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Plant biodiversity assessment of locally cultivated crops and household food security in Northern Iran

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Abstract

Background Locally cultivated crops play an important role in the food security. The biodiversity of these crops can be important for the livelihood of households in current and future generations. This research aims to study the socio-economic, agronomic, and ecological aspects which contribute to the maintenance of crop diversification and food security in the study area.

Method Based on latitude and topography 10 villages were randomly selected, which was done in a study with 227 household farm managers. Food security was evaluated based on the species richness, and area under cultivation of food groups, and the probit logistic regression model was used for evaluation. Probit regression, also known as probit models, is used when the output or dependent variable of the model is bivariate. In inverse probit models, the standard normal distribution is modeled as a linear combination of predictor variables. In this situation, the application of normal regression methods is not applicable because the distribution occurred in two levels. In this study, it is assumed that the protection of biodiversity of local plants is related to food security, and for this reason, we have used this model.

Results The findings showed that socio-economic status of different households and farms in this coastal area is one of the key factors affecting the biodiversity of locally cultivated crops. Local cultivars, especially those of rice, are resistant to most environmental factors and contribute to family food security. Food security and rice abundance are significantly correlated in all of the research area's communities.

Conclusions To ensure the sustainability, and health of production, and to ensure food security, planting various crops in this study area is recommended. Future research is needed to focus on solutions and technologies rich in diversity tailored to the socio-economic and environmental factors of locally cultivated crops.

Keywords Household livelihood, Agroecology, Sustainability, Self-sufficiency, Local market, Food health

Background

Cultivated plants are one of the most important components in agricultural management systems. Among these, locally grown crops are crucial to preserving family livelihoods and food security. The present and future populations may benefit from a variety of sustainable diets by increasing plant diversity [6]. Moreover locally cultivated crops can contribute to health, social justice, and sustainable economic growth [1, 2, 12, 19, 23]. The wide range of temperature fluctuation in different parts of the country

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and the multiplicity of climatic zones make it possible to cultivate a diverse variety of crops, including cereals, fruits, vegetables, cotton, sugar beets, sugarcane and pistachios (World's largest producer with 40% of the world's output in 2005), nuts, olives, More than 2000 plant species are grown in Iran [4, 40, 41, 47].

Locally cultivated crops in the agroecosystems helped ensure the food security of rural communities [7, 8], sustainable food supply [16], sustainable use as well as adaptation of local varieties to different environmental conditions [9–12].

Although plant biodiversity and food security are directly associated, according to some studies [11, 30, 31, 60]. Meanwhile some others reported little or no correlation. Studies on agronomy, the environment, economics, society, and institutions, as well as factors affecting crop variety, help to explain the relationship between crop diversity and food security at the household level [45]. Iran has been regarded as one of the centers of origin for agricultural plant biodiversity, and domestication of many contemporary crops (such as cereals and pulses) occurred in this part of the world [17, 18]. Diversity of agricultural plants in iran is important because every living species has a valuable role in the food chains and crop diversification reduces the negative impacts of agricultural production on environment [24, 26, 44]. Also, it has been stated that the more use of croplands for food purposes affects biodiversity through. Although many studies have been conducted in Iran related to agricultural biodiversity [27, 33–35]. Despite Iran's long history of crop production and the past contribution of its farming societies to world food production, little has been done to fully recognize the past achievements, present status, and the future prospect of crop production in the country based on this rich biological diversity [36, 38, 39]. However, the present study is different from the existing studies (crop diversity, food security and the relationship between the two). Therefore, he tried to introduce effects from different settings. Therefore, the dominant studies that show there is also an impact on biodiversity and food security. Overall, to understand the magnitude of impacts and inform adaptation strategies and policy development efforts. In addition, this study presents challenges and future feeding options in agrodiversity conservation scenarios, explaining this relationship and actions that other studies did not [40, 44–48, 51, 53], but few studies have been conducted regarding food security [57]

Materials and methods

Study area

Badar Anzali (Fig. 1) is located among latitudes 37°27′45.3″ N and longitudes 49°29′01.0″ E. The average annual rainfall is 892 mm, while the range of the yearly relative humidity is 71 to 97%. There is a temperature swing of 3.5 to 28 degrees Celsius. Local agriculture predominates in the region and is essential to ensuring households have access to food. In the past, most of the people of Anzali were fishermen. Rice farming and agriculture are other traditional professions of Anzali port, which are still common in the villages of Anzali city. Today, the people of this city are mostly employed in administrative, government and freelance jobs. Agriculture is a dominant sector in Bandar Anzali, which is cultivated every year with various varieties of rice, and the rest of the land is dedicated to the cultivation of crops including watermelon, cucumber, legumes, rapeseed and garden products such as citrus fruits, plums and kiwi.

Data collection

As a result, it can be said that the translated version of survey tools is an acceptable scale for use in research. The research in this article is based on the primary data collected from 10 villages (Table 1) in the period from 2018 to 2020. It mainly draws on data from a survey conducted in 227 households; however, some insights from focus group discussions and in-depth interviews are discussed. The household survey covered following themes: home garden characteristics, including a list of all the plant species; housing characteristics; respondents' perceptions of home garden dynamics, and well-being meanings; socioeconomic characteristics of the household members; food consumption; and support received in the household from development actors.

Following a proportionate stratified random sampling strategy, households were chosen. This method made it easier to choose homes that were equally spread geographically. To ensure that each part had a comparable number of households, maps of each study location were split into 10 villages. The sampling variables used were diversity measurements of home gardens from previous studies, and the sample size was calculated for a confidence level of 95% and 99%. The diversity of native plant species in the field was measured according to the proportion of farmer households that cultivate these crops and the area of the field dedicated to these crops, and species richness. Based on the number of species and the area that is grown, food security was assessed. Key socioeconomic factors of families were correlated with the proportion of land set aside for native goods. Information gathering tools include the use of library studies (searching documents and articles) and field studies (observation, interview and questionnaire). The results showed that the instrument has good internal consistency and Cronbach's alpha coefficients in its subscales are between 89.8 and 96.5. Also, to determine the factor validity of the instrument, confirmatory factor analysis was used, and

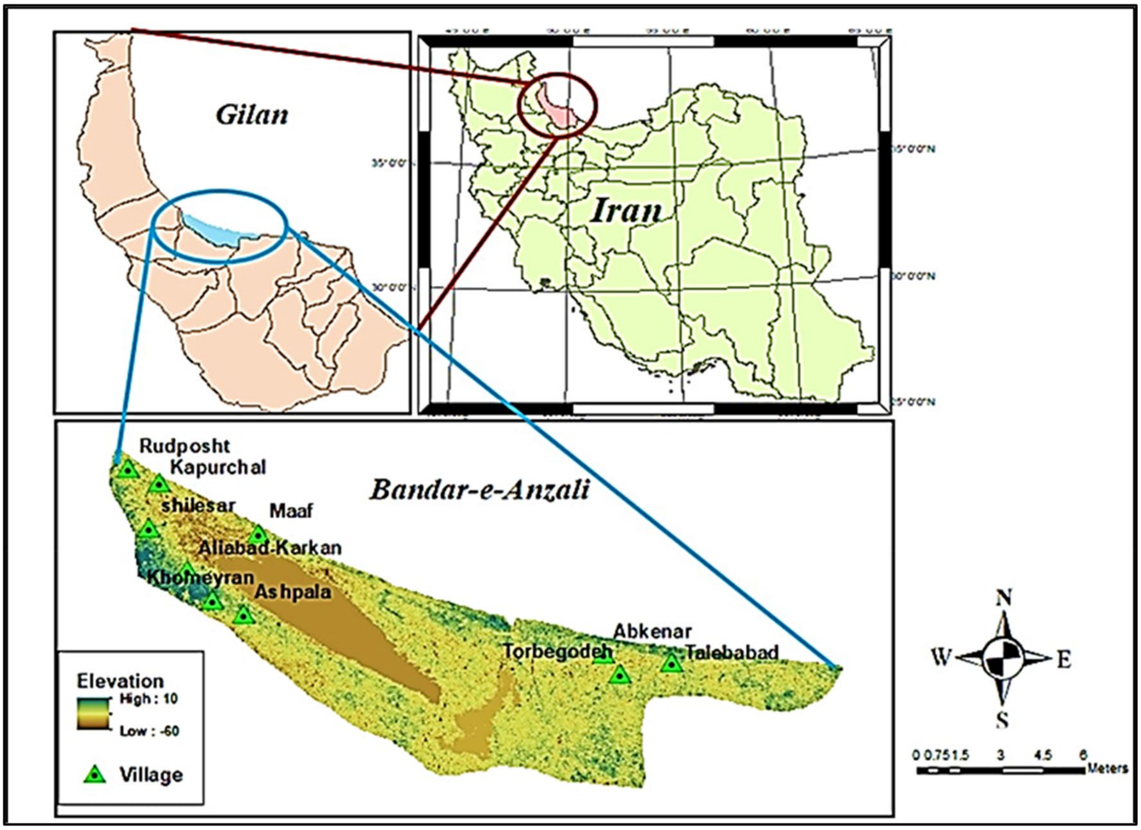

Fig. 1 Map of study area

Table 1 Statistical data of the villages of the studied area

Village	Longitude	Latitude	Altitude (m.asl.)	Sampling unit
Torbegode	49°32′03.0″E	37°26′58.9″N	− 27	17
Talebabad	49°34′05.1″E	37°27′20.8″N	− 22	30
Rudposht	49°12′36.6″E	37°33′27.1″N	− 16	22
Khomeyran	49°15′57.8″E	37°29′14.5″N	− 17	21
Shilesar	49°13′23.5″E	37°31′31.4″N	− 15	24
Maaf	49°16′40.2″E	37°24′23.9″N	− 14	20
Ashpala	49°17′11.0″E	37°28′39.9″N	− 19	22
Abkenar	49°19′04.3″E	37°28′04.1 ″N	− 21	22
Aliabad-karkan	49°14′56.2″E	37°30′10.9″N	− 18	24
Kapurchal	49°13′46.2″E	37°33′11.1″N	− 20	25
Total				227

the results showed that the structure of the questionnaire has an acceptable fit with the data. All goodness of fit indices confirm the model.

Analysis

There are various regression tools, and techniques to analyze the effect of different variables on the maintenance of different agricultural species. Microsoft Excel software was used for descriptive statistical analysis of socio-economic sciences (SPSS26), and STATA (10) was used for statistical analysis of other purposes. Hence, for the socio-economic study of households and institutional factors affecting the conservation of native plant species of the farm, the index of diversity in the farm-like area

Table 2 Socio-economic information in the studied places in the years 2018–2020 with 227 household

Social variables	Torbegode	Talebabad	Rudposht	Shilesar	Khomeyran	Maaf	Ashpala	Aliabad-karkan	Abkenar	Kapurchal	Average
Number of farms	12	55	10	5	37	14	26	28	12	28	23
Age	47.5	48.5	52.7	53	55	65	54.9	45.3	58.5	47.18	52.7
Farm area (h)	5	5.5	4	2.2	6.5	4	5.05	2.4	9.5	4.09	4.8
Household number	4	3.2	4.12	3.6	3.4	3.6	4.2	4.1	3.6	3.36	7
Farmers (%)	62	41	41	61	35	47	45	37	45	51	46.5
Femal participation (%)	57.5	55	31.8	77	64.5	36.5	50	55.5	48.12	27.27	50.3
Participation of women (%)	50	60	0	60	70	0	40	44	25	0	35
Income (%)	37.5	40	50	72	46	51	62.5	48	75	54.5	53.6

ratio and the allocation of the farm to specific crops over some time are used. The probit logistic regression model is suitable when the data are continuous and measures the level of production of plant species by households and diversity in the field. All observations are used for estimation [8].

$$D_i^* = \beta\prime X + \varepsilon_i$$

If D_i^* is less than or equal to zero, then D_i becomes zero. If $D_i^*$is greater than zero, D_i is equal to D_i^*. Where D_i^* is a variable omitted from the dependent variable, the share of indigenous species cultivation in that region is expressed, which depends on the different variables of analysis. β' is a vector parameter that should be estimated. X is the explanatory vector that includes socio-economic variables. ε is the term of measurement error. Socio-economic dimensions include the age of the head of household, the education of the head of household, the percentage of female participation, the percentage of the female head of the household, the purpose of planting, type of consumption, education, and role of educated and trained people as farm management. Economic indicators include the distance from the village to the nearest sales center (km), access to local markets (km), income from agriculture and off-farm, type of sales, and type of land. Agricultural ecology variables are using inputs and strategies to control pests, diseases, weeds, etc. The dependent variable used in this study is the proportion of areas that are assigned to each of the categories that provide food security, such as grains (rice), fruits, etc. The independent variables include socioeconomic and ecological factors. Species richness index and area under cultivation of agricultural species determine agricultural biodiversity. Ecological variables, which are the rate of using chemical inputs, are considered the dimensions of food security health. The adequacy of crop production and market access are other components of food security.

Results

Socio-economic characteristics

Based on socioeconomic information in the studied areas, the following results were obtained (Table 2).

The age of the head of household is negatively related to the planting of grains, fruits, and protein grains. The cultivation of rice and fruits is positively correlated with the household head's education, but the cultivation of vegetables and protein-rich grains is negatively correlated. In other words, in this city, the higher the education of people, the greater the tendency to plant grains and fruits (Table 3).

As the percentage of women's participation in Anzali port farms increases, the tendency to plant protein grains and fruits increases, and the tendency to plant grains and vegetables decreases the percentage of women's participation in planting vegetables is significant at the level of five percent. Planting rice in this city is negatively correlated with women's involvement in farm management, while planting vegetables is positively correlated with women's involvement in farm management at the one percent level and planting protein grains is positively correlated with women's involvement in farm management at the 0.05 percent level. People who earn most of their income from agriculture and agriculture, have a positive relationship to the planting of protein grains, a positive and significant relationship to the planting of rice at the level of 0.01, and they have a negative relationship with planting fruits and a negative and significant relationship with planting vegetables at the level of one percent.

Pest and disease management may be broken down into three ecological and non-toxic categories, Integrated Pest Management (IPM), which utilizes both natural and synthetic chemical inputs, and the use of chemical inputs and toxins. Planting fruits, grains, and vegetables all have a favorable and significant link with pest, disease, and weed management techniques, however, planting protein grains and vegetables has a positive and significant relationship at the level of 0.01 percent. They have a negative relationship with protein grain planting and a negative and significant relationship with vegetable planting at the level of one percent.

One of the economic elements in Bandar Anzali is the distance between the various settlements and the market for the sale of agricultural products. This distance has a positive association with grain planting, a negative relationship with protein grain planting, but a positive relationship with fruit planting. Vegetable planting is negatively correlated with this factor at a level of 0.05 and one percent. The purpose of planting crops was divided into different groups for personal consumption, use of landscapes, interests, beliefs of farm management, seed preparation, and other uses, such as souvenirs, research, education, and a combination of the them. Rice planting has a negative and significant relationship which has a positive and significant relationship with vegetable planting at the level of one percent. They have a negative relationship with fruit planting and a positive relationship with oilseed planting at the level of five percent.

Crop consumption was broken down into the categories of fresh food, a mixture of them, wood consumption, drying, freezing, and canning. growing protein grains at a level of 0.01 is advantageous, while growing vegetables at a level of 1% is advantageous and substantial.

Biodiversity indices of local crops

Species richness is an indicator of crop diversity. The highest share of crops belongs to rice with about 70%

Table 3 Average percentage of area covered by cultivated crops in each village of the study area

Food group	Product names	Torbegode	Talebabad	Rudposht	Shilesar	Khomeyran	Maaf	Ashpala	Aliabad-karkan	Abkenar	Kapurchal	average	Share of each region %*
Starchy Cereal	Rice	3.75	2.17	2.07	1.70	1.67	2.20	1.64	1.64	5	1.40	3.26	67
Starchy Tuber	Tomato	0	0.18	0	0	0.13	0	0.30	0.10	0	0.05	0.08	1.6
Vegetable	Cucumber	0.35	0.20	0	0	0.21	0	0.26	0.10	0	0.05	0.12	2.5
	Squash	0.16	0.18	0	0	0.23	0	0	0.10	0	0	0.07	1.45
	Garlic	0	0.15	0	0	0	0	0	0	0	0	0.02	0.41
	Radish	0	0.10	0	0	0	0	0	0	0	0	0.01	0.2
	Pepper	0	0.15	0	0	0.05	0	0.27	0	0	0	0.05	1.1
	Eggplant	0	0.10	0	0	0.08	0	0.53	0.10	0	0	0.08	1.6
	Become	0	0.10	0	0	0	0	0	0	0	0	0.01	0.2
	Onion	0	0.15	0	0	0	0	0	0	0	0	0.02	0.41
	Potato	0	0.17	0	0	0.25	0	0	0	0	0	0.04	0.83
	Persian shalot	0	0.18	0	0	0	0	0	0	0	0	0.2	4.16
	Coriander	0.17	0.50	0	0	0.44	1.38	1.33	0.10	0.40	0.15	0.45	9.4
Fruit	Watermelon	0	0	0.75	0	0	0	0	0	0	0	0.07	1.46
	Kiwi	0	0	0	0	0.1	0	0	0	0	0	0.01	0.20
	Plum	0	0	0	0	0	1	0	0	0	0	0.1	2.08
	Melon	0.35	0	0	0	0.30	0	0.10	0.10	0.30	0.16	0.13	2
Legume (protein grain)	Beans	0	0.20	0	0	0	0	0	0	0	0	0.02	0.4
	Faba	0	0.15	0	0	0.28	0	0	0.10	0.30	0.28	0.11	2.3
Nuts	Sunflower	0	0.17	0	0	0.10	0	0	0	0	0	0.03	0.6
	Peanut	0	0	0	0	2	0	0	0	2	0	0.4	8.3
wood	Alder	0	0	1	0	0.10	0	0	0	0	0	0.11	2.3
	Poplar	0	0	0	0	0	0.57	0	0	1.50	2	0.4	8.03
	Area (h)	5	5.5	4	2.2	6.5	4	5.05	2.4	9.5	4.09	4.8	100
	Species (no.) number of species in the village	5	16	2	1	13	3	7	8	5	7	–	–

*The share of the region includes the percentage of the share of the specific crop about the total crop of the region by the farmers of the region under cultivation of the cultivated area and the lowest share belongs to parsley, coriander, and parsley with 0.3% of the cultivated area (Table 3). Respondents and research indicate that native cultivars, especially those of rice, are resistant to most environmental factors. The variety of rice cultivars planted in the Anzali port fields, which accounts for 70% of the total farmed area, helps to ensure the food security of the local coastal population. Rice is cultivated in all studied villages, which indicates the suitable climatic conditions of this region for rice growth. After rice, watermelon is cultivated with a difference from rice (10% of the total crop).

The diversity of locally cultivated plants, such as rice, melons, cucumbers, beans, tomatoes, and watermelons was preserved in most of villages. The area of each cultivation was checked in detail and the last line of the table shows the total area of cultivation (Table 3).

In Khomeyran village, the greatest diversity of species is seen, but each of its indigenous agricultural species is planted in a small area. In general, rice has the largest average cultivation area in the villages under study, at 23.2 hectares, and oranges, parsley, coriander, and dill have the lowest, at 0.1 hectares. The level of species richness is relatively high, with species richness in Talebabad (16 species) being the highest (Table 3).

Food security status

The analysis of average food security and the level of cultivation of crop species and its relationship with the diversity of its species in the fields is considered (Fig. 2).

The villages of Talebabad, Khomeyran, and Aliabad-Karkan have the highest species richness, whereas Rudposht and Shileh Sar have the lowest. Species diversity and intensive farming of several food categories are indicators of food security. In Talebabad, Rudpasht, Khomeyran, and Aliabad-Karkan, the average of all food groups such as cereals(rice), fruits, vegetables, legumes, etc. are high, and they have high food security compared to other villages (Fig. 2). In other words, the average cultivation level of crop species is the highest in RudPosht, Shileh Sar, and Abkenar rivers, respectively, and the lowest in Talibabad, Khomeyran, Aliabad-Karkan. Finally, we conclude that species richness and area under cultivation are inversely related to each other, and the higher the area under cultivation and farm area, the greater the tendency to single vessel.

Food security in this village is directly correlated with species richness and inversely correlated with area under cultivation, which demonstrates that food security in this village is directly correlated with species richness and is contrary to various food categories as food security. The most important part of food security is its adequacy. Nutritional adequacy in terms of the production

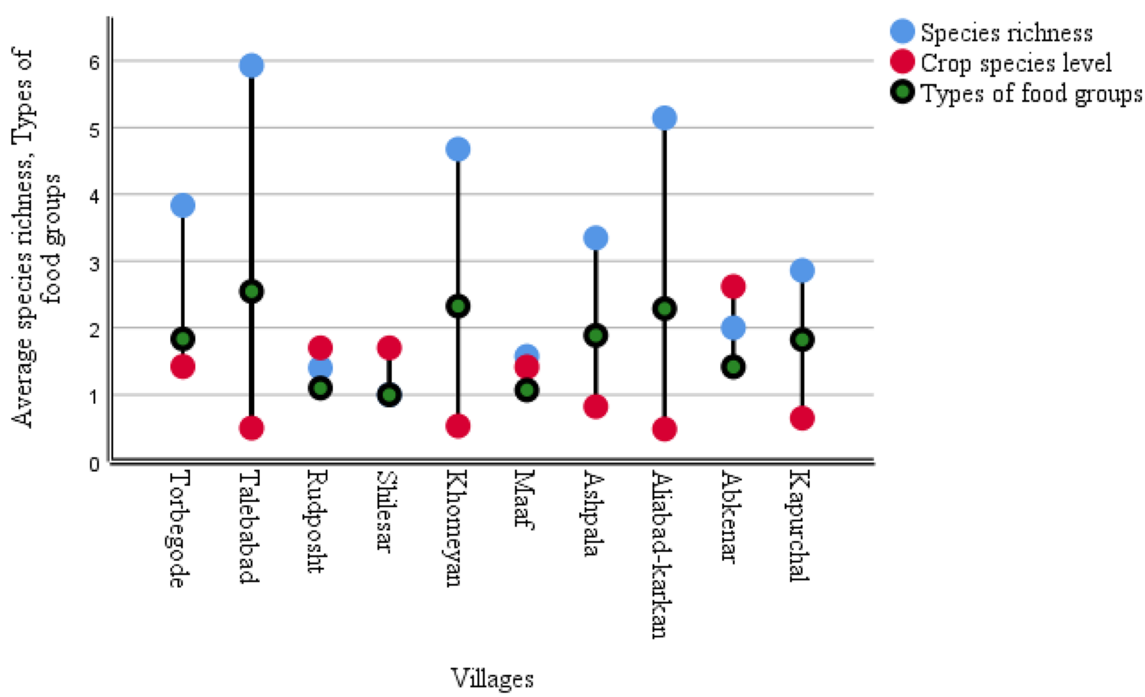

Fig. 2 Species of species richness, level of each crop, and food security in each of the studied villages

of grains, fruits and vegetables, and protein as legumes throughout the field should be assessed over some time, such as 3–5 years. All four food categories are present in the villages of Talebabad, Khomeyran, Aliabad-Karkan, and Kapurchal, with Khomeyran and Talebabad having the greatest levels of food security at 6.5 and 3.5 hectares, respectively, and significant food variety (Fig. 3). Therefore, it is self-sufficient to provide food security and, along with other villages, can provide food security in Bandar Anzali in terms of adequacy and nutrition. Given that they have access to the plants they cultivate year-round, both fresh and freeze-dried, it is apparent that the kind of people's consumption is as follows: after providing the home consumption, the excess is sold. They only provide rice grown in large quantities.

The probit regression model in the relationship between food security and plant biodiversity of indigenous crops

Rice richness in all villages of Bandar Anzali city has a significant relationship with food security. In Torbgodeh, Khomeyran, Aliabad, and Abkenar villages, it is significant at a 5% level, and in other villages, it is significant at a 1% level. In general, the grain level of Bandar Anzali city is significant with about 60% at the level of 0.01. The level of 0.5% is noteworthy in terms of the variety of fruits in the villages of Talebabad, Maaf, Aliabad, and Kapurchal. In Khomeyran, the level of 0.01 is noteworthy and, with a value of roughly 10%, the level of one percent is crucial for ensuring the city's food security. Regarding the species richness of vegetables in the villages of Torbgodeh, Khomeyran, Ashpala, and Aliabad at the level of 0.05 and Talebabad at the level of one percent, food security in this city, is significant. The level of vegetables with an amount of about 40% has a significant relationship at the level of 0.05 with its food security.

In terms of vegetable protein, only Talebabad and Khomeyran in two villages showed a significant link at the level of 0.05, but this amount (10%) in the whole Anzali port region at the level of 0.01 was important in ensuring food security in this area (Table 4).

The area under cultivation of rice, especially rice, is relatively high in the whole city. It has the highest average area under rice in Abkenar and the lowest area under rice. Maaf has the largest average area dedicated to fruit agriculture, whereas Rudpasht and Shileh Sar have the lowest averages. In Shileh Sar and Maaf, as well as Aliabad-Karkan again, the maximum average area under vegetable cultivation is close to nil. The highest average area under cultivation of plant proteins is in Rudposht and the average area under cultivation in the villages of Tarbgoodeh, Shileh Sar, Maaf, and Ashpala is about zero (Fig. 4).

Finally, in the probit regression model, we have analyzed socio-economic factors affecting the diversity of Indigenous species (Table 5).

Discussion

Socio-economic characteristics

The findings showed that the socioeconomic status of different households is one of the key factors affecting farmers' decisions to cultivate various crops (Table 2). In a similar review, in 2018, Whitney conducted a similar study on the effect of home gardener crop diversity

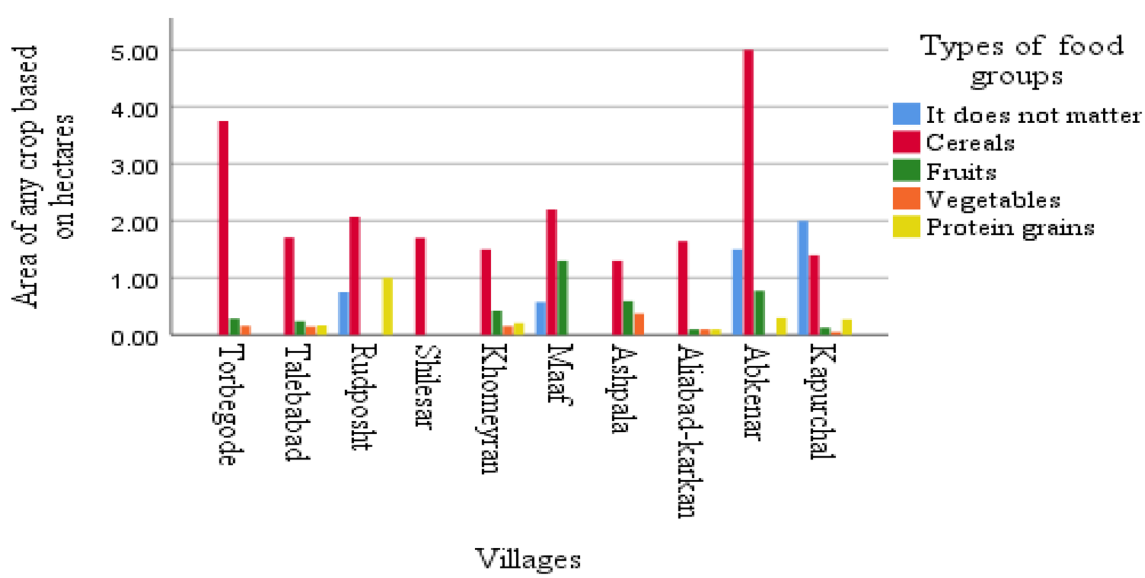

Fig. 3 Relationship between the area under cultivation of different food groups in providing food security

Table 4 Comparison of the average relationship between food and agrobiodiversity (species richness)

Variety of food groups	Torbegode	Talebabad	Rudposht	Shilesar	Khomeyran	Maaf	Ashpala	Aliabad-karkan	Abkenar	Kapurchal	Total area
Cereals	1.25*	0.35**	1.45**	1.70**	0.28*	0.78*	0.55**	0.41*	2.08*	0.46*	0.60*
Fruits	0.14	0.30*	0	0	0.18**	0.46*	0.15	0.30*	0.25	0.50*	0.11**
Vegetables	0.20*	0.80**	0	0	0.37*	0	0.11*	0.30*	0.25	0.05	0.40**
Legumes	0	0.18*	0.10	0	0.20*	0	0	0.10	0	0.10	0.10**

**Significant relationship at the level of 0.01

*Significant relationship at the level of 0.05

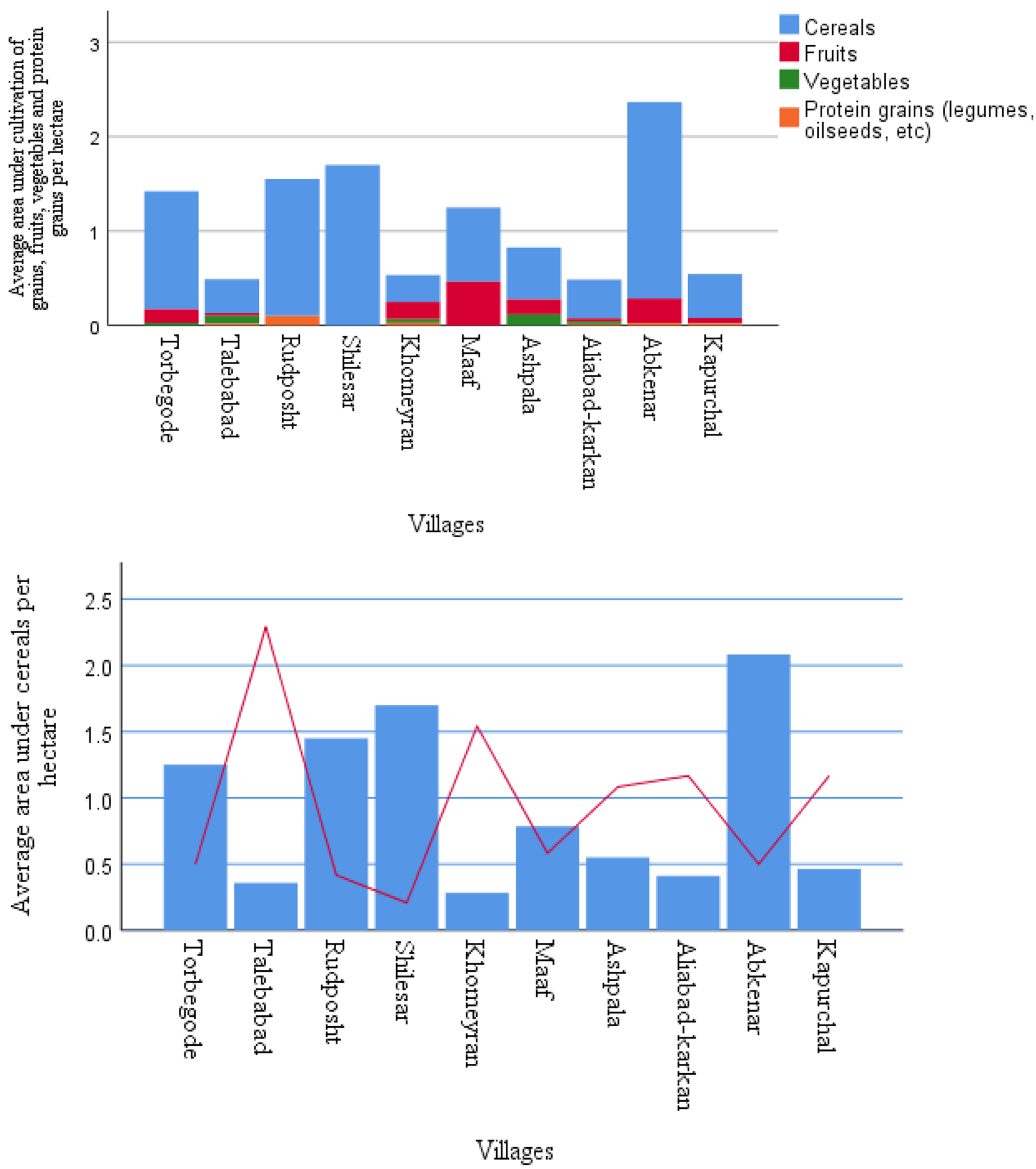

Fig. 4 Histogram diagram The relationship between the level of different food groups in providing food security

and socioeconomic factors on household food security in southwestern Uganda. He concludes that supporting diverse horticultural systems can reduce food insecurity in Uganda to some extent[49]. The variety of crop species is mostly dependent on farm size (Table 3). The bigger field has the potential to have a lot of diversity since it allows for the planting of a range of crops across a broader region on the farm (Fig. 4). Gauchan conducted a study in 2020 to analyze socioeconomic factors on the conservation of crop diversity in Nepal. He concluded that the age of farmers, the size of their families, the size of their farms, the agricultural ecology, and market considerations are the primary determinants determining the variety of crops grown on their farms and food security [28]. Vegetables require seed knowledge and crop management (Table 5). On the other hand, the use of high-yield seeds increased market demand and the adoption of processing methods are likely to have an impact

Table 5 Results of probit regression model and socio-economic factors affecting the diversity of indigenous crop species

Socio-economic characteristics (correlation coefficient)	Cereals	Fruits	Vegetables	protein seeds
Head of household (age)	− 0.09	− 0.04	0.08	− 0.01
Head of household education	0.04	0.04	− 0.03	− 0.08
Women's participation (%)	− 0.12	0.05	0.15*	0.09
Female decision maker and farm manager	− 0.24**	− 0.02	0.19**	0.15*
Most income from agriculture (%)	0.19**	− 0.04	− 0.17**	0.03
The solution to fight pests, diseases, weeds, etc	0.26**	0.097	− 0.35**	− 0.11
Distance from the village to the nearest sales center (km)	0.053	0.147*	− 0.22**	− 0.05
The purpose of planting	− 0.23**	− 0.190	0.20**	0.14*
Type of use	− 0.25**	− 0.048	0.30**	0.09
Number of observations	227	227	227	227
Likelihood ratio [LR chi2 (9) and Prob (> Chi2)]	426.65**	405.8*	259.30**	128.97*

**Significant relationship at the level of 0.01

*Significant relationship at the level of 0.05

on diversity acceptance, according to Jabir's analysis of the variables impacting the variety of vegetable farming [50]. Household size was important in the Plant Biodiversity of these indigenous crops, which are grown in the family farming subdivision (Table 5). Conversely, Zanello (2019) conducted a study on indigenous crop diversity, markets, and food security in Afghanistan. He concluded that the role of household size to increase the production diversity on the farm is not well understood and that improving markets is seen as a way to improve the food diversity of smallholders.

In the case of protein grains and grains, increasing the age of the head of the household has a negative relationship with the diversity of these crops. Rice planting is a delicate and hectic process. It can be done by younger folks. It is sufficient to provide the elderly's expertise at all planting, holding, and harvesting phases. In studies with outcomes equivalent to those of people 44 years old on average, gardening was negatively correlated with aging. Young people thought participating in community gardening projects was a fun way to unwind and relieve stress. The percentage of women participating in planting fruits, vegetables, and protein grains is high and significant in planting vegetables. In the case of rice planting, low participation was observed only in some stages of planting and harvesting in some farms. Men play an important role to manage the rice and fruit fields, transportation, processing, and preparation for consumption. Instead, women are more likely to grow vegetables and protein grains on their farms. Studies examined the role of women and all concluded that the degree of women's influence in family decisions is high [61]. It takes time and money to grow protein grains, thresh them, and transport them everywhere. More work resources are available for this from larger families. The family's children do, however, work in other occupations in addition to agriculture. A study concluded that income from agriculture and non-agriculture of households with farms of various types helps ensure food security, and the livelihood of households. Households are more successful to meet their consumption needs by having a higher level of crop diversity per hectare and by providing food from off-farm income, as other studies have agreed [6]. Providing income from agriculture is enough only for people who have rice fields. Farmers who exclusively produce fruits and vegetables on their fields are unable to provide for their family and must find other means of income. This city also engages in seasonal fishing, livestock husbandry, etc. in addition to agriculture.

For farmers who grow exclusively rice, off-farm revenue has little impact. Rice farmers work off-farm seasonally outside the planting and harvesting season and tend to farm on the farm at the time of planting and harvesting rice. As studies emphasized the provision of household income from non-agriculture [52, 54, 58]. Income from fruits, vegetables, and protein grains is less important to many farm households than rice. Similar research came to the conclusion that improving nutrition knowledge, livelihoods, and income may enhance the variety of high-crop species. Food security for young children in western Kenya is greatly increased by crop diversification, according to research on participatory farms and nutrition education [59]. In another study, the participation of small farms in the production of regional food is closely related to different types of crops, which in turn is formed under the effect of climate, location, and specific traditions of the region. The role of education and knowledge in growing grains and fruits is higher [45]. In all cities, access to education is available, although it is negatively correlated with the age of the home head (Table 5). The elderly do not desire to be educated and are content with their farming expertise in terms of old age and incapacity [2]. The value of education is clear from several research [16, 59], and it has a substantial influence on sustaining the variety of locally cultivated farms together with experience, farmers' innate knowledge, and access to education.

Biodiversity indices of local crops

In similar studies, the species richness was determined by the number of indigenous agronomic species and their cultivation area [9, 10]. They concluded that biodiversity conservation should be done in the center of diversity, which has a high species richness. The highest species richness belonged to rice, while in another study, legumes have the highest species richness [60, 61].

The socioeconomic, environmental, and nutritional aspects of change are all part of the biodiversity knowledge framework. The characteristics of these knowledge areas, together with the connections among them, show how quickly environmental, economic, and social transformations have impacted research, management, and agronomic diversity policies. Plant Biodiversity declines together with the agricultural system's adaptability. Because of the increased flexibility and new marketing possibilities that result, product systems are appropriately shaped. Regarding the production of regional food, small farms within these systems are increasingly significant [13, 23].

Food security

Adequacy level of local crop species

Allocating the area to rice is the preference of all farmers in this city. The allocation of farmland to this crop increases by increasing farmers' income sources (Fig. 4). The rest of the crop is planted for personal consumption only, and the surplus is sold. The purpose of planting and the type of consumption are often reported in sales [11]. The results of a study show that there is a positive relationship between crop diversity and food security (Fig. 5). Agriculture as a substitute for purchasing has a great effect on food security and, consequently, the quality of the diet and self-sufficiency [62]. Despite the fact that there is currently enough food for all food groups, fluctuations are caused by socioeconomic factors affecting crop species diversity, differences in agricultural and environmental systems, distribution systems, the significant role of intermediary purchases, and transportation of these native crop species. Moreover, the people of each area have seen an equal price rise [49]. There were no rental farms found at Anzali port since more than 50% of the paddy fields were passed down from ancestors.

The diversity of indigenous crop species due to the age of the fields, the continuation of each year of cultivation, and resistance to living and non-living stresses of indigenous crop species seem quite logical and reasonable. Among indigenous crops, the diversity of stress-tolerant rice and variable rainfall pattern plays an important role to ensure the food security of coastal households in this region and the whole country [31, 58].

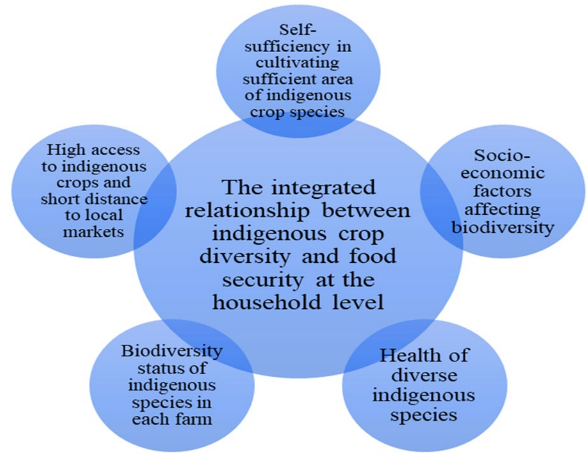

Fig. 5 Factors affecting agrobiodiversity in providing food security

Food health

In the case of rice, they often use chemical inputs. Farmers consider using the chemical inputs necessary because the rice is harvested in several crops. They use less than 5% of Trichoderma mushrooms to fight pests and diseases [7]. In the margins of their paddy fields, most other crops are grown, such as fruits and vegetables, which do not require chemical inputs. More than 90% of pests, diseases, and weeds manage their fields with integrated control (IPM) [50]. According to the findings of one study, organic farming may improve the well-being of subsistence farmers in disadvantaged regions, particularly in terms of profitability and nutritional security. Except for rice, all crops in this city are grown without the use of chemicals, as research indicates that organic and environmentally responsible agricultural practices increase crop health. Make a certification bio that is linked to the location of cultivation in terms of geography [63].

Market access

There is a great demand for indigenous agricultural species in the markets of Anzali port, although most of the agricultural species are sold on the farm in terms of previous knowledge of consumers and people have high access to them. The distance to the market as a factor in access to vegetables was negative and significant, but not significant for protein grains. Because farming families sell more than 80% of their production, and grains locally, their distance from the market is not a detriment to them.

This illustrates why farming homes are situated further from the market. The distance from the market is seen to be a drawback for vegetables and protein grains that need to be prepared and kept for a lengthy time. The studies showed the existence of local markets for greater access and food security [11, 54]. It's important to consider how often you consume perishable produce like fruits and vegetables. Fruit consumption by producers is mostly fresh, as seen by the negative association between type of consumption and fruits. They are less likely to keep fruits for a long time. Because the fruits can be daily sold, farmers tend to grow them in their area, including in their home gardens. As in studies, the tendency of farmers to cultivate crops in orchards with high diversity to have high access to it was concluded [12].

Relationship between plant biodiversity and food security with the probit regression model

Biodiversity Knowledge Framework is essential to address the key challenges, including sustainable development with food security, biodiversity conservation, social justice, climate change, and food pollution. It is important to sharpen the emphasis and analyze complex human-environmental interactions since food and agricultural biodiversity serve as a connection between human-dominated management and agriculture. The relationship between more diverse agricultural systems and household food security is affected by several other variables, such as the household's market orientation, the ownership of livestock or ships, non-agricultural job opportunities, and the availability of land resources [16, 58]. Not only we can succeed by increasing the diversity of Locally Cultivated as a direct result of strategies supported by agricultural ecology, but also by creating social and human capital (e.g., knowledge) in these areas. In Imbabura, the local markets appear to provide socio-economic training workshops for food exchange, food production, and consumption knowledge. They provide women the chance to travel, learn about the environment, and make money.

It's an intriguing integrated method to promote nutrition objectives with corrective agricultural techniques because of the management duties associated with this unique indigenous crop. The relationship between plant biodiversity and food security largely depends on the measurement of environmental diversity indices. For example, in a study on the impact of household food security on crop harvest, the results show that growing agricultural income or increasing crop diversity may not be enough to ensure improved food diversity. The first stage in creating a strategy for the conservation of plant biodiversity, and sustainable usage for the area is the conclusion of research on wild plants that are connected to human food and economic security in the area and worldwide. The likelihood function identifies the analysis's stage. Chi-square indicates that the probability of this stage is lower than the likelihood of the stage before it. The influence of the model's independent variables on the dependent variable's probability ratio increases with the magnitude of this change. Likelihood indicates the suitability of the likelihood logistic model. The likelihood is the probability of observed results based on parameter estimation (regression coefficients of independent variables). The larger the likelihood, the more fit the model. The logistics model fits well as the probability increases. The number 4226.65, which is significant at the level of one percent, is the highest in rice. Following that, fruits (0.05), which is significant, and vegetables (259.3) (1%), which are significant. Finally, it has less likelihood of protein grains which are significant at the level of five percent (Table 4).

Conclusion

This research is to understand how the relationship between Plant Biodiversity, and the factors affecting it in food security (Fig. 5). There is evidence that maintaining crop diversity can help bring about positive livelihood outcomes [11, 64]. Our first result is that agricultural biodiversity is maintained and preserved in part by the socioeconomic characteristics of farmers, including farmers' age and farm size. Second, issues like family size, rent, and financial hardships have made guaranteeing food security for the city's residents less important. But, there is still a lot of research to be done. We thus conclude that increased diversity in locally cultivated crops could contribute significantly towards food security and income generation. Future research should focus on the role of agrobiodiversity conservation and different cropping patterns on food security. There is a need to undertake policy reforms that target household food security and smallholder farmers and create awareness on the significance of agrobiodiversity. We suggest that cultivated diverse and forgotten varieties of indigenous cultivars and environmental factors should be considered in such cases. Second, market factors play an important role to increase the diversity of cultivated species. As the market demand for local cultivares is increasing in terms of its organic perspective in the markets of this city, the development of the market in the coastal areas and the lack of sales which it should be considered.

The ability of farmers to make their own decisions based on close monitoring of system performance is crucial to ensure system stability. Finally, regarding the prevalence of (Covid-19) disease, the need for sustainable food security and health is strongly seen [16, 45]. Plant biodiversity in the direction of ecological agriculture can achieve these goals.

Currently, while creating a range of biological farms that extend to the level of the landscape, community, and biological area, it is vital to take into account the distinctiveness of each site and its population, as well as other indigenous agricultural species. Food systems ecology will lead to the development of broader interdisciplinary research teams and attractive courses based on diverse agricultural systems for the best prospects. This definition helps us raise higher-level research questions whose solutions are aimed at developing a sustainable agricultural and food system. This study's findings show the effectiveness of programs aimed at improving rural livelihoods via the transfer of more knowledge and the use of Indigenous plant biodiversity. The potential of biodiversity to enhance the well-being of rural people has to be monitored and assessed further [20]. Future studies should concentrate on sophisticated solutions and technologies that are compatible with the variety of domesticated species and the institutional, socioeconomic, and agronomic configurations of farms. These goals are essential to increase the food security and home management of coastal crop biodiversity.

Limitations of the study

- The sample related to fields of study was obtained from only one city in the northern cities of Iran; Therefore, the results may not be generalizable to the entire population.
- There are many variables in food security that are beyond the researcher's control and can affect the completion of results.

These factors might be things like unpredictable price variations during the study or a lack of research on sources of animal and cattle proteins that could help to widen the conclusions of experts.This research was conducted cross-sectionally, for this reason, it makes it difficult to draw conclusions about causality.

- This information is somewhat different and heterogeneous in terms of different perceptions of the cost in the villages and the low level of literacy of the people regarding the goals and subject of the research.

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Consent for publication
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