the salt harvest period from July to November. This rainfall hampers the crystallization of salt and the aging of the water, leading to a decrease in salt production and resulting in crop failure in the Pangenan District, Cirebon Regency.

Rawa Urip Village, Pangenan District, Cirebon Regency, is one of the areas affected by weather variability, such as an increase in high rainfall. Extreme weather, in the form of increased rainfall in 2022, has harmed salt farmers in Rawa Urip Village due to a decrease in salt production, which has impacted their income. This impact is evident in the reduction of salt production in Rawa Urip Village. In general, salt production in Rawa Urip Village in one year if the regular season can reach 250,000 tons, but when there is an increase in rainfall intensity resulting in Robb floods in 2022 that hit the pond land of Rawa Urip salt farmers, the amount of salt production has dropped drastically (DKPP Cirebon Regency 2023).

Weather variability can trigger various disasters, including the flash flood disaster. This Robb flood disaster can result in a decrease in salt pond land in Urip Village, which previously had an area of 350 hectares, to only 50 hectares that can be used as a salt production site but cannot be used optimally due to climatic influences such as rain, so that this condition can increase the threats and pressures faced by the people of Urip Village, especially salt farmers (DKPP Cirebon Regency 2023).

Adaptation efforts undertaken by salt farmers serve as a form of defense against seasonal uncertainties. One of the adaptations that salt farmers in Rawa Urip Village have begun to make is optimizing salt production using geomembrane technology to minimize the negative impact of weather variability. The use of this technology certainly considers the aspect of capital owned by salt farmers. In general, salt farmers cultivate their salt using soil production media. However, those with sufficient capital can take advantage of geomembrane salt cultivation, which can double the potential harvest period and increase salt income.

Meanwhile, the use of geomembrane production media is a strategy for farmers to minimize losses experienced due to weather variability Because, based on the results of survey interviews with key persons, the use of geomembrane production media during weather variability conditions in the form of robb floods and high rainfall shows that farmers who use geomembrane do not need re-slender so that the preparation process and damage costs experienced by geomembrane farmers can be minimal compared to traditional farmers. The adaptation actions chosen by salt farmers will affect the sustainability of their lives. Each farmer's adaptation will also be related to their capital assets. According to Hidayat (2017), the livelihood of pencil farmers generally refers to the capabilities, assets, and activities needed to maintain their standard of living. Therefore, the study aims to compare the income of traditional salt farmers and those using geomembranes during regular seasons and weather variations, and to identify the adaptation mechanisms of salt farmers in Rawa Urip Village, Cirebon Regency.

RESEARCH METHODS

Location and Time of Research

Research was conducted in Rawa Urip Village, Pangenan District, Cirebon Regency, West Java Province. The research began in October 2023 through a literature review of books and scientific journals, followed by a review of related news, discussions with key persons, and an examination of the methods used in this research. The location was deliberately chosen, considering the area's potential as the center

of national salt production and its expected ability to represent smallholder salt farmers in Indonesia regarding the impact of weather variability currently being experienced.

Types and Data Sources

The data used in this study include primary and secondary data. Researchers obtain secondary data from various sources such as literature studies, scientific journals, previous research, the Internet, and data from related agencies such as (the Ministry of Marine Affairs and Fisheries, BMKG, and the Cirebon Regency Marine and Fisheries Service).

Sampling Method

Sampling in this study uses the non-probability sampling method. The sampling technique in this study was conducted deliberately (purposive sampling) by considering the respondents' criteria. The study included 52 respondents, all of whom were salt farmers. The number of respondents was divided into two types of cultivation: 38 traditional salt farmers and 14 geomembrane salt farmers.

Data Analysis

This analysis is based on the primary data from the salt farmer interviews. Statistical analysis is used to explore the income difference, while qualitative analysis is employed to answer the farmer's strategy. The following table shows the data processing and analysis methods used in the research.

Table 2. Data analysis methods

Research objectives	Analysis Tools	Analysis methods
Analyzing the comparison of traditional salt farmers and geomembrane due to weather variability in Rawa Urip Village, Pangenan District	*STATA and* Microsoft Excel *software*	Revenue Analysis and Paired Test
Identifying the form of salt farmers' adaptation mechanisms in the face of weather variability	*Microsoft Excel*	Quantitative Descriptive Analysis

1. Comparative Analysis of Traditional and Geomembrane Farmers' Income

The impact of weather variability on salt farming income, both with and without extreme weather events, can be observed using the farming income analysis approach. Income is an indicator that measures the welfare of a community through its production. Income can be calculated by comparing the revenue obtained and the costs incurred during the production period (Soekartawi 2002). Some variables considered in the income analysis are revenue, costs, and farming income.

The income of traditional and geomembrane salt farmers in this study was calculated based on the harvest season, specifically the extreme weather and regular harvest seasons. The income is then differentiated into income on cash costs and total cost income. The costs incurred in salt farming are divided into cash and non-cash costs. Cash costs are the expenses that producers incur when purchasing goods and services during Production. Cash costs include land taxes, buying machinery or equipment, and wages for workers outside the family (TKLK). Non-cash costs refer to expenses incurred by producers that do not have a direct monetary value (Soekartawawi, 2002).

Salt farmer income changes due to weather variability can be calculated using salt farming income analysis. The calculation of farmers' income in this study is analyzed based on the income generated in 2022, a year characterized by weather variability with increased rainfall intensity, and the income in 2023, a year with near-normal climate conditions. The results of the revenue calculation will be compared between the two years. The change in income was calculated by subtracting farmers' expenditures from their receipts during the harvest season. The general formula can be expressed in the following equation:

$$TR_1 = Y_1.PY_1 \quad (1)$$

Information:
TR1 = Total salt revenue during the 2023 regular harvest season (Rp/year)
Y1 = Salt Production during the 2023 regular Harvest Season (kg/year)
PY1 = Salt prices during the 2023 regular harvest season (Rp/kg)

$$TR2 = Y2.\ PY2 \quad (2)$$

Information:
TR2 = Total salt receipts during the 2022 crop failure season (Rp/year)
Y2 = Salt production during the 2022 crop failure season (kg/year)
PY2 = Salt prices during the 2022 crop failure season (Rp/kg)

Salt pond business expenses or costs are investments made by salt farmers, the main actors in salt production, to achieve maximum Production. Expenses or costs incurred in the salt pond business can be calculated based on the following formula:

$$TC_1 = FC_1 + VC_1 \quad (3)$$

Information:
TC_1 = Total cost of salt pond business under normal conditions in 2023 (Rp/year)
FC_1 = Fixed cost of salt pond business during normal conditions in 2023 (Rp/year)
VC_1 = Variable costs of salt pond business under normal conditions in 2023 (Rp/year)

$$TC_2 = FC_2 + VC_2 \quad (4)$$

Information:
TC_2 = Total salt pond business costs during the 2022 crop failure season (Rp/year)
FC_2 = Fixed cost of salt pond business during the 2022 crop failure season (Rp/year)
VC_2 = Variable costs of salt pond business during the 2022 crop failure season (Rp/year)

The analysis of salt pond business income can be calculated through the difference between total *revenue* and total *cost* and can be formulated as follows,

$$\Pi_1 = TR_1 - TC_1 \quad (5)$$

Information:
Π_1 = net revenue under normal conditions in 2023 (Rp/year)
TR_1 = Total receipts during normal conditions in 2023 (Rp/year)
TC_1 = Total cost during normal conditions 2023 (Rp/year)

$$\Pi_2 = TR_2 - TC_2 \quad (6)$$

Information:
Π_2 = net revenue during the 2022 crop failure season (Rp/year)
TR_2 = Total Revenue during the 2022 crop failure season (Rp/year)
TC_2 = Total costs during the 2022 crop failure season (Rp/year).

The income change method is used to estimate the difference in income of salt farmers during the regular season and the extreme season. According to Garrod and Willis in Lia (2018), environmental changes will affect the income level of business actors resulting from their production process, either due to an increase or decrease in Production, or even a reduction or loss of sales revenue. The impact of this change in environmental quality can be calculated by assessing the change in income that results (Lia,

2018). This method estimates the changes in salt farmers' income during the ordinary dry season of 2023, which was preceded by extreme weather seasons, including high rainfall in 2022. The equation can be written as follows:

$$\Delta\Pi = \Pi_1 - \Pi_2 \quad \text{...(7)}$$

Information:

Π_1 = Salt farming net revenue (income) for the 2023 regular season (Rp/ha/year)

Π_2 = Salt farming net revenue (income) for the 2022 crop failure season (Rp/ha/year)

2. Paired sample *t-test*

The data analysis method used to answer the first research question is a paired sample t-test. The basic assumption for conducting a test of two paired samples is that the data are usually distributed and the variables are parametric (Nazir, 2014). The test of two paired samples in this study was carried out twice to compare the income of geomembrane salt farmers during the regular season with the income during the crop failure season, as well as comparing the income of traditional salt farmers during the regular season with the income during the crop failure season or weather variability. The hypothesis in this study is in line with the research of Montalalu et al. (2018) in the decision-making of the test of two paired samples, which are as follows:

H_0: There is no difference in the income of salt farmers during the regular season and the crop failure season (weather variability)

H_1: There is a difference in the income of salt farmers during the regular season and the crop failure season (weather variability)

3. Descriptive Analysis of Salt Farmers' Adaptation Strategies in Facing Weather Variability

Descriptive analysis accurately describes and explains phenomena at the research site (Naura *et al*., 2018). This analysis was used to identify the adaptation strategies employed by salt farmers in response to weather variability, as assessed through a semi-structured questionnaire. The type of questions asked by the researcher to respondents was in the form of a choice of questions about the adaptation strategies that respondents commonly carry out in dealing with weather variability. The results of the interviews were grouped by the selection of the same adaptation strategy and presented according to the number of respondents.

RESULTS AND DISCUSSION

The Impact of Weather Variability on Salt Production and Productivity

Weather variability, in the form of high rainfall and unseasonal conditions, has a detrimental impact on salt commodities. This is because salt is a commodity that is highly sensitive to weather conditions. Rainfall throughout the year disrupts salt production, resulting in crop failure. In general, salt production carried out by the community is still traditional, utilizing sunlight for assistance. Salt commodities require a long dry season without being interspersed with at least 140 rainy days (Kurniawan et al. 2012). The weather variability experienced by salt farmers in this condition is characterized by high-intensity rainfall and increased sea tides, which impact the submersion of salt pond land by coastal tidal water. The high rainfall at the research site occurred from April to July. This event necessitates improvements to the salt production process, which will take a considerable amount of time to yield salt crystals. In addition, the event was also exacerbated by the occurrence of sea tides three times a year, namely in May, July, and the end of September, resulting in obstacles for salt farmers in producing salt and causing farmers to experience losses. Based on the results of an interview with the Village Head, it is evident that the phenomenon that occurred in 2022 resulted in the salt pond land in Rawa Urip Village becoming submerged. The maximum salt that can be harvested only reaches 10 percent of the usual

Production. Still, many salt farmers have just harvested but have been hit by tidal floods again and need to repeat the initial stage.

Table 3. Average salt productivity in Rawa Urip Village in 2022 and 2023

Year	Area (ha)	Average Production (tons)	Productivity (tons/ha)
2022**	0,6	2,43	4,06
2023*	0,6	57,95	96,5

Description: *) Normal; **) Crop failure

Table 3 shows that salt production and productivity in 2023 are higher than in 2022 in the same area. This is because, in 2022, a crop failure occurred due to excessive rainfall, which also led to increased flooding. The average salt production reached 57.95 tons, or 57,952 kg, with an average productivity of 96.5 tons per hectare. Meanwhile, in 2022, only 2.43 tons, or 2,435 kilograms, of salt were produced in the same area, with an average productivity of 4.06 tons per hectare. Based on this, there has been an average decrease in productivity in 2022, with a difference of 94.07 tons/ha/year or 97.5% of the usual total Production.

Salt Farming Revenue

Salt farmers in Rawa Urip Village carry out salt production activities to meet their daily needs. Weather variability, of course, has decreased the income salt farmers receive compared to during the regular season without obstacles in the form of weather disturbances. In this study, the income of salt farmers is calculated based on the income from salt farming in 2022, the year of occurrence of weather variability indications in the form of high rainfall intensity and an increase in market water intensity, such as flash floods, and 2023, under normal conditions. Under normal conditions, salt farmers in Rawa Urip Village carry out salt production activities only once a year, with the harvest season lasting four to six months. However, in 2022, salt farmers only get one to two months of harvest at most, but even then, not all farmers can save their salt from weather instability. The income from salt farming is calculated based on the technology used. The average revenue from salt farming is seen in Table 4.

Table 4. Average salt farmer revenue in 2022 and 2023 based on technology use status

Type of Technology	Revenue 2022 (Rp/ha/year)	Revenue 2023 (Rp/ha/year)
Traditional	6.176.596	55.596.728
Geomembrane	21.024.206	108.685.000

Table 4 shows that the average income of salt farmers in Rawa Urip Village in 2023 is dominated by those using geomembrane salt farming methods. The lowest income is found among farmers who use traditional technology. Meanwhile, in 2022, the year of unpredictable weather, it is evident that the acceptance of both technology use is low, and everyone suffers losses. The losses experienced by traditional farmers are more significant than those experienced by farmers who use geomembranes. This is because geomembrane technology is considered to accelerate the salt crystallization process. Geomembrane is a salt production medium made of High-Density Polyethylene (HDPE) plastic, which is black, allowing the material to catch sunlight when exposed to sunlight easily. In addition, with the variability of weather, geomembrane technology also plays a role in minimizing the losses caused; namely, it can accelerate the salt production process because, through the use of this geomembrane technology, salt farmers do not need to re-slender the soil but only clean the plastic mat and wash it by draining water into the pond land and then disposing of it through the breach of channels between the plots.

The revenue of salt farmers who use traditional technology in 2022 is IDR 6,176,596 with an average production of 2.69 tons per ha and a price of IDR 2,300 per kg, while in 2023, the revenue obtained by traditional farmers is IDR 55,596,728 with an average production of 81.04 tons per hectare for IDR 600-700 per kg. The income received by farmers using geomembrane in 2022 is IDR 21,024,206, with an average

production of 8.4 tons per ha and a price of IDR 2,500 per kg, while in 2023, under normal conditions, farmers using geomembrane technology can get revenue from salt farming of IDR 108,685,000 with an average production of 129.39 tons per ha and a price of IDR 800-900 per kg.

Salt Farming Costs

Cash costs in salt farming in 2023 in Rawa Urip Village include sack costs, fuel, transportation, mattress ropes, labor outside the family, equipment rental, warehouse rent, insecticides, cash land rent, and taxes. The cost component incurred by salt farmers in 2022 is also the same as in 2023. However, in 2022, there will be additional costs, including repair costs for production facilities such as windmills, embankment, and waterways, as well as extra labor costs for repairing the equipment. Non-cash costs that salt farmers incur in their farming activities include depreciation costs for tools, labor costs for family members, and cash land rental costs. Non-cash costs incurred by salt farmers in 2022 are more significant because, when weather variability conditions occur, salt farmers tend to rely on family labor and are considered to incur lower farming costs, apart from the cost of repairs made. The cash and non-cash cost components between traditional and geomembrane farmers are almost the same; however, geomembrane farmers incur additional costs, specifically for isolator plastic, which has a price range of Rp 2,300,000 to Rp 3,500,000 per roll. The plastic has a technical life of 1-2 years and is included in the depreciation cost, so the non-cash cost of geomembrane salt farmers is greater than that of traditional farmers.

Salt Farming Income

Salt farming income is divided into income from cash costs and income from total costs. Income from cash costs is obtained from the difference between the revenue of salt farmers minus the total cash costs incurred by salt farmers during the production period to harvest, while the income on total costs is obtained from the difference between the revenue received by farmers minus the total expenses incurred by farmers during the production period until harvest. Based on the analysis results, it was demonstrated that there was a difference in income between the regular season and the season with unstable weather conditions. The average change in income experienced by salt farmers is presented in Table 5.

Table 5. The average income of salt farmers in Rawa Urip Village in 2022 and 2023

Type of Technology	Income on cash costs		Income on total costs	
	2022 (Rp)	2023 (Rp)	2022 (Rp)	2023 (Rp)
Traditional	1.293.785	39.667.396	-11.426.446	28.741.241
Geomembrane	15.177.996	75.940.868	173.610	61.849.247

Table 5 shows that salt farmers experienced a loss of income. The loss of income to farmers was due to decreased Production during the 2022 harvest season, resulting in a decrease in farmers' income that year. The loss of income due to cash and total costs is most pronounced among farmers using traditional technology. This is because the use of conventional technology is considered to take longer in the production process and requires higher costs, such as labor costs that are quite adequate in terms of preparation and management to produce better salt. However, during weather variability conditions, traditional farmers have more significant repair costs than geomembrane farmers. The income on cash costs for traditional farmers increased by Rp38,373,611, and the income on total costs increased by Rp40,167,688. The income on cash costs for geomembrane farmers increased by Rp60,762,872, and the income on total costs increased by Rp62,555,413. The percentage change in total income for traditional farmers was -139.75 percent, while geomembrane farmers experienced a change in the percentage of total income by -101.15 percent.

Paired t- test

In this study, the income calculated above will be continued by conducting a paired t-test. The test aims to see if there is a significant difference in the average income of salt farmers during the regular season in 2023 and the season of weather variability in 2022. Before conducting the paired t-test, a

normality test is performed as a prerequisite for using the paired sample t-test. The results of the paired sample t-test show a significant difference in the income of geomembrane farmers and traditional farmers in 2023, which is the regular season, and in 2022, the season of weather variability. The decision is seen based on the results of the test (2-tailed) in both tests with values of 0.0008 and 0.0006, respectively, which means that the significance value < 0.05 (5%), so it rejects H0. The average income of geomembrane salt farmers during the regular season is Rp 61,695,438 per production season, ranging from Rp 41,767,941 to Rp 83,974,133.

Meanwhile, the average income of traditional salt farmers during the regular season is Rp 28,594,319 per production season, with an income range of Rp 15,821,752 to Rp 45,113,111. The average income of geomembrane and traditional salt farmers during the consecutive crop failure season was Rp 10,277 and Rp -10,652,857. The income of conventional salt range farmers during the crop failure season is IDR -27,464,286 to IDR 4,215,320, while the income range of geomembrane salt farmers during the 2022 crop failure season is IDR -18,462,119 to IDR 20,758,800. This condition indicates that the income of geomembrane farmers is higher than that of traditional farmers. This finding is also consistent with the study by Agustya et al. (2024), which reported that geomembrane farmers have higher incomes.

Adaptation mechanism of salt farmers

Weather variability encourages salt farmers to implement various adaptation measures according to their abilities and resources. Uncertain income is the result of weather variability, as well as farmers' daily needs, which must be met. Salt farmers are required to take various actions, such as exploring alternative livelihoods to survive. The actions taken by farmers cover multiple aspects, including economic, ecological, and social factors. This action is designed to mitigate the adverse effects of weather variability. It can increase the resilience capacity of salt farmers in the event of a shock or disruption to their salt farming operations (Purboningtyas, 2018). The adaptation actions undertaken by salt farmers in Rawa Urip Village are illustrated in Figure 2.

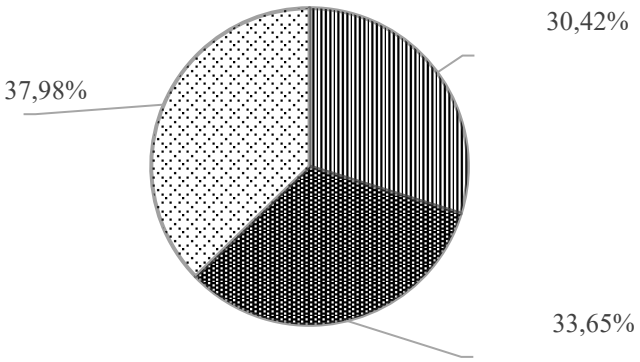


Figure 2. Salt Farmer Adaptation Strategy

Figure 2 illustrates that the adaptation carried out by salt farmers in Rawa Urip Village can be categorized into three types: adaptation in terms of financial capital, adaptation in terms of natural or ecological capital, and adaptation in terms of social capital. Referring to the picture, the most adapted adaptation is social adaptation. Details of each adaptation can be seen in the following explanation:

1. Social Adaptation

Social adaptation is an adaptation carried out by farmers who utilize social networks to help them meet their living needs during crises. This adaptation is one of the most adapted adaptations carried out by salt farmers in Rawa Urip Village in response to weather uncertainties. In this study, the adaptations employed by salt farmers in Rawa Urip Village include borrowing money from relatives, relying on remittances from family, borrowing from neighbors, and borrowing from farmer group members. The adaptation of salt farmers in terms of social capital is illustrated in Figure 3.

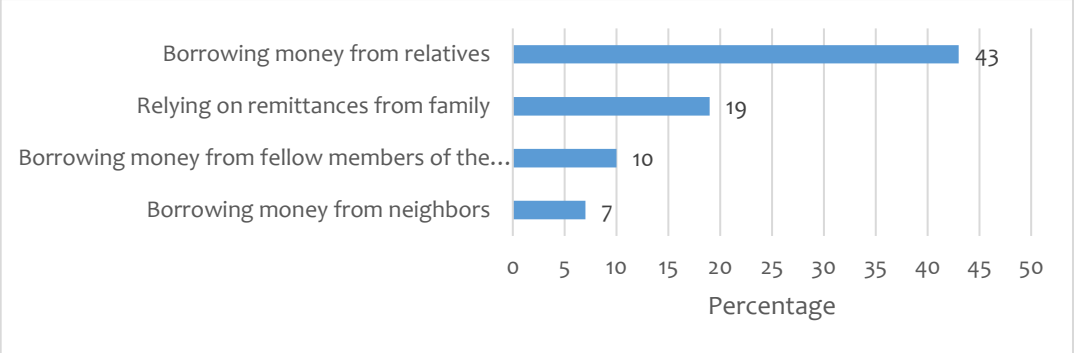


Figure 3. Adaptation of salt farmers based on social capital

Figure 3 illustrates that the efforts of salt farmers, facilitated by their social capital, are primarily focused on lending money to relatives. Based on the statements from the respondents, when there is an urgent need and they do not have savings, salt farmers often rely on loans from relatives, such as brothers or sisters, who are more economically able than the respondents. Respondents considered borrowing money from relatives to be easier than borrowing from a bank. The loan repayment can also be returned when the salt farmer has the money to return it..

> *"…Well, if I need to borrow money, it's usually from family. I don't dare to go to the banks, miss, because I'm afraid I won't be able to pay it back. Also, sometimes the banks ask for all those guarantees, and then there are so many forms and signatures to complete—it's complicated"* -Tosin

In addition to making loans to relatives, salt farmers also often rely on deliveries from their families who are migrating, especially for their children who work as migrant workers abroad. Salt farmers send their children away once a month, at a cost of around IDR 1,500,000 to IDR 4,000,000 per month. The shipment from his son will be used for daily needs and sometimes even for capital for salt farmin

> *" …. Well, fortunately, thank God, I have a child working in Poland. If I didn't, it would be really difficult…"*- Sadli

Social adaptation, such as lending to neighbors and farmers, is not limited to salt farmers. This adaptation is carried out for some farmers whose KUGAR group actively contributes between members and management. Farmers who adopt loans from the KUGAR group are those whose KUGAR group provides cash or credit. In the loan, farmers are usually required to repay the loan on time. If a farmer fails to return the loan by the deadline, the chairman of the farmer group will reprimand the member who borrowed it, encouraging them to return it immediately according to the agreement. Adaptation through lending to neighbors is a strategy employed by farmers when the situation is urgent, and the repayment process also adjusts to the farmer's ability to replace it.

2. Ecological Adaptation

Ecological adaptation refers to the adaptation carried out by salt farmers based on demographic in the surrounding area. Ecological adaptation encompasses various alternative livelihoods that serve as an alternative source of income for salt farmers, utilizing the availability of surrounding natural resources. Ecological adaptations that salt farmers widely carry out in Rawa Urip Village include activities such as palawija farmers, goat breeders, poultry farmers, and fish farmers. This applies to salt farmers who have land and capital. Salt farmers, in general, typically start cultivating land in May and October. This condition will be disturbed if there is rain every month accompanied by a large robb. Salt farmers will begin cultivating in the same year by waiting for the water to recede in these conditions. Suppose salt farmers need land and natural capital to adapt. In that case, they choose to work as cultivators on land owned by others, earning a wage of Rp60,000 to Rp80,000 per day, as well as salt transport workers around warehouses and salt ponds, with wages of around Rp15,000 to Rp20,000 per day per transportation group. The ecological adaptation carried out by salt farmers is illustrated in Figure 4.

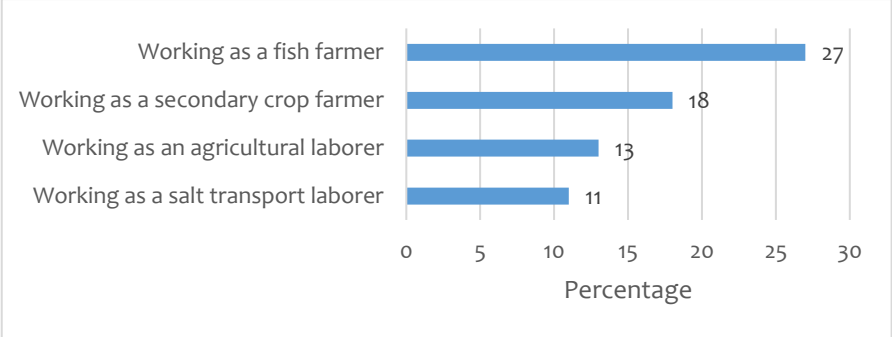


Figure 4. Farmer adaptation based on the characteristics of natural conditions

Figure 4 shows that the most ecological adaptation carried out by salt farmers in Rawa Urip Village is as a fish farmer, followed by adaptation as a secondary crop farmer. Salt farmers usually carry out this activity when salt is not in Production. Salt farmers convert their pond land into milkfish ponds. The cultivation of salt ponds is generally carried out for three to four months, and the harvest is usually sufficient only for daily needs. However, for farmers with extensive land holdings who choose to rent additional land for milkfish cultivation, the harvest can be more substantial. The salt farmer can sell milkfish harvested at a price range of Rp15,000 to Rp20,000 per kg, depending on the quantity of milkfish sold. Then, salt farmers conduct rainfed rice farming for three to four months with an income ranging from IDR 5,000,000 to IDR 20,000,000 per planting season.

3. Economic Adaptation

Salt farmers carry out economic adaptation by utilizing the ownership of assets that can be monetized. The financial adaptations carried out by salt farmers in Rawa Urip Village include having a job in the city, having a non-farm job in the village, borrowing money from a Batak bank, utilizing savings, selling previous crops, indebtedness to intermediaries, selling jewelry, renting land, selling assets, and selling livestock. Details of the proportion of respondents who made financial adjustments are shown in Figure 5.

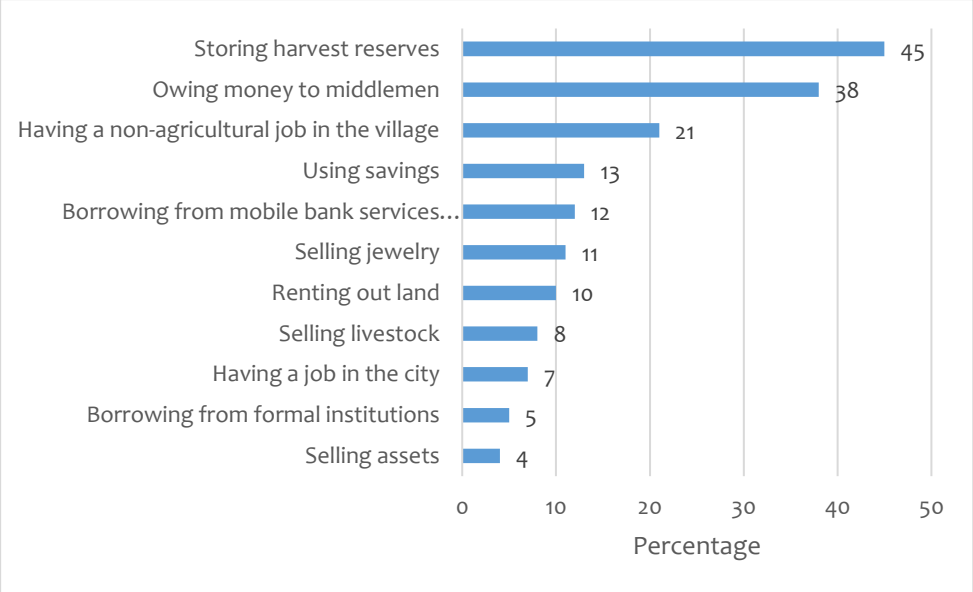


Figure 5. Adaptation based on the financial capital of Salt Farmers

Figure 5 shows that the economic adaptation carried out by salt farmers in Rawa Urip Village is primarily based on selling previous crops from the remaining crop reserves stored. Farmers do this because they are waiting for the price of salt to stabilize. After all, in the long dry season, the price of salt usually falls, and during the rainy season, the price of salt will increase dramatically. This finding aligns with Haryanto's (2013) research, which indicates that salt farmers employ a cultural adaptation strategy to address environmental problems by storing salt in warehouses. In addition, salt farmers make this adaptation because they consider that salt does not have an expiration date, making it suitable for

stockpiling in warehouses. In addition to selling the previous crop, the adaptation, dominated by salt farmers in terms of financial utilization, is successively in debt to intermediaries, with a loan range for initial cultivation of Rp 500,000 to Rp 2,000,000, which is paid when harvesting salt. Another adaptation made by salt farmers in Rawa Urip Village is to take on non-farm jobs, including those of village employees, traders, motorcycle taxi drivers, construction workers, mechanics, and individuals with various other occupations. In addition to relying on employment in the town, some salt farmers also adapt by looking for jobs in Cirebon City, such as working at Radar Cirebon; there are also salt farmers who migrate outside Java, such as Palembang and Riau, to find jobs as workers installing gas pipelines and installing PDAM with wholesale wages, taking advantage of savings for farmers who have savings in the form of money, borrowing money from Batak banks, renting land to those who own land because it is considered more profitable to lease than cultivating it themselves, selling assets in the form of land, warehouses, and jewelry that are considered as valuable investments, borrowing money from formal institutions such as BRI banks involving the KUR program, and selling livestock for farmers who do business in the field of animals such as goats and poultry. Weather variability affects the income of salt farmers, prompting them to make various adaptations. Salt farmers can still meet the daily needs of farmers. Adaptations carried out by farmers' ownership of capital in their livelihood assets include natural, financial, physical, social, and human capital. The five capitals have a relationship with each other and complement each other.

CONCLUSION

The results show that weather variability negatively impacts salt production and the income of salt farmers, both traditional and those using geomembranes, in Rawa Urip Village. These can be observed from the 95% decrease in production and the difference in income generated between the regular season and during weather variability conditions. The value of the loss is seen from the difference in average income during the regular season and the season of crop failure. The difference in average income between different seasons and years reveals a significant disparity in income that salt farmers experience between geomembrane and traditional technology users. The most considerable loss in value occurred among traditional farmers, with a percentage change in income to total costs of -139.75%. Adaptations made by salt farmers in the face of weather variability mostly adapt through the use of social capital by carrying out various activities to borrow funds or capital through the social networks they have, especially borrowing money from relatives be one of the mainstays of adaptation carried out by salt farmers, Another adaptation carried out by salt farmers is by utilizing natural resources to meet their living needs. Salt farmers make financial adjustments by taking various actions, including the most dominant, namely storing crops or selling previously stored crops from warehouses, making them a source of income to meet daily needs during economic crisis conditions.

REFERENCES

Agustya, N., & Sapanli, K. (2024). Kerentanan Usahatani Garam Rakyat di Desa Bungko Lor Kabupaten Cirebon. *Indonesian Journal of Agricultural Resource and Environmental Economics*, *3*(2), 116-127.

[BMKG] Meteorology, Climatology, and Geophysics Agency. 2023. Rainfall Data for Pangenan 2018–2023. Bogor: BMKG.

[Diskanlut] Department of Marine and Fisheries, West Java Province. (2023). Salt Production Based on Production Periods in West Java.

[DKPP] Department of Food Security, Marine and Fisheries, Cirebon Regency. (2022). Statistical Data on Salt Production by Subdistrict in Cirebon Regency. DKPP Cirebon Regency, Cirebon.

[DKPP] Department of Food Security, Marine and Fisheries, Cirebon Regency. (2023). Statistical Data on Salt Production by Subdistrict in Cirebon Regency. DKPP Cirebon Regency, Cirebon.

Faqih A, Listyarini J. (2021). Climate Projection Using GCM CMIP5 Outputs: Statistical Bias Correction for Climate Scenarios (SiBias) version 1.2. Department of Geophysics and Meteorology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University.

Haryatno, D. P. (2012). Kajian strategi adaptasi budaya petani garam. *Komunitas*, *4*(2).

Hasanah U. 2019. Economic Analysis in Developing Community-Based Salt Industry in Indramayu Regency [thesis]. Bogor: Bogor Agricultural University.

Hidayat, N. K. (2017). At the bottom of the value chain: Sustainability certification and the livelihoods of palm oil smallholders in Indonesia.

Kurniawan, T., & Azizi, A. (2012). Dampak perubahan iklim terhadap petani tambak garam di Kabupaten Sampang dan Sumenep. *Jurnal Masyarakat Dan Budaya*, *14*(3), 499-518.

Lia. (2018). Vulnerability of Arabica Coffee Farmer Households to Rainfall Variability: Case Study in Suntenjaya Village, Lembang Subdistrict, West Bandung Regency [thesis]. Bogor: Bogor Agricultural University.

Megarani Amandra. (2022) May 10. Bandung. ForestDigest.com.

Montolalu C, Langi Y. 2018. The Effect of Basic Computer and Information Technology Training for Teachers Using Paired Sample t-test. d'CARTESIAN: Journal of Mathematics and Its Applications. 7(1):44–46. doi:10.35799/dc.7.1.2018.20113.

Naura A, Riana FD. (2018). Impacts of Climate Change on Production and Income of Red Chili Farming (Case in Sumberbendo Hamlet, Kucur Village, Malang Regency). Journal of Agricultural Economics and Agribusiness. 2(2):147–158.

Nazir M. (2014). Research Methods. Bogor: Ghalia Indonesia Publishing.

Purboningtyas PT, Dharmawan AH, Putri Eka Intan K. (2018). Impacts of Climate Variability on Farm Household Livelihood Structures and Adaptation Patterns. Jurnal Sosiologi Pedesaan. 6(3):189–197.

Sinaga O, Antara M, Dewi RK. (2020). Development Strategies for Community-Based Salt Enterprises in Kusamba Village, Dawan Subdistrict, Klungkung Regency. Journal of Agricultural Socioeconomics and Policy. 4(1):96–110.

Sinurat RY. (2016). Adaptation and Mitigation of Rice Farmers to Drought Due to Weather Variability. Bogor: Bogor Agricultural University.

Soekartawi. (2002). Farm Business Analysis. Jakarta: UI Press.

Sugiyono. (2017). Statistics for Research. Bandung: Alfabeta.

Widjaja S, Radiarta N, Suhelmi IR, Bramawanto R, Akhwady R, Widodo AW, Triwibowo H, Prabawa FY, Mahabror D, Sagala SL, et al. (2021). Academic Review: A Portrait of National Salt. Jakarta: Amafrad Press.