



Local rice cultivar diversity and household food security in northern Iran

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Abstract

The world's population is constantly increasing and is expected to reach 8 billion by 2030. After wheat, rice is the second major crop in terms of acreage and food security. The major crop in the north of Iran is rice. The study of diversity in rice cultivars is an excellent predictor of food security. Rice monoculture is one of the major challenges to achieving basic self-sufficiency in ensuring sustainable food security in the country. The current study evaluated the relationship between rice cultivar diversity and food security in response to this challenge. In this study, 10 villages and 106 farms were randomly surveyed with interviews, direct observations, and focal group discussion. Logistic regression analysis showed the relationship between mean species richness, cultivar richness, and Shannon–Wiener index of rice and food security is positive and significant. From regression graphs, we can conclude that crop diversity indices, i.e., the Simpson index, have a negative relationship and average species richness, cultivar diversity index, and the Shannon–Wiener index have a positive relationship with food security. Therefore, we suggest focusing on formulating adaptation strategies and major training in the diversity of local rice cultivars to improve food security.

Keywords Agrobiodiversity · Food sustainability · Local cultivars · Monoculture · Self-sufficiency

1 Introduction

The global population is projected to increase from nearly 7 billion today to 8 billion by 2030 and more than 9 billion by 2050 (Erni, 2015; Fouilleux, 2017). Rice is the staple food of about half of the world's population. In Asia, the security of rice equals food security.

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About 90% of the world's rice is cultivated in Asian countries (Almanac, 2013). Therefore, it plays a central role in food security, social culture, and strategic government interventions in many developing countries (Omar, 2019; Fahad et al., 2019). Conventional rice production systems have led to an increase in barren lands and the simultaneous loss of biodiversity (Lanz et al., 2018). Preserving the biodiversity of rice cultivars is an agricultural approach to food security, as it is fully compatible with the effects of global warming on agricultural land reduction and land-use change in the face of change, increasing resource competition such as water resources and other shocks (Zimmerer, 2019, 2020).

Most rice paddy fields are cultivated on a small scale. The role of crop diversity depends on the production of local and regional food. As a result, each region should be studied separately (Fouilleux, 2017; Calderon, 2018; Castaneda-Navarrete, 2021). Preserving rice biodiversity in agricultural systems is not a new approach; it is a solution pursued by many smallholder farmers around the world, who have concluded that the nutritional and livelihood benefits of diversified production are one way to achieve sustainable food security (Agroecological, 2019; Kerr et al., 2019).

Agriculture is the dominant sector in northern Iran. Gilan Province has about five thousand hectares of arable land, of which 4,000 hectares are cultivated every year with various rice cultivars, including Hashemi, Ali Kazemi, and Khazar, and the remaining land is used to cultivate other crops, including watermelon, cucumber, legumes, and canola as well as horticultural products including citrus fruits, plums, and kiwi (Ahmadzadeh, 2020; Yavari, 2021). The city of Bandar Anzali in Gilan Province ranks high in terms of rice yield per unit level. In this city, rice is the major crop species. Therefore, rice safety is the most important part of food security in this area (Einollahi, 2021). The cultivation of rice cultivars can be key to resisting agricultural shocks and achieving sustainable food security (Wezel, 2017; Haynes, 2018; Lourme-Ruiz, 2021; Prasanna et al., 2021). For many of the current farmers, their livelihood depends on agriculture, so it is necessary to develop flexible farming systems by diversifying rice cultivars (Aguilar-Støen et al., 2009; Alam, 2020; Ker, 2020). Despite a range of empirical studies examining the relationship between food security, agricultural system resilience, and on-farm rice biodiversity, a gap remains in our knowledge (Gauchan, 2005; Kim, 2012; Jones, 2014; Sharma et al., 2018; Fernandez & Méndez, 2019; Firdaus, 2019; Sanoj Kumar Patel, 2020; Raihanul Islam, 2020; Connor et al., 2022; Nabuuma et al., 2021).

The present study aimed to evaluate the diversity of rice cultivars, their nutritional adequacy, the relationship between rice production level and food security, and to determine the factors affecting the diversity of rice cultivars for adaptation strategies and integration of biodiversity protection and food production in the household.

2 Materials and Methods

2.1 Study area

The study area is located in the range of 35.5–39°N latitude and 47.5 to 51.5°E longitude. Bandar Anzali is the largest port beside the Caspian Sea in northern Iran. Its land covers an area of approximately 275 km², and the city has a population of over 150 thousand people. This city is one of the most important economic and social centers in Gilan Province of Iran (Fig. 1).

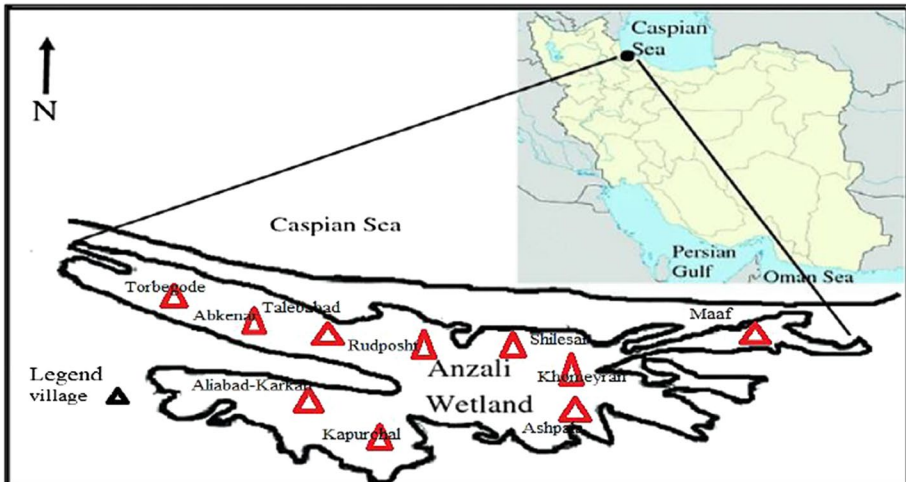


Fig. 1 Map of Bandar Anzali and the studied villages

3 Research method

This field study was conducted in 2021 to study agroecosystems and agrobiodiversity. Ten villages (namely Rudposht, Talebabad, Torbgodeh, Shilesar, Maaf, Khomeyran, Ashpala, Aliabad, Abkenar, and Kapurchal) were selected by random cluster sampling based on geographical distribution, population, and high species diversity. Structural questionnaires were designed based on biodiversity indices, factors affecting various rice species, socio-economic factors affecting farmers' crop decisions, as well as farm features. A total of 106 households in ten villages were studied as sampling units. The information contained in the questionnaires was gathered through direct observation of agroecosystems, interviews with the heads of agricultural farms, and completion of the questionnaire. Socio-economic status was examined through individual and family characteristics of farmers (comprising farmer age, sex, level of education, level of female participation, years of farming experience, size of household, number of farm employees, sources of income from different sectors, working hours on the farm, information about the properties of the species, and the purpose of planting the species) and farm characteristics (comprising farm area; house area; distance from the sales center; domesticated plants; type of crop planted and area under cultivation of that species; planting date; source of seed preparation; fertilizer consumption; methods of fighting pests, diseases, and weeds; production rate; percentage of personal consumption or sale of products; method of selling products with a percentage of consumption or sale or other consumption). Data were coded using statistical methods and tabulated in IBM Statistics software SPSS version 26, STATA, and Excel. In the results of this study, the agrobiodiversity indicators were analyzed.

$$Y_i = 0; P Y_{(I = 1)} P_i$$

$$Y_i = 1; P Y_{(I = 0)} P_i$$

where a binary dependent variable is equal to one of the farmer's practice adaptation methods; the function is optimal or otherwise zero. In the model, X_i contains the vector of explanatory variables used.

Estimated parameters β , constant number $0 = \beta_0$, model error $= \varepsilon_i$, natural basis of logarithms $\exp I = LI =$ and ratio of household to farm $= [PI/1-PI]$; therefore, logistic binary regression model Expressed.

Factors influencing household decision-making on the biodiversity of rice cultivars were evaluated through logistic regression. The model uses a suggested value of one or zero, with one indicating food insecurity and zero indicating food safety. Logistic regression is a method of observing the probability of a household's food being safe from various factors or variables as necessary strategies that $P I = E (Y = 1/X)$. $P I$ represents the conditional mean of Y to specific values of X . Logistic conversion of the likelihood of farmers practicing the adaptation strategy was performed.

Rice constitutes the most planted crop (82.8%) (Fig. 2). As a result, most of the city's food security depends on rice. Therefore, the diversity of rice cultivars was investigated.

4 Results and discussion

4.1 Evaluating the diversity of rice cultivars

The richness of all rice cultivars and their cultivated area in the studied villages were investigated. The Sorenson similarity index was used to find similarities between villages in terms of planted rice cultivars. In pairs, all cultivars and species growing in the two villages were evaluated. The Sorenson similarity index among cultivars grown indicated a high level of similarity, probably due to similar topographic conditions (Simon Wambui Mburu, 2016; Ker, 2020; Zimmerer, 2020).

The following equation was used to calculate the Sorenson index:

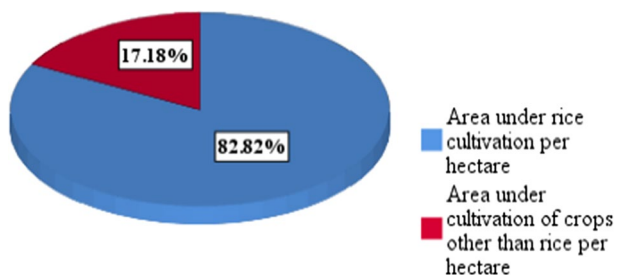
$$SQ = 2J / (a + b)$$

SQ = Sorenson similarity index J = number of similar cultivars in two villages

b = number of village cultivars $b - a$ = number of cultivars of the village a

The Sorenson similarity index scores range from 0 to 1, with zero meaning dissimilarity and one complete similarity. The Simpson Index is the first diversity index used in ecology, and its scoring varies from 0 to 1. It shows how likely it is that two individuals randomly

Fig. 2 Ratio of the area under rice cultivation to other crops and the total area of farms in the study area



removed from a population are of the same species (Table 1). If such probability is high, the diversity of the sampled population is low. The following formula is used to calculate the Simpson diversity index:

$$D = 1 - \sum_i p_i^2, P_i = n_i/N$$

D = Dominance index.

N = Number of total species or all members of society.

n_i = Frequency of n species.

Hashemi rice is cultivated in 56.6% of villages, indicating its precedence. Ali Kazemi rice, grown in only 0.9% of villages, is the least planted species in this city. Approximately 40.6% of the rice produced in the studied area is planted in 1–2-hectare lands, which shows the smallholder ownership of Bandar Anzali lands. The biodiversity of rice species, i.e., the number of rice cultivars (cultivar richness), is highest in the villages of Rudposht, Shilesar, Khomeyran, Maaf, and Abkenar.

The largest areas under Hashemi rice cultivation are in the villages of Rudposht and Taleabad, followed by the villages of Abkenar, Ashpala, and Torbgodeh. This cultivar covers the lowest areas in the other studied villages. Jamshidi rice is cultivated only in Aliabad, and Dom siyah rice is cultivated only in Kapurchal. Torbgodeh is the only studied village in which rice is not planted. The largest areas under Khazar and Shiroodi rice cultivation can be seen in Abkenar, followed by Khomeyran and Maaf. Rudposht has the area of Khazar rice cultivation (Fig. 3).

Abkenar with 32 hectares constituting 81% has the highest area under rice cultivation, while Shilesar with 8.5 hectares has the lowest area under cultivation among all studied villages.

Average species richness is based on the average richness of rice cultivars. The highest richness (0.5) was found in Rudposht, Shilesar, Khomeyran, Maaf, and Abkenar, and the lowest (0.16) was seen in Ashpala. Simpson and Shannon indices and uniformity were also measured.

The Simpson index is one of the most important indicators for measuring heterogeneity and the first nonparametric index of diversity. This diversity index is strongly influenced by the dominant species in the sample but is slightly sensitive to species richness (Table 2). Its score ranges from zero, i.e., low variability, to almost one, indicating high variability. Using the Simpson photo index, we can also find the degree of uniformity, i.e., numbers close to zero indicate the least uniformity, and numbers close to one indicate the highest level of uniformity. Dominance measurement indices such as Simpson are strongly influenced by the relative abundance of dominant species. Thus, Simpson suggested that diversity is directly related to the likelihood that two randomly selected individuals belong to two different species. The uniformity index shows how the population of species is distributed. The more uniform the distribution of species is, the greater the similarity of number of individuals or frequency of species, the stability, and the biodiversity will be (Sharma et al., 2018; Miraji et al., 2021; Connor et al., 2022).

The average rice species richness index is highest (0.5) in the villages of Rudposht, Shilesar, Khomeyran, Maaf, Aliabad, and Abkenar and lowest (0.16) in the villages of Taleabad and Ashpala. The Shannon diversity index is highest (0.35) in Khomeyran, while it is 0 in Shilesar. The Simpsons diversity index is also highest in Shilesar (1). In other words, only one type of rice cultivar (Hashemi rice) is planted in this village. This index is lowest in Abkenar (0.36) (Table 3).

Table 1 Sorenson rice similarity index in the study area

Village Name	Torbegode	Talebabad	Rudposht	Shilesar	Khomeyran	Maaf	Ashpala	Aliabad-Karkan	Abkenar	Kapurchal
Torbegode	1	0.66	0.40	0.40	0.40	0.40	0.66	0.50	0.40	0.50
Talebabad		1	0.50	0.50	0.50	0.50	1	0.66	0.50	0.66
Rudposht			1	1	1	1	0.50	0.40	1	0.40
Shilesar				1	1	1	0.50	0.40	1	0.40
Khomeyran					1	1	0.50	0.40	1	0.40
Maaf						1	0.50	0.40	1	0.4
Ashpala							1	0.66	0.50	0.66
Aliabad-Karkan								1	0.40	0.40
Abkenar									1	0.40
Kapurchal										1

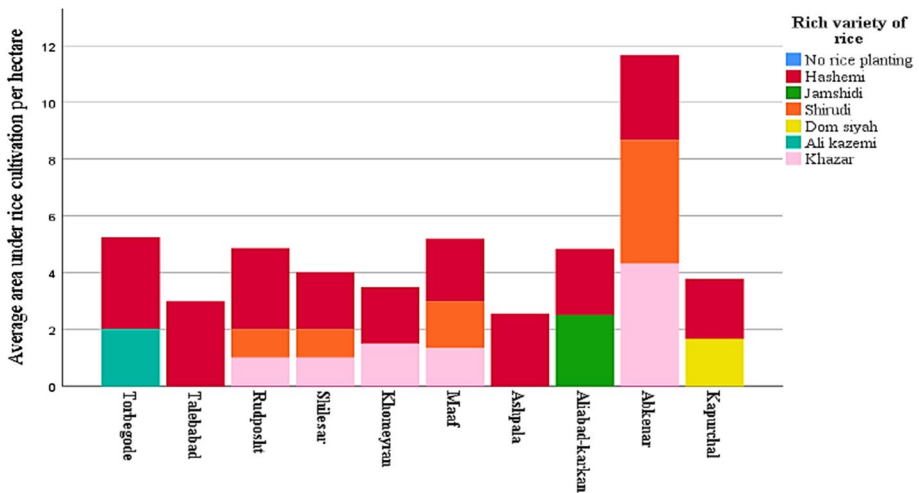


Fig. 3 Area under cultivation of different rice cultivars in the villages of Bandar Anzali

Most of the rice grown in the study area is sold in those same villages (Fig. 4). Only in Abkenar, the people consume the same amount of rice as they sell. In other villages, in addition to their consumption, sales are conducted locally through markets and intermediaries. It can be concluded that Bandar Anzali can provide food security in terms of rice. Moreover, 73.6% of the agricultural products of this city are sold, which shows the ability and self-sufficiency of this city to produce products and provide food security (Gibson, 2017; Manzoor and Dar, 2020).

The purpose of planting in less than 20% of the studied villages is to use the land, for personal consumption, due to interest and belief in agriculture, to prepare seeds, and other uses (animal feed, souvenirs, etc.). Thus, in all villages of Bandar Anzali city, the main purpose of planting rice is to sell it. In the villages of Torbgodeh, Talebabad, Maaf, Ashpala, Abkenar, and Kapurchal, rice is planted only for sale. Rice species richness is high in more than 70% of the city, which is an important factor in agrobiodiversity. Ali Kazemi rice is planted only in Torbgodeh, and Dom siyah is planted only in Kapurchal. Hashemi and Ali Kazemi rice is planted in Torbgodeh; Talebabad has Hashemi rice cultivars and rice-free fields; in Rudposht, Hashemi, Shiroodi and Khazar rice and rice-free fields are seen; Khomeyran has Hashemi, Shiroodi, and Khazar rice fields; Hashemi rice, Khazar And farms without rice, in exemption of Hashemi, Shiroodi, Khazar and rice-free farms, in Ashpala, farms of only Hashemi rice and farms without rice are seen; Aliabad Hashemi, Jamshidi and rice-free farms, near Hashemi, Shiroodi, Khazar and other rice fields Farms without rice and finally in Hashemi Hashemi rice and Dom siyah and farms without rice are observed.

4.2 Adequacy of food

The first and major indicator of food security is food adequacy. In the Bandar Anzali area, 73.6% of the surrounding villages sell more than 75% of their products. Because of the high number of rice cultivars, farmers first provide for their personal consumption and

Table 2 Area under rice cultivation to the total area of cultivated crops

Village name	The area under cultivation of all crops *	The area under rice cultivation *	The ratio of area under cultivation of rice to the total cultivation area	The ratio of area under rice cultivation to the whole city
Torbegode	20	15	0.75	0.07
Talebabad	30	21.5	0.71	0.10
Rudposht	18.5	14.5	0.78	0.06
Shilesar	8.5	8.5	1	0.04
Khomeyran	21.5	10	0.46	0.04
Maaf	20.5	11	0.53	0.05
Ashpala	22	11.5	0.52	0.05
Aliabad-Karkan	17.5	11.5	0.65	0.05
Abkenar	32	26	0.81	0.12
Kapurchal	20.5	13.5	0.65	0.06
Total	211	143	0.67	0.64

* Units are in hectares

then sell the rest. Therefore, this city is self-sufficient in terms of species richness of rice cultivars.

As a result, decisions regarding food security, one component of which is adequate access at all times, can be made in this city. Rice crop diversity in the city is a strong predictor of food security. Two biodiversity indices have been used to estimate the relationship between the agrobiodiversity of rice cultivars and food security (Alam, 2020). In the current study, classified food security was used to investigate the relationship between crop diversity and correlation with the Simpson and Shannon–Wiener index of various rice cultivars (Table 4).

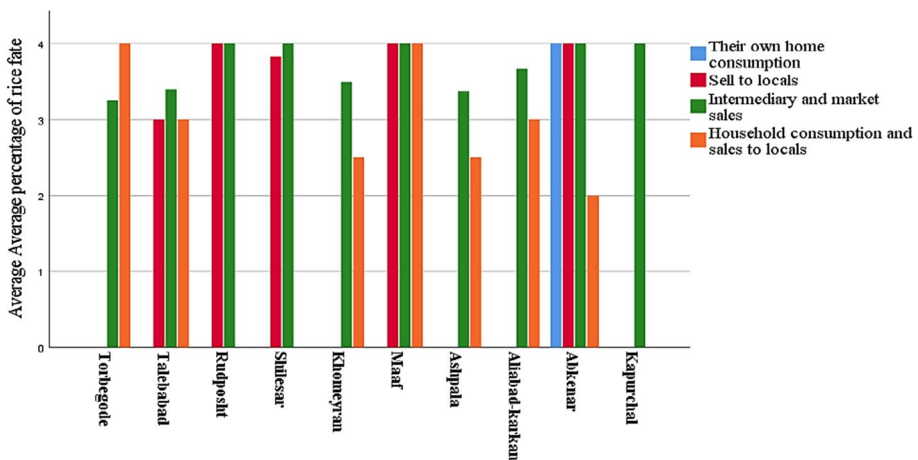
When sig is below 0.05, the regression model is significant and the relationship between mean species richness and food security is positive and significant. Moreover, 91.8% of the dependent variable, i.e., food security, is determined by the independent variable, i.e., average species richness, which is a measurable variable. The relationship between rice cultivar richness and food security is positive and significant, and 7.8% of the dependent variable is determined by the independent variable, meaning rice cultivar richness which is a nominal variable. The relationship between the Shannon–Wiener index and food security is positive and significant; 0.4% of the dependent variable is determined by the independent variable, i.e., the Shannon–Wiener index score which is a measurable variable. The relationship between Simpson’s diversity index and food security is negative and significant; 9% of the dependent variable is determined by the independent variable, i.e., the Simpson diversity index which is a measurable variable (Fig. 5). Finally, we can conclude from the regression graphs that the applied crop diversity indices forecast good food security (Nicholas & Williams, 2018; Valencia, 2019; Kaini, 2020; Connor et al., 2021).

4.3 Factors determining the diversity of rice cultivars for adaptation strategies

A binary logistic model was used to determine the amount of rice cultivar diversity among farms and their adaptation strategies. Factors determining the compatibility of diverse rice have been prioritized in farmers’ decision-making strategies regarding farmers’ food

Table 3 Indices of rice cultivar diversity in the study area

Village name	Species richness index	Average species richness index	Shannon Index	Simpson Diversity Index
Torbegode	2	0.33	0.21	0.96
Talebabad	1	0.16	0.26	0.94
Rudposht	3	0.5	0.19	0.97
Shilesar	3	0.5	0	1
Khomeyran	3	0.5	0.35	0.79
Maaf	3	0.5	0.28	0.62
Ashpala	1	0.16	0.33	0.73
Aliabad-Karkan	2	0.5	0.18	0.38
Abkenar	3	0.5	0.17	0.36
Kapurchal	2	0.33	0.23	0.5

**Fig. 4** Average percentages of rice consumption in different villages of Bandar Anzali

security status (Lijbert Brussaard, 2010). This model assumes that the decision to plant cultivars of rice includes a strategy for adapting to the level of food security.

In this model, the likelihood logarithm measures the weakness of the model prediction. It can be said that a model with a smaller statistic is a better model, and herein, we have a small amount, i.e., 216.2. Chi-square linear regression shows how much the designed model is supported based on real data. In other words, it shows the compatibility of the experimental model with the theoretical model. In this study, the Chi-square value was 108.65, which was statistically significant at the level of 0.0001 (Table 5).

As a result, this model is statistically reliable and has high accuracy. The fit index in this model is used mainly to compare accuracy and precision among models. This means that according to the fit index, which is false, the linear regression is not easily interpreted and thus is used only as a measure of the accuracy and precision of the model.

Table 4 Correlation of food security and crop diversity indices with average cultivar richness and Shannon–Wiener and Simpson index

Food security	Average species richness	The rich cultivar of rice	Shannon–Wiener Index	Simpson Diversity Index
The correlation coefficient	32.0**	0.28**	0.06	−0.3**
R ²	0.75	0.07	0.004	0.09

Goodness of fit determines the fit between the model and a set of observations; the sig value of less than 0.05 indicates the model has a good fit for the data. The predictive power of the model was 52% which in interpreting the model shows that the marginal effects of regression coefficients, calculated from partial derivatives as a marginal probability, were high. Above 50% indicates the accuracy of the model. In Bandar Anzali, there is a tendency for monoculture in rice cultivars, and farmers do not want to apply a cultivar of rice cultivars in diversify of cultivation. This number is about 50%, which clearly shows the figure below the final model predicted based on studies (Fig. 6).

According to Table 6, men’s management, women’s participation, farmer experience, home area, and the major fate of the rice sold are negatively related to the biodiversity of the rice cultivation (Pashupati Chaudhary, 2020; Sanoj Kumar Patel, 2020; Wencong

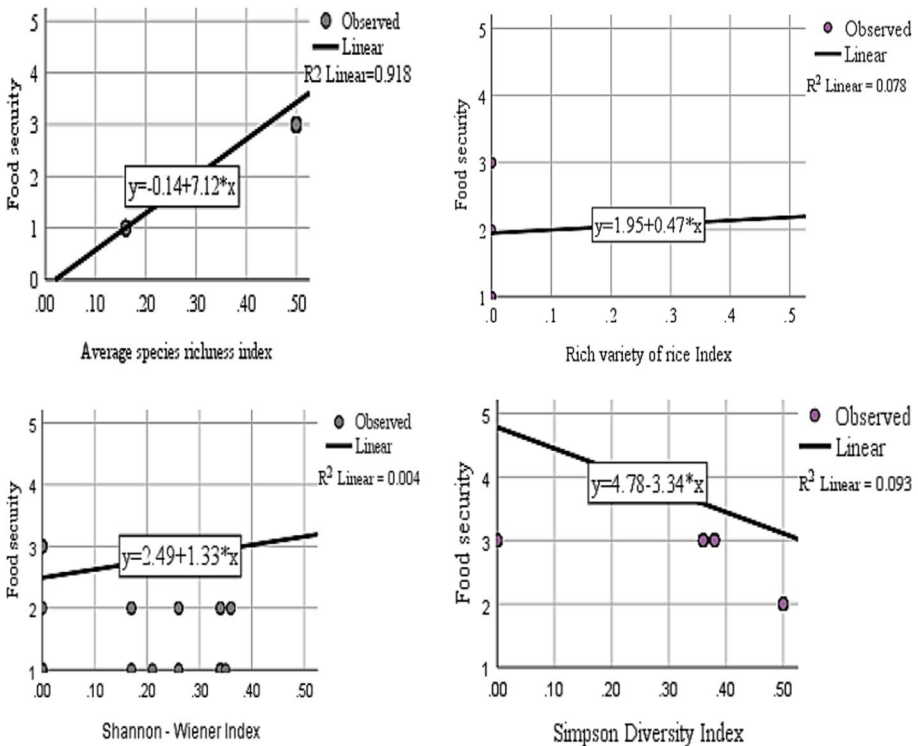


Fig. 5 Regression diagram of the relationship between food security and agrobiodiversity indicators in rice

Lu, 2021). Male-headed households are more resistant to accepting a variety of rice cultivars on their farms. The higher the participation of women in the fields is, the lower the tendency of the farm manager to plant cultivars of rice, the higher the experience of the farmer, and the higher the tendency toward monoculture will be (Cornwall, 2015; Weltzien, 2019). Similarly, it is concluded that conventional agriculture (monoculture) through management and its effects on farm structure are among the most important reasons for the reduction in biodiversity, and that ecosystem degradation profoundly alters yield (Xiaoxing Qi, 2018; Lanz et al., 2018; Vanbergena, 2020; DAO, 2021). The area of the farm manager's house is negatively related to rice biodiversity. The larger the farm manager's house is, the more monoculture in rice vessels will be seen on the farm (Fazlul Karim, 2020; Aminul Islam, 2020). The age of individuals, the source of income from agriculture, and the major fate of the products sold have a negative and significant relationship with the acceptance of diversity in rice cultivars. The older the farmers are, the less inclined they are to apply a variety of rice cultivars to their farms (Roy et al., 2020).

Several studies have concluded that farmers' decisions regarding on-farm biodiversity depend on technical or market considerations (Ahmed, 2017; Connor et al., 2021; Sanoj Kumar Patel, 2020). Education, working hours on farms, farm life, ecological strategies to control pests, diseases, and weeds, and the type of consumption, which is majorly fresh, have a positive relationship with the acceptance of planting a variety of rice cultivars on farms. Agricultural science and farm area have a positive and significant relationship with the farm manager's acceptance of planting various cultivars of rice. One study concluded that profitability and the choice of methods based on the rotation of time and space can feed people, but this action requires participatory education to improve human health by reducing the use of pesticides and increasing the yield of material products. Areas with more agricultural diversity produce more nutritious food (Bachmann, 2009; Herrero, 2017; Singh, 2018; Kaini, 2020).

The result of logistic regression analysis showed that the age of the head of the household has a negative effect at the level of 0.01, agricultural knowledge has a positive effect at the level of 0.05, household income only through agriculture has a negative effect at the level of 0.05, and farm area has a positive role at the level of 0.05 (Fig. 6). In this study, the decision to diversify the cultivation of rice in Bandar Anzali, and subsequently to ensure food security, was directly related to the richness of rice cultivation (Osawa, 2014; Singh, 2018). Finally, the expected logistic regression model is synchronized with the observed data as follows.

Table 5 Analysis of statistical description of various variables used in logistics model

Number of observations	106
Log likelihood	-216.2
LR Chi	(Prob > chi2)=0.0001 108.65***
Pseudo R2	0.87
Goodness of fit	Pearson Chi2 (134)=108.83. sig Prob > chi2=0.94
The area under the ROC curve	0.52
Overall correct prediction	52

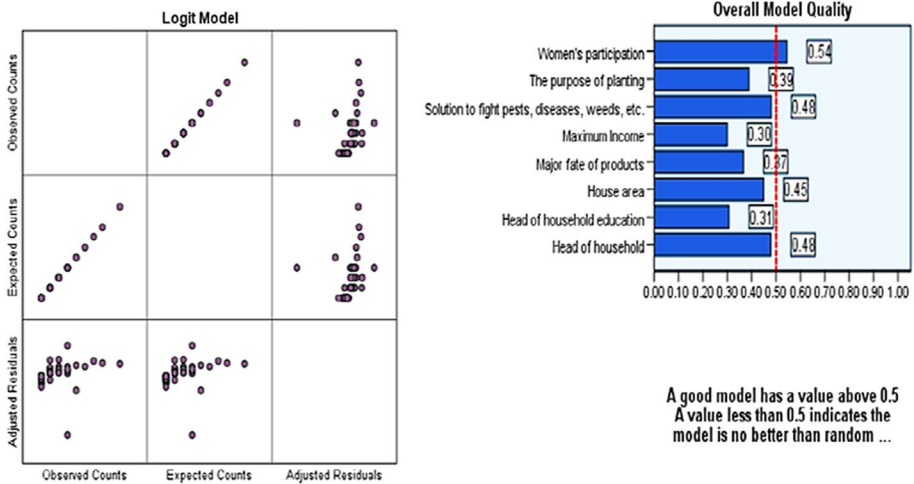


Fig. 6 Expected final logistic regression model to the impact of independent and dependant variables on food security

Table 6 Factors Determining the Status of Households in Deciding on Diversification of Rice Types Using Logistic Regression Model

Variables	Average	Standard deviation	Coefficient of variation	Standard error of the mean	$P > Z = 0.05 $	dy/dx
Gender	0.46	1.70	-0.35	0.04	0.76	-0.07
Age	0.45	1.28	-0.23	0.06	0.02	-0.31**
Education	0.70	2.96	0.41	0.08	0.03	0.06
Agricultural science	0.86	2.10	0.08	0.01	0.002	0.24*
Maximum revenue	0.50	1.49	-0.33	0.05	0.03	-0.21*
Women's participation	1.03	2.26	-0.45	0.10	0.55	-0.09
Farmer experience	0.84	2.99	-0.28	0.08	0.08	-0.05
Solutions to fight pests, diseases, weeds, etc	0.60	2.55	0.23	0.06	0	0.13
Farm area	0.77	1.47	0.52	0.07	0.01	0.20*
House area	0.66	2.58	-0.25	0.06	0.71	-0.14
Farm working hours	0.79	2.96	0.26	0.07	0.03	0.08
Farm life	1.07	2.89	0.37	0.10	0.002	0.12
The purpose of planting	2.00	3.00	-0.66	0.20	0.41	-0.21*
The major fate of products	0.57	2.99	-0.29	0.10	0.09	-0.07
Type of use	0.98	3.42	0.20	0.05	0.005	0.18
Decision on the application of rice biodiversity on the farm	0.46	1.70	-	0.84	2.766	-

$R^2 = 0.73$

Dy/dx = Relationship between independent variables and dependent variables (decision to apply rice biodiversity on the farm)

* = Significance at the 0.05 level

** = Significance of the relationship at the level

5 Conclusion

Considering the variety of rice cultivars and the high level of cultivation of this crop in the studied area, we can conclude that the cultivation of types of rice is a good predictor of food security in the study area. Policies for the use of biodiversity on farms need to be examined as regards the needs of individuals with different socio-economic characteristics. In many ecological ways, a continuous flow of crops is required for an evolutionary process, and the path to achieving the goals of sustainable management, food security, and flexibility must be considered (Rockstrom, 2017; Watson et al., 2019; Martin, 2019; Lourme-Ruiz, 2021).

Further research should focus on the role of crop conservation and prioritize its importance for better food security, especially for disadvantaged and vulnerable groups. The relationship between food security and crop diversity and policy should be focused on raising awareness of crop diversity goals (Fig. 6). In this regard, more research is needed to emphasize the importance of individual and market incentives in the face of environmental and managerial change and asymmetry at different scales (Dentoni, 2017).

Data Availability Statement The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical approval As authors, we would like to tell you that this is our original work, and this paper has not been submitted anywhere except in this journal.

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