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ARTICLE

Analysis of Climate-Smart Agriculture (CSA) Adoption Level on Tidal Land and Its Effect on Household Food Security

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ABSTRACT

Climate change is a universal challenge for all those natural resource-based sectors, including agriculture. The farming community should adapt to climate change effects through Climate Smart Agriculture (CSA) approaches to resolve the same. The objectives of the study are to analyze the level of technology adoption of CSA practices that have been implemented by rice farmers on tidal land, to analyze the level of household food security of rice farmers on tidal land, and to analyze the effect of the level of technology adoption of CSA practices towards household food security in Telang Jaya Village, Muara Telang District, Banyuasin Regency. Sixty farmers are used for the respondents number. A study method with a survey approach of visiting the research site directly is employed here. The outcomes of this study indicate an increased awareness of climate change among farmers; one way is by adopting CSA, which can optimize farm productivity and increase farmer income, thus positively impacting food security. The adoption rate of CSA technology, i.e., tractors, water pumps, drainage, direct seeding planting, and combined harvesters, positively influences food security.

Keywords: Climate Smart Agriculture; Tidal Land; Food Security; Technology Adoption

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1. Introduction

The agricultural sector plays an important role in maintaining the Availability and stability of food in the market. It allows people to obtain the food they need, both economically and physically. As the human population continues to increase every year, this will certainly drive demand for agricultural products that are much greater than food ingredients. Food security is highly dependent on agricultural productivity, so ensuring food security and supporting sustainable development can help prevent food insecurity in the community [1].

The global challenge affecting all aspects of human life today is climate change, including the agricultural sector, which is directly dependent on natural resources. Acceleration of the evapotranspiration process and increased thermal stress in plants are caused by rising temperatures so that crop yields decrease. Changes in rainfall patterns also cause uncertainty in water management. This causes the risk of flooding and drought that can damage crops. In addition, climate change also affects soil fertility levels, and the spread of pests and plant diseases will further worsen the productivity of food crops [2]. The risks farmers face from climate change include floods, droughts, and pest attacks, which impact farmers' production and income [3]. Globally, climate change is happening, including in Indonesia. As the fifth-largest greenhouse gas emitter, Indonesia contributes 35% of total emissions related to land-use change and forestry and 2.6% related to agriculture [4]. The Food and Agriculture Organization (FAO) states that climate change is one of the most important challenges to food security. With no efforts to reduce exposure and improve coping ability, the rapid rates of change related to climate change will make many areas more vulnerable. Adaptive capacity is the capacity to adapt to minimize negative impacts and maximize any benefits from climate change [5].

Farmers' ability to adapt and mitigate climate change can be done through CSA practices. Farmers in Indonesia must carry out efforts to adopt and use CSA practices because CSA practices have used various technologies, such as technology in soil processing, water processing, and increasing nutrients for plants that can increase agricultural productivity, improve adaptability, and reduce greenhouse gas emissions. Increased agrarian productivity will maintain the long-term stability of the Availability of the entire food system that is threatened by climate change. Likewise, maintaining stability prevents food prices from soaring so that the community can access and use food ingredients. CSA is currently being promoted as an approach farmers can adopt to increase food security by adjusting agricultural systems to deal with climate change. In several countries, CSA practices are implemented through integrated soil fertility management, watershed management, composting, conservation agriculture, and using seeds resistant to climate change [6]. The CSA concept was first launched in 2009 and received Input from various stakeholders until the CSA concept was established. All practices are implemented starting with the use of technology and methods with a focus on 3 CSA objectives; farmers are said to have begun to adopt CSA practices. Through the Ministry of Agriculture, the Indonesian government has already started to supervise and assist CSA in various SIMURP program areas through local governments [7].

The Indonesian people's main source of carbohydrates is rice. According to BPS (2023), per capita rice consumption on Papua Island is 93,791 kg [8]. Thus, as a food crop commodity, rice is still a strategic commodity in meeting the needs and maintaining the food security of the Indonesian people. In 2023, Java Island will still dominate Indonesia's largest rice-producing region, especially in the rice production center provinces, namely East Java, West Java, and Central Java. Among others, South Sulawesi, South Sumatra, and Lampung are provinces that serve as rice production centers outside Java Island. According to the Central Statistics Agency (BPS), Indonesia's total rice harvest area in 2023 was 10.20 million hectares. This figure fell by 10.45 million hectares or 2.45 percent compared to last year. Rainfall indicator is an important factor that affects rice production. Climate change in Indonesia strongly influences food agriculture, so it impacts national food institutions because Indonesia is an archipelago country around the equator. Research by Malau et al. [9] shows that almost all regions of Indonesia are affected by climate change. This situation challenges farmers to improve their production and income and achieve food security at the household level. It is very important to use future climate predictions to formulate adaptation policies and strategies to reduce the impacts of climate change on rice production [10]. These steps are essential to ensure the sustainability and resilience of the rice farming sector in Indonesia [11].

In response to these problems, farmers should adapt and adopt CSA practices as a solution to the impact of climate change on agriculture. Farmers' adoption decisions are the result of multifaceted ideas. Important factors that can help predict adoption decisions can be classified into five groups: socioeconomic factors, agricultural-physical factors, technical factors, institutional factors, and psychological and behavioral factors [12].

According to the National Land Agency (BPN), in 2019, the largest land typology in South Sumatra was tidal land of 214,454 Ha. Rice commodities can be planted in various types, including tidal land. Tidal land is very vulnerable to climate change. Global warming can raise the water level so that soil salinity increases due to salt accumulation, affecting soil fertility. The risk of flooding, drought, and the spread of pests and plant diseases are also impacts of climate change that affect rice productivity. Variations in rainfall that occur each month can affect changes in the planting season.

When facing climate change, land and commodity management practices are needed in tidal areas, and these practices are expected to increase agricultural productivity. One of these practices is implementing integrated technology in accordance with the nature and conditions of tidal areas. There are still problems with technological innovation, where research institutions consider that many research technologies are ready to be applied. However, according to some farmers, research technology is still very limited to be utilized by farmers [13]. In tidal areas, farmers still have limitations in obtaining information and accessing and using appropriate and appropriate technological innovations to deal with the impacts of climate change. Superior technologies in tidal swamps include water management, using superior varieties, land amelioration and fertilization, pest and disease control, and harvesting. However, farmers in Telang Jaya Village have not fully implemented this technology or are still partial, so rice production is still relatively low. This is because farmers' level of knowledge and understanding regarding new technologies to deal with climate change is still lacking. Technological innovation and information development are expected to encourage food independence, added value, and farmer welfare [14].

The practice of CSA and its adoption level are used by farmers to make rice plants resilient to climate change. However, the problem is the limited ability of tidal farmers in Telang Jaya Village to adopt technology and CSA, especially in dealing with climate change, which will later impact land productivity, farmer income, and food security of farmer households. Therefore, the specific objectives of the study were to analyze the adoption level of technology applied in CSA practices by rice farmers on tidal land, to analyze the condition of household food security of rice farmers on tidal land, and to analyze the impact of the adoption level of technology in the implementation of CSA on household food security in Telang Jaya Village.

2. Materials and Methods

2.1. Description of the Study Area

Telang Jaya Village is one of the villages in Muara Telang District, Banyuasin Regency, South Sumatra Province. Telang Jaya Village is located 0.25 km from the sub-district capital, 120 km from the district capital, and 60 km from the provincial capital. Even though Telang Jaya Village is far from the district and province capital, the farmer can access agricultural information from the CSA technologies. Telang Jaya Village has administrative boundaries with the surrounding villages. The administrative boundaries of Telang Jaya Village are as follows: The north side borders Pancamukti Village; the South side borders Mukti Jaya Village; the West side borders Telang Makmur Village; the East side borders Mekar Mukti Village and Upang Ceria Village.

Telang Jaya Village generally has a tropical and wet climate with an average rainfall of 20 millimeters per year and an average humidity of 70%. A tropical and wet climate with an average rainfall of 20 millimeters per year and an average humidity of 70% per year. With a tropical and damp environment, Telang Jaya Village has a temperature range between 27°C and 37°C. The area of Telang Jaya Village is 1,348.00 Ha, and some of the lowlands are suitable for rice fields. Telang Jaya Village is crossed by many rivers, namely the SPD, SDU, and Alam. The existence of this river is a source of water for domestic and agricultural activities.

The location was selected intentionally, considering that in Telang Jaya Village, there are farmers who grow rice using tidal land and that most farmers use CSA practice technology (**Figure 1**).

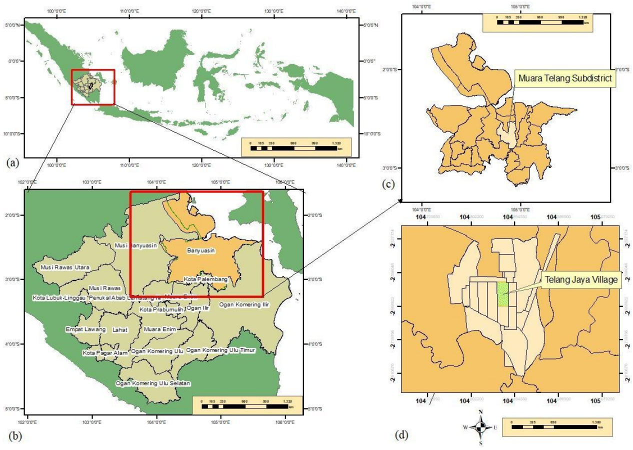

Figure 1. Map of Telang Jaya Village, Banyuasin District. (**a**) South Sumatra Province, Indonesia; (**b**) Banyuasin Regency; (**c**) Muara Telan District; (**d**) Telang Jaya Village.

2.2. Research Method

The method used in this study was a survey carried out directly by visiting the research location. Furthermore, the researcher interviewed farmers with rice farming businesses in tidal land using several questions called questionnaires. This method is carried out to obtain primary data at the research location, namely in Telang Jaya Village, Muara Telang District, Banyuasin Regency. This study took data for one year, 2024.

2.3. Sampling method

The sampling method used in this study was a simple random sampling method. There are 614 rice farmers of 18 farmer groups with homogeneous characteristics at that location. The rice farming land in Telang Jaya Village is close to the river, which is always affected by climate change. The size of the sample obtained using the Slovin formula was 60 rice farmers. The data collection carried out in this study is primary data and secondary data. Primary data was collected through questionnaires, focus group discussions, observations, interviews, and case studies [15]. Meanwhile, secondary data was obtained through references from previous research and literature that can support the research to be carried out [16].

2.4. Data analysis methods

To answer the first problem regarding the level of adoption, the data was analyzed using a Likert scale by calculating the overall score obtained from the results of the questionnaire interview. Each answer has a different score weight. Each statement will be given a score of 5 for the strongly agree criteria, a score of 4 for the agree criteria, a score of 3 for the undecided criteria, a score of 2 for the disagree criteria and a score of 1 for the strongly disagree criteria. Respondents' answers are categorized into intervals; for class intervals, the formula used is as follows:

$$NR = NST - NSR \quad (1)$$

$$PI = NR : JIK \quad (2)$$

where NR, Range Value; PI, Interval Length; NST, Highest Score Value; NSR, Lowest Score Value; JIK, Number of Class Intervals.

Furthermore, to answer the second objective, the data is measured with four indicators: Availability, accessibility, utilization, and stability. Each indicator has four questions. Each question is given a score of 5 for the strongly agreed criteria, a score of 4 for the agreed criteria, a score of 3 for the doubtful criteria, a score of 2 for the disagree criteria, and a score of 1 for the strongly disagree criteria (**Table 1**). The questions for each indicator are arranged in **Table 2**.

The availability indicator in the first question is calculated using the formula:

$$S = Input - Output \quad (3)$$

where S = Availability of staple food (rice) for farmer households (kg/cap/year); Input = Source of staple food from rice production (kg/cap/year); Output = Output of rice food sold or given to other parties (kg/cap/year).

To categorize the existing data into five categories, you can use the interval width formula, namely (max-

Table 1. Class interval values for the level of adoption of CSA technology by rice farmers on tidal land in Banyuasin Regency.

No.	Class Interval Value (Statement)	Class Interval Value (Indicator)	Class Interval Value (Overall)	Criteria
1.	$1.00 \le x \le 2.33$	$5.00 < x \le 11.67$	$40.0 < x \le 93.333$	Low
2.	$2.33 < x \le 3.66$	$11.67 < x \le 18.34$	$93.333 < x \le 146.67$	Medium
3.	$3.66 < x \le 5.00$	$18.34 < x \le 25.0$	$146.667 < x \le 200$	High

Table 2. Description of Accessibility, Utilization, and Stability Indicators.

Indicators	Description
Availability	Availability based on the calculation of Input minus Output; Availability of diversified daily food choices (rice, sweet potatoes, tofu, tempeh, fish, meat, fruit, vegetables, etc.); Availability of external food assistance (government, Jimbaran, etc.); Availability of sufficient and nutritious food throughout the year.
Accessibility	Access to production inputs (land, mulch, seeds, fertilizers, pesticides, tractors); Access to market distance as a source of food and a place of marketing; Access to agricultural extension workers as a medium for information and development; Access to food purchase prices.
Utilization of rice	into ready-to-eat food (porridge, fried rice, cakes) Utilization of rice; waste into body scrubs and other skincare ingredients Utilization of rice; washing water into LOF (Liquid Organic Fertilizer); Utilization of household yards for cultivating food crops (chili, eggplant, onion, cassava, etc.).
Stability	Maintaining rice supply throughout the year; Getting enough income to meet food needs for one year; Maintaining planting stability by producing rice every year; Able to face economic shocks (e.g., job loss, inflation).

imum value-minimum value)/number of categories, namely five so that the following categories of household food availability are obtained [17]:

a. Very Low: $62.5 \le x \le 116.67$
b. Low: $116.67 < x \le 170.83$
c. Medium: $170.83 < x \le 224.99$
d. High: $224.99 < x \le 279.16$
e. Very High: $279.16 < x \le 333.33$

Furthermore, the third objective is to answer the third objective, namely analyzing the influence of the adoption level of CSA practices on tidal land rice farming on household food security using multiple linear regression analysis.

The accuracy of the sample regression function in estimating the actual value can be measured from the goodness of fit. Statistically, it can be calculated from the coefficient of determination, the F statistic, and the t statistic value. The coefficient of determination essentially measures how far the model can explain the dependent variable's variation. The F statistic test shows whether all independent variables included in the model have an overall influence on the dependent variable. The t-statistic test basically shows how far the impact of one independent variable on the dependent variable is by assuming the other independent variables are constant.

The type of data in this study uses ordinal data that has been transformed using the successive interval method (MSI) into intervals because linear regression must use interval/ratio data. The mathematical equation model of this method is as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + e \quad (4)$$

where Y = Household Food Security; X_1 = Tractor; X_2 = Organic Fertilization; X_3 = Pump and Biopore System; X_4 = Drainage Irrigation; X_5 = Superior Variety Seeds; X_6 = Direct Seed Planting; X_7 = Combine Harvester; X_8 = Planting Calendar; a = Constant; b = Regression Coefficient; e = Standard Error.

3. Results

3.1. Socioeconomic Characteristics of Farmer Households

In this study, the socioeconomic characteristics of farmers in Telang Jaya Village can be identified based on their age, level of education, family size, length of farming experience, cultivation area, and other income outside of agriculture. There were 60 farmers in total (**Table 3**). The indication is that farmers use several technologies in CSA practices to improve their ability to reduce and adapt to the impacts of climate change.

Table 3. Socioeconomic characteristics of farmer households in Telang Jaya Village.

No.	Socio–Economy Factors		Household (Person)	Percentage (%)	Note
1	Age (years)	23–33 34–44 45–55 56–66 67–77	7 15 24 7 7	12 25 40 12 12	*Mean*: 49 *Max*: 77 *Min*: 23 *Srd*: 12
2	Education Level (years)	0 3 6 9 12	0 0 17 22 21	0 0 28 37 35	*Mean*: 19 *Max*: 12 *Min*: 6 *Srd*: 2
3	Family size (kapita)	1 2 3 4 5	11 18 24 4 3	18 30 40 7 5	*Mean*: 3 *Max*: 5 *Min*: 1 *Srd*: 1
4	Experience (years)	0 3 6 9 12	0 0 17 22 21	0 0 28 37 35	*Mean*: 9 *Max*: 12 *Min*: 6 *Srd*: 2
5	Cultivation Area (Ha)	1–2 3–4 5–6 7–8 9–10	45 11 2 1 1	75 18 3 2 2	*Mean*: 2 *Max*: 8 *Min*: 1 *Srd*: 1
6	Other Income (IDR/mth)	500,000–1,300,000 1,300,001–2,100,0001 2,100,002–2,900,0001 2,900,002–3,700,0001 3,700,002–4,500,0003	3 2 1 1 1	17 11 6 6 6	*Mean*: 2.037.500 *Max*: 4.500.000 *Min*: 500.000 *Srd*: 1.241.911

Source: Primary Data Analysis, 2025.

The average age of the respondents, as presented in **Table 3**, shows that farmers in the productive category still dominate in agricultural activities, with an average age of 49 years. The education level of farmers indicates that their average education is at the secondary school level. Up to 28% finished elementary school, 37% finished junior high school, and 35% completed high school. The number of dependents is the total number of individuals living in one house and is the responsibility of the head of the family. The average number of family members per farmer's household is three people.

The respondents' farming experience varies, with an average farming experience of 9 years (**Table 3**). Farmers utilize land as a site to cultivate crops of a diverse range of types. The majority of farmers (75%) possess agricultural land measuring 1–2 hectares; 18% of the survey participants own land that spans 3–4 hectares; 3% have a land area of 5–6 hectares; 2% cultivate land covering 7–8 hectares; and another 2% possess land between 9–10 hectares. Respondents' general status of land ownership is that they are privately owned for their farming activities. The typical respondent possesses a land area of two hectares. In addition to their main job as farmers, farmers in Telang Jaya Village also have a side. The average side income or other income respondent farmers 2obtain is Rp 2,037,500 per month.

Based on **Table 3**, the average age of respondents is 49 years, ranging from 23 to 77 years old, with a standard deviation of 12 years, indicating a broad distribution across age groups. In terms of education, respondents have an average of 9 years of schooling, with a minimum of 6 years and a maximum of 12 years, and a standard deviation of 2 years, suggesting relatively consistent educational backgrounds, primarily at the basic to secondary levels. The average household size is 3 members, varying between 1 and 5 members, with a standard deviation of 1, indicating minimal variation in family size across respondents. Regarding farming experience, respondents have an average of 9 years, with a range between 6 and 12 years, and a standard deviation of 2 years, reflecting a stable and relatively uniform level of experience. The average cultivation area managed is 2 hectares, with the smallest being 1 hectare and the largest 8 hectares, and a standard deviation of 1 hectare, which shows that most respondents operate on small to medium-scale farms. Meanwhile, the average additional monthly income is IDR 2,037,500, with figures ranging from IDR 500,000 to IDR 4,500,000, and a relatively high standard deviation of IDR 1,241,911, highlighting significant disparities in supplementary income among the respondents.

3.2. Level of Adoption of CSA Practices in Telang Jaya Village

There are several levels of technology adoption in CSA practices. In this study, the areas studied include land processing using tractors, organic fertilization, use of water pump systems, drainage irrigation, use of superior variety seeds, using direct seed planting methods, harvesting using combine harvesters, and using planting calendars.

Based on **Table 4**, the overall score of farmer adoption of CSA technologies shows that the level of farmer adoption of CSA technologies in Telang Jaya Village is in the high category, with a total score of 170.3.

Table 4. CSA Adoption Level Recapitulation.

No.	Type of CSA Adoption	Score	Category
1.	Tractor	21.9	High
2.	Organic Fertilization	17.9	Medium
3.	Water Pump	21.3	High
4.	Drainage	20.8	High
5.	Superior Variety Seeds	21.7	High
6.	Direct Seed Planting	22.3	High
7.	Combine Harvester	22.8	High
8.	Planting Calendar	21.6	High
Total		170.3	High

Source: Primary Data Analysis, 2025.

3.3. Level of Food Security of Rice Farming Households on Tidal Land in Telang Jaya Village

The results of calculating the total food security score are used to determine the level of food security of respondent farmers in Telang Jaya Village. The results of the calculation or recapitulation of the total household food security score can be seen in **Table 5**.

Table 5. Level of Food Security of Farmer Households.

No.	Variable	Score	Criteria
1.	Availability	13.98	Medium
2.	Utilization	14.42	Medium
3.	Accessibility	15.22	High
4.	Stability	17.33	High
Total		60.96	High

Source: Primary Data Analysis, 2025.

Based on **Table 5**, the overall score of the four indicators of household food security of Telang Jaya Village farmers, including Availability, utilization, accessibility, and stability, is 60.96. The total score is included in the high category.

3.4. Impact of Adoption Level of CSA on Farmer Household Food Security

In this study, a hypothesis test will be conducted to determine whether the level of CSA adoption (X) influences the food security of farmer households (Y). The analysis was carried out using multiple linear regression with IBM SPSS.

The F test determines the collective influence of all independent variables (X) in the model and the dependent variable (Y). If the sig. Value < 0.05, it is concluded that the independent variables significantly affect the dependent variable. To see the results of the f-test in this study, see **Table 6** below.

Table 6. F Test Result.

Model	F	Sig.	Description
Regression Residual	57.454	0.000b	Significant

Source: Primary Data Analysis, 2025.

Based on the results of **Table 6**. which shows that the Sig F level is 0.000 < 0.05 with the variables tractor $_{(X1)}$, organic fertilizer $_{(X2)}$, water pump $_{(X3)}$, drainage $_{(X4)}$, superior variety seeds $_{(X5)}$, direct seed planting $_{(X6)}$, combine harvester $_{(X7)}$, and planting calendar $_{(X8)}$ have a significant effect simultaneously (together) on the food security variable (Y).

T-test to test whether or not the influence of independent variables individually on the dependent variable is real. If the sig value is 0.000b less than 0.05, then H_0 is rejected, and H_1 is accepted, which means that the independent variable affects the dependent variable. To see the results of the T-test analysis, see **Table 7** below.

Table 7. T-test Result.

Model	b	Std. Error	T.	Sig.	Description
Constant	7.539	2.277	3.311	0.002	
Tractor (X_1)	3.388	0.531	6.381	0.000	Significant
Organic fertilizer (X_2)	−0.521	0.346	−1.506	0.141	Not Significant
Water pump (X_3)	1.694	0.640	2.645	0.012	Significant
Drainage (X_4)	3.358	0.699	4.806	0.000	Significant
Superior variety seeds (X_5)	−0.447	0.623	−0.717	0.478	Not Significant
Direct seed planting (X_6)	2.319	0.610	3.800	0.001	Significant
Combine harvester (X_7)	2.094	0.517	4.047	0.000	Significant
Planting calendar (X_8)	0.389	0.603	0.644	0.523	Not Significant

Source: Primary Data Analysis, 2025.

Based on the results of **Table 7**, when tested partially, it is known that tractors $_{(X1)}$, water pumps $_{(X3)}$, drainage $_{(X4)}$, direct seed planting $_{(X6)}$, and the use of combined harvesters $_{(X7)}$ have a significant effect on food security because the significance value is less than 0.05. Meanwhile, the other three variables do not have a significant effect on food security, namely the variables of organic fertilization $_{(X2)}$, the use of superior seeds $_{(X5)}$, and planting calendars $_{(X8)}$.

4. Discussion

4.1. Discussion Socioeconomic Characteristics of Farmer Households

The average age of farmers as respondents is still classified as the productive age. This shows that farmers in Telang Jaya Village have good and strong physical conditions, thus providing opportunities for farmers to innovate and adopt technology, especially CSA, to optimize the increase in rice farming productivity due to climate change. Older smallholder farmers are likelier to access climate information and adopt climate-smart adaptation strategies than younger farmers [18]. On the other side, CSA adoption was influenced by the age factor of farmers [19]. Other research revealed that a farmer's age is one of the significant factors that has a positive relationship with the adoption of CSA practices [20].

The education level of farmers from **Table 3** indicates that the various stages of education are relatively similar, yet those who pursue education to the highest degree remain a small fraction. This is because of restricted costs and time, leading farmers to prioritize their work as farmers. According to research conducted by Pandeya et al. [21], the higher the level of farmer education, the greater the possibility of farmers adopting CSA technology. Hassan et al. [22] argued that the level of farmer education was a significant factor driving adoption and innovation in CSA.

A family size is determined based on the number of people living in a house and enjoying food daily. The larger the family, the greater the requirements it has to satisfy. Still, if there are fewer family members, the total number of relatives it has to fulfill will also be lower. The family's size dictates the labor available for conducting rice farming operations. The more family members, the more workers are available. The family size can act as an inducement and stimulus that prompts them to pursue farming seriously and meet their own needs, particularly if the farmers have no other source of occupation and depend on their rice fields alone. Thus, the greater the number of family members, the greater their dedication to carrying on their farm enterprise. Individuals or family members living in farming households can be used as labor in agriculture, assuming that agricultural production will increase if they are involved in farming [23]. Research conducted by Hoque et al. [24] shows that the size of the farming family significantly positively affects the adoption of CSA practices. The number of members in a farming household can influence its ability to embrace new methods. Bigger households might possess more labor resources, which can be crucial for implementing labor-intensive climate-smart technologies. Moreover, family members can offer assistance and exchange information on new practices in the home, facilitating their adoption. According to a systematic review by Tariku & Kebede [25], the quantity of family members positively influences CSA adoption.

The time farmers have been farming can affect their ability to decide about their rice farming. Farmers with experience in rice farming will naturally have extensive knowledge and strategic skills to increase rice production. According to Rukundo et al. [26], the longer a farmer's experience in farming, the more likely the farmer will continue to use or adopt certain technologies. Another study conducted by Machete et al. [27] revealed that farmers with longer farming experience are more aware of the risks posed by climate change. Still, some farmers are reluctant to adopt technology because they prefer local knowledge. Factors of farming experience, family size, and education significantly influence the adoption and intensity of CSA in rainfed farming systems across the states of southeast Nigeria [28].

The wider the land, the more rice farmers will produce. The area of land owned by farmers in this study varies. Research by Yamin & Putri [29] revealed that climate change significantly correlates with the carrying capacity of agricultural resources. Aisyah et al. [30] said in their research that the area of agricultural land has a significant relationship with the success of the farming technology program. The wider the land cultivated by farmers, the better the level of success of the farming technology program. Mkansi, Ledwaba, and Mokhaukhau's [31] research reveals the contrary: farming experience, household size, education level, and farm size in hectares do not significantly influence climate change adaptation strategies. This does not imply that these variables are insignificant but offers minimal evidence to back their influence on farmers' views regarding the adoption of climate change adaptation strategies in Greater Giyani Local Municipality.

Earnings play a crucial role in sustaining the family's financial well-being. Side jobs are jobs that are done in between main jobs. Income from side jobs is used to increase the income from the main job to increase the total revenue of the farmer's family. Based on research conducted by Rahmawati et al. [32], farmers in Setia Mulya Village can raise capital in farming with side jobs. Other studies also reveal that having another income outside of agriculture can increase the overall revenue of farming households [33].

4.2. Discussion Level of Adoption of CSA Practices in Telang Jaya Village

The high category for farmers' adoption of CSA technologies in tidal land. This shows that the farmer's adoption of CSA technologies on tidal land is very good and has been implemented in tidal rice farming practices so that farmers can reduce losses due to climate change. Thus, by adopting CSA, farmers in Telang Jaya Village can still optimize their farming productivity despite climate change so that farmers' income remains stable or even increases. Seeing these results, it is hoped that in the future, all farmers, not only farmers on tidal land, will adopt CSA to deal with climate change.

This is in line with the opinion of Weerasooriya & Karthigayini [34], who stated that CSA practices can increase the adaptation of farmers in Sri Lanka to environmental changes and can reduce agricultural losses. Farm households in the Central Rift Valley of Ethiopia have also adopted different CSA practices, such as crop diversification, soil fertility management, conservation agriculture, and small-scale irrigation, which can mitigate the adverse impacts of climate change so that the risk of crop failure can be minimized [35]. Nong et al. [36] also revealed that the adaptation methods used by farmers in Northeast Vietnam to climate change were using seeds that were resistant to climate change, adjusting planting times, and investing in irrigation.

4.3. Discussion Level of Food Security of Rice Farming Households on Tidal Land in Telang Jaya Village

The high category of the four indicators of farmers' household food security shows that tidal land farmers are already food secure. This means farming households have sufficient food supplies to meet their daily needs. On the other hand, the availability and utilization indicators require more attention so that the household food security of farmers in Telang Jaya Village is more evenly distributed.

This is in line with research conducted by Muhammad et al. [37], the Availability and access to food have a significant effect on the food security of tidal swamp rice farmer's households in Banjar Regency. However, overall, the level of food security of farmer households is included in the category of food insecurity because it has a value of 38.41 from the national IKP. Research by Mekonnen et al. [38] also revealed that all aspects of the food system are influenced by climate change, including food production and Availability, quality, access, utilization, and stability. Hartoni & Shafriani [39] also argue that food availability for rice farmer households in tidal lands in Barito Kuala Regency affects food security.

According to research conducted by Khalifa [40], there needs to be an adaptive strategy to overcome the negative impacts of climate change. Strategies that can be carried out include the implementation of CSA and the improvement of sustainable agricultural systems to encourage increased agricultural production so that the food security and economic stability of the community can improve. In line with the study, Gold [41] also revealed that climate change positively correlates with food insecurity. This is because climate change causes vulnerabilities in the agricultural sector that can exacerbate food insecurity. The implementation of CSA practices is one of Gold's recommendations for addressing climate change.

4.4. Discussion Impact of Adoption Level of CSA on Farmer Household Food Security

Climate change affects agricultural production; this can affect food availability and ultimately threaten the food security of farming households and even the nation. The adoption of CSA may have implications for food security at the household level. Justifying this fact, a study by Tilahun et al. [6] postulates that farmers who adopt more than one type of CSA practice enjoy better food security and livelihood than non-adopters. The study of Masha et al. [42] also stated that the implementation of CSA affects food security significantly because there will be a stable and diversified supply of fresh produce. Additionally, the CSA practices of water management and soil management techniques will help farmers to adapt to changing weather patterns and extreme weather events. This could help make food supplies more assured, even with the onset of climate-related stresses. Through his research, Ali et al.[35] revealed that the CSA practices adopted by farming households in the Central Rift Valley of Ethiopia could increase crop productivity by reducing the adverse impacts of climate change so food security can increase. Kamau, Kiprop, and Kipruto[43] also mentioned in their study that the rising risks and uncertainties in the agricultural economy caused by global warming make climate-smart agriculture essential.

In **Table 7**, it is partially known that there are three independent variables, namely organic fertilizer, superior variety seeds, and planting calendar, which do not significantly affect food security. Fertilization plays an important role in the Input of rice farming production. Good fertilization must be based on the needs of the soil and the type of plant. While partially, variables of organic fertilizer have no significant influence on food security. Based on interviews with rice farmers on tidal land, organic fertilizers are used only in addition to chemical fertilizers. Farmers believe that chemical fertilizers provide quicker results for plants than organic fertilizers. Farmers take advantage of this and use even more chemical fertilizers to ensure the best harvest outcome. The two organic fertilizers farmers usually use on tidal land are liquid organic fertilizers and manure. Organic farming practices are CSA practices that can reduce dependence on chemicals, thereby helping to reduce greenhouse gas emissions[44].

Using a superior variety of seeds is an important factor in rice farming because it can positively impact harvest yields and production efficiency. Superior varieties are produced through plant breeding to obtain superior traits such as disease resistance, high productivity, and the ability to adapt to certain environments. In rice farming, a superior variety of seeds significantly increases production yields and farmers' competitiveness. Farmers in tidal land tend to buy new seeds rather than using their own harvested seeds because the next planting schedule is uncertain. Many will not grow optimally if seeds are stored for too long without a good storage method. But, partially, variables of superior variety have no significant influence on food security. This is because farmers in tidal land have limited access to quality seeds, and the impact of climate change causes superior seeds not to grow optimally. This is not in line with research conducted by Ratmini et al.[45], where in the study they conducted, the increase in rice production was influenced by superior varieties because they can adapt to climate change. The use of seeds significantly impacts crop productivity and food security[46].

Planting calendars in rice cultivation is crucial to ensure successful harvests, increase efficiency, and manage risks. Proper scheduling can avoid the risk of water shortages at the beginning of the planting season or damage due to flooding. Uniform and scheduled planting helps break the life cycle of pests that usually attack rice repeatedly. The rice planting season in tidal land has reached IP 300 in one year. The agricultural land is used to plant rice thrice in January, May, and September. The planting schedule is determined and adjusted to the climate. Using a planting calendar can also equalize the planting season of farmers 1 with others; this is also useful for breaking the life cycle of pests that usually attack rice repeatedly. While partially, the variable of planting calendars has no significant influence on food security in tidal land. This is because even though the plants planted have followed the planting calendar, the uncertainty of the weather and rapid climate change cause the plants not to grow optimally. In addition, not all farmers have sufficient knowledge of the planting calendar, so its implementation is inappropriate or does not run effectively. This is not in line with research conducted by Truong An[47], where a rice planting season calendar is an effective solution and contributes to increasing rice productivity and minimizing the negative impacts of climate change. Another researcher revealed that implementing CSA practices such as using complementary organic fertilizers, crop rotation, and double cropping significantly increased the food security of farmer households because of increased yields and incomes[48]. The assessment results conducted by Saud et al.[49] concluded that the impacts of various climate scenarios indicate that the rice growing period will be shorter and the harvest will decrease. This means that climate change will seriously affect rice production and food security.

5. Conclusions

Based on the analysis results, farmers on tidal land have utilized technologies identified as CSA technology. According to the study, the adoption rate of CSA technology in tidal land is high. This shows that the technologies identified as CSA technology, namely tractors, organic fertilizers, water pumps, drainage, superior varieties, direct seeds planting, combine harvesters, and planting calendars, have been implemented well by farmers in their farming businesses. The level of food security of farmer households on tidal land, namely Availability, utilization, accessibility, and stability, shows that it is in the high category, so the farmers on tidal land are included in the food secure category. From the results of the analysis, the influence of the independent variables, namely the adoption rate of CSA technology, namely tractors $_{(X1)}$, organic fertilizers $_{(X2)}$, water pumps $_{(X3)}$, drainage $_{(X4)}$, superior varieties $_{(X5)}$, direct seed planting $_{(X6)}$, combine harvesters $_{(X7)}$and planting calendars $_{(X8)}$ on the Food Security variable (Y) shows that there is a significant influence together. While partially, three variables have no significant effect, namely organic fertilizer variables $_{(X2)}$, superior varieties $_{(X5)}$, and planting calendars $_{(X8)}$. Some suggestions that researchers can give after conducting research with the borrowed title are as follows: for tidal land farmers, continuing the technology put in place is advised to ensure stability and increase the production and productivity of rice crops. This move is also expected to improve the resilience capacity of farming companies against climate change, reduce climate disaster effects, and allow for mitigation. The government must immediately prepare regulations, rules, or programs to enable the implementation of CSA. The program will benefit farmers by increasing their well-being, enhancing food security, and reducing poverty levels among farmers. This is to stimulate Indonesian agricultural development through sustainability further.

Author Contributions

Conceptualization, writing—original draft, and writing—review & editing: M.Y.; conceptualization, writing—original draft and writing—review & editing: T.W.S.P.; conceptualization and methodology: S.D.S.; writing—review & editing: M.F.T.; writing—review & editing: M.A.S.; writing—review & editing: D.D.; and writing—review & editing: S.R.A. All authors read and agreed the final manuscript for publication.

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Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Christyanto, M., Mayulu, H., 2021. Pentingnya pembangunan pertanian dan pemberdayaan petani wilayah perbatasan dalam upaya mendukung ketahanan pangan nasional: Studi kasus di wilayah perbatasan Kalimantan. Journal of Tropical AgriFood. 3(1), 1. DOI: https://doi.org/10.35941/jtaf.3.1.2021.5041.1-14

[2] Rusmayadi, G., Silamat, E., Abidin, Z., et al., 2024. Analisis Dampak Perubahan Iklim terhadap Pro-

duktivitas Tanaman Pangan. Jurnal Review Pendidik Dan Pengajaran. 7(3), 9488–9495. DOI: https://doi.org/10.31004/jrpp.v7i3.31300

[3] Yamin, M., Ayundari, L.D., Andelia, S.R., et al., 2023. Adopsi Teknologi Dalam Persiapan Menghadapi Risiko Teknis Usahatani Padi Akibat Perubahan Iklim. Mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis. 9(2), 2496. DOI: https://doi.org/10.25157/ma.v9i2.10456

[4] Climate Watch, 2021. Global Historical Emissions. Available from: https://www.climatewatchdata.org/ (cited 16 February 2025).

[5] Zhai, L., Lee, J.E., 2024. Investigating Vulnerability, Adaptation, and Resilience: A Comprehensive Review within the Context of Climate Change. Atmosphere. 15(4), 474. DOI: https://doi.org/10.3390/atmos15040474

[6] Tilahun, G., Bantider, A., Yayeh, D., 2023. Impact of adopting climate-smart agriculture on food security in the tropical moist montane ecosystem: The case of Geshy watershed, Southwest Ethiopia. Heliyon. 9(12), 1–17. DOI: https://doi.org/10.1016/j.heliyon.2023.e22620

[7] Mereu, V., Santini, M., Cervigni, R., et al., 2018. Robust Decision-Making for a Climate-Resilient Development of the Agricultural Sector in Nigeria. In: Lipper, L., McCarthy, N., Zilberman, D., Asfaw, S., Branca, G. (eds.). Climate Smart Agriculture. Springer International Publishing: Cham, Switzerland. pp. 277–306.

[8] Center for Agricultural Data and Information System, 2023. Statistics of Food Consumption 2023. Available from: https://satudata.pertanian.go.id/assets/docs/publikasi/Buku_Statsitik_Konsumsi_Pangan_2023.pdf (cited 2 February 2025).

[9] Malau, L.R.E., Rambe, K.R., Ulya, N.A., et al., 2023. Dampak Perubahan Iklim Terhadap Produksi Tanaman Pangan Di Indonesia. Jurnal Penelitian Pertanian Terapan. 23(1), 34–46. DOI: http://dx.doi.org/10.25181/jppt.v23i1.2418

[10] Ansari, A., Wuryandani, S., Pranesti, A., et al., 2023. Optimizing water-energy-food nexus: achieving economic prosperity and environmental sustainability in agriculture. Frontiers in Sustainable Food Systems. 7, 1–7. DOI: https://doi.org/10.3389/fsufs.2023.1207197

[11] Ansari, A., Pranesti, A., Telaumbanua, M., et al., 2023. Evaluating the effect of climate change on rice production in Indonesia using a multimodelling approach. Heliyon. 9(9), 1–15. DOI: https://doi.org/10.1016/j.heliyon.2023.e19639

[12] Cui, L., Wang, W., 2023. Factors Affecting the Adoption of Digital Technology by Farmers in China: A Systematic Literature Review. Sustainability. 15(20), 1–14. DOI: https://doi.org/10.3390/su152014824

[13] Mamat, H.S., Sukarman, S., 2020. Manfaat Inovasi Teknologi Sumberdaya Lahan Pertanian Dalam Mendukung Pembangunan Pertanian. Jurnal Sumberdaya Lahan. 14(2), 116–133. DOI: https://doi.org/10.21082/jsdl.v14n2.2020.115-132

[14] Darsani, Y.R., Alwi, M., 2022. Inovasi Teknologi Budidaya Padi Unggul di Lahan Rawa Pasang Surut Tipe Luapan C: Kasus Desa Matang Danau, Kecamatan Paloh, Kabupaten Sambas, Kalimantan Barat. Jurnal Sosial Ekonomi Pertanian dan Agribisnis. 18(1), 41–54.

[15] Ajayi, V.O., 2023. A Review on Primary Sources of Data and Secondary Sources of Data. European Journal of Education and Pedagogy. 2(3), 1–7.

[16] Cheong, H.i., Lyons, A., Houghton, R., et al., 2023. Secondary Qualitative Research Methodology Using Online Data within the Context of Social Sciences. International Journal of Qualitative Methods. 22, 1–19. DOI: https://doi.org/10.1177/16094069231180160

[17] Wahab, A., Syahid, A., Junaedi, J., 2021. Penyajian Data Dalam Tabel Distribusi Frekuensi Dan Aplikasinya Pada Ilmu Pendidikan. Journal of Education and Learning. 2(1), 40–48. DOI: https://doi.org/10.33096/eljour.v2i1.91

[18] Alidu, A.F., Man, N., Ramli, N.N., et al., 2022. Smallholder farmers access to climate information and climate-smart adaptation practices in the northern region of Ghana. Heliyon. 8(5), 1–9. DOI: https://doi.org/10.1016/j.heliyon.2022.e09513

[19] Agyekum, T.P., Antwi-Agyei, P., Dougill, A.J., et al., 2024. Benefits and barriers to adopting climate-smart agriculture practices in West Africa: A systematic review. Climate Resilience and Sustainability. 3(3), 1–15. DOI: https://doi.org/10.1002/cli2.79

[20] Tunio, R.A., Li, D., Khan, N., 2024. Maximizing farm resilience: the effect of climate-smart agricultural adoption practices on food performance amid adverse weather events. Frontiers in Sustainable Food Systems. 8, 1–14. DOI: https://doi.org/10.3389/fsufs.2024.1423702

[21] Pandeya, S., Gajurel, A., Mishra, B.P., et al., 2024. Determinants of Climate-Smart Agriculture Adoption Among Rice Farmers: Enhancing Sustainability. Sustainability. 16(23), 1–11. DOI: https://doi.org/10.3390/su162310247

[22] Hassan, K.S., Islam, M.N., Billah, M.M., et al., 2024. Effective extension and access to education drive optimal adoption of climate-smart agriculture interventions in affected tidal flood-

plains: A case study. Heliyon. 10(11), e31616. DOI: https://doi.org/10.1016/j.heliyon.2024.e31616

[23] Abegunde, V.O., Sibanda, M., Obi, A., 2022. Effect of climate-smart agriculture on household food security in small-scale production systems: A micro-level analysis from South Africa. Cogent Social Sciences. 8(1), 1–27. DOI: https://doi.org/10.1080/23311886.2022.2086343

[24] Hoque, M.Z., Mahmud, A.A., Haque, M.E., et al. Adoption of Climate Smart Agricultural Practices by Charland Farmers in Charfasson, Bangladesh. Journal of Agriculture and Ecology Research International. 24(5), 87–97. DOI: https://doi.org/10.9734/jaeri/2023/v24i5545

[25] Tariku, G.D., Kebede, S.A., 2025. Climate-smart agricultural practices and their implication in Ethiopia: a systematic review. International Journal of Climate Change Strategies and Management. 17(1), 1–20. DOI: https://doi.org/10.1108/IJCCSM-01-2024-0012

[26] Rukundo, E., Tabe-Ojong, M.P.J., Gebrekidan, B.H., et al., 2023. Adoption and impacts of agricultural technologies and sustainable natural resource management practices in fragile and conflict-affected settings: A review and meta-analysis. Available from: https://hdl.handle.net/10568/132360 (cited 31 January 2025).

[27] Machete, K.C., Senyolo, M.P., Gidi, L.S., 2024. Adaptation through Climate-Smart Agriculture: Examining the Socioeconomic Factors Influencing the Willingness to Adopt Climate-Smart Agriculture among Smallholder Maize Farmers in the Limpopo Province, South Africa. Climate. 12(74), 1–17. DOI: https://doi.org/10.3390/cli12050074

[28] Mbanasor, J.A., Kalu, C.A., Okpokiri, C.I., et al., 2024. Climate-smart agriculture practices by crop farmers: Evidence from southeast Nigeria. Smart Agricultural Technology. 8, 1–12. DOI: https://doi.org/10.1016/j.atech.2024.100494

[29] Yamin, M., Putri, N.E., 2024. Agricultural Household Economic In Condition Flood Impact Of Climate Change In Indonesia. IOP Conference Series: Earth and Environmental Science. 1364(1), 1–9. DOI: https://doi.org/10.1088/1755-1315/1364/1/012017

[30] Aisyah, S., Faqih, A., Rahudi, R., et al., 2023. Relationship Between Farmer Characteristics and Farmer Group Dynamics with The Success of Farmer Empowerment Programs Through Agricultural Technology and Information. Eduvest - Journal of Universal Studies. 3(8), 1487–1497. DOI: https://doi.org/10.59188/eduvest.v3i8.878

[31] Mkansi, N.D., Ledwaba, J.L., Mokhaukhau, J., 2025. Smallholder Farmers' Perceptions of Climate Change Adaptation Strategies: The Case of the Greater Giyani Local Municipality, Limpopo Province. Research on World Agricultural Economy. 6, 276–289. DOI: https://doi.org/10.36956/rwae.v6i1.1287

[32] Rahmawati, A., Alwin, A., Adiputra, A., 2024. The Impact of Farmers' Socio-Economic Conditions Due to the Conversion of Agricultural Land in Setia Mulya Village, Bekasi Regency, Indonesia. Jambura Geo Education Journal. 5(2), 104–114. DOI: https://doi.org/10.37905/jgej.v5i2.26493

[33] Anang, B.T., Apedo, C.K., 2023. The influence of off-farm work on farm income among smallholder farm households in northern Ghana. Cogent Economics & Finance. 11(1), 1–14. DOI: https://doi.org/10.1080/23322039.2023.2196861

[34] Weerasooriya, G.V.T.V., Karthigayini, S., 2023. Adoption of Climate Smart Agriculture (CSA) Technologies in Sri Lanka: Scope, Present Status, Problems, Prospects, Policy Issues, and Strategies. DOI: https://doi.org/10.1007/978-981-19-8738-0_9

[35] Ali, H., Menza, M., Hagos, F., et al., 2022. Impact of climate-smart agriculture adoption on food security and multidimensional poverty of rural farm households in the Central Rift Valley of Ethiopia. Agriculture & Food Security. 11(62), 1–16. DOI: https://doi.org/10.1186/s40066-022-00401-5

[36] Nong, H.T.T., Gan, C., Hu, B., 2021. Farmers' Perception of and Adaptation to Climate Change: An Investigation in Northeast Vietnam. Journal of Development Economics. 46(4), 65–85. DOI: https://doi.org/10.35866/caujed.2021.46.4.003

[37] Muhammad, S., Muhammad, H., Sadik, I., 2023. Households' Food Security Model Of Rice Farmers On Tidal Lands Of Banjar District, Indonesia. Russian Journal of Agricultural and Socio-Economic Sciences. 136(4), 106–118. DOI: https://doi.org/10.18551/rjoas.2023-04.09

[38] Mekonnen, A., Tessema, A., Ganewo, Z., et al., 2021. Climate change impacts household food security and farmers adaptation strategies. Journal of Agriculture and Food Research. 6, 1–9. DOI: https://doi.org/10.1016/j.jafr.2021.100197

[39] Hartoni, H., Shafriani, K.A., 2023. Food Security of Households Paddy Rice Farmers in Tidal Land Barito Kuala Regency. Tropical Wetland Journal. 9(1), 32–37. DOI: https://doi.org/10.20527/twj.v9i1.115

[40] Khalifa, J., 2025. The Impacts of Climate Change, Agricultural Productivity, and Food Security on Economic Growth in Tunisia: Evidence from an Econometrics Analysis. Research on World Agricultural Economy. 6(1), 577–599. DOI: https://doi.org/10.36956/rwae.v6i1.1457

[41] Gold, K.L., 2024. Food Insecurity in West Africa:

Is Global Warming the Driver? Research on World Agricultural Economy. 5, 403–419. DOI: https://doi.org/10.36956/rwae.v5i4.1186

[42] Masha, M., Bojago, E., Ngare, I., 2024. Determinants of adopting urban agriculture (UA) as climate-smart agriculture (CSA) practices and its impact on food security: evidence from Wolaita Sodo city, South Ethiopia. Discover Sustainability. 5(1), 168. DOI: https://doi.org/10.1007/s43621-024-00365-5

[43] Kamau, J.N., Kiprop, I.N., Kipruto, G.K., 2020. The Role of Farmers' Social Networks in Adopting Climate Smart Agriculture: Case of Horticultural Farmers in Nyeri County, Kenya. Research on World Agricultural Economy. 1(1), 35–38. DOI: https://doi.org/10.36956/rwae.v1i1.241

[44] Retnaningtyas, T.A., Padmaningrum, D., Anantanyu, S., 2024. Perilaku Petani Milenial Provinsi Jawa Barat dalam Penerapan Climate-Smart Agriculture (CSA) pada Tanaman Hortikultura. Jurnal Ilmiah Membangun Desa dan Pertanian. 9(2), 160–171. DOI: https://doi.org/10.37149/jimdp.v9i2.1105

[45] Ratmini, N.P.S., Herwenita, I.F. Climate change mitigation through superior varieties use to increase rice production in tidal swamp land. IOP Conference Series: Earth and Environmental Science. 824(1), 1–7. DOI: https://doi.org/10.1088/1755-1315/824/1/012019

[46] Ghodasaini, K.U., Ghimire, H., 2022. Role of Quality Seeds in Food Security and Self-S Sufficiency in Nepal. INWASCON TECHNOLOGY MAGAZINE. 4, 52–55. DOI: https://doi.org/10.26480/itechmag.04.2022.52.55

[47] Truong, A.D., 2020. Shifting crop planting calendar as a climate change adaptation solution for rice cultivation region in the Long Xuyen Quadrilateral of Vietnam. Chilean Journal of Agricultural Research. 80(4), 468–477. DOI: https://doi.org/10.4067/S0718-58392020000400468

[48] Saadu, B., Ibrahim, H.Y., Nazifi, B., et al., 2024. Adoption of climate-smart agricultural practices and its impact on smallholder farming households in some rural areas of North-Western Nigeria. Agricultura tropica et subrotopica. 57(1), 23–34. DOI: https://doi.org/10.2478/ats-2024-0003

[49] Saud, S., Wang, D., Fahad, S., et al., 2022. Comprehensive Impacts of Climate Change on Rice Production and Adaptive Strategies in China. Frontiers in Microbiology. 13, 1–12. DOI: https://doi.org/10.3389/fmicb.2022.926059