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Understanding Farmers' Perceptions and Adaptations to Precipitation and Temperature Variability: Evidence from Northern Iran

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Abstract: Precipitation and temperature variability present significant agricultural risks worldwide. Northern Iran's agriculture mainly depends on paddy fields, which are directly affected by precipitation and temperature variability. The main aim of this study is to explore farmers' attitudes towards precipitation and temperature variability and their adaptation strategies in paddy fields in a typical agricultural province in northern Iran. Primary survey data were collected from a sample of 382 paddy farmers of Rasht County in Guilan Province. Data have been analyzed using both summary statistics and bivariate analysis (Pearson, Spearman, and Eta correlation coefficients). Empirical findings reveal that most paddy farmers had experienced precipitation and temperature variability and were taking measures to reduce its negative impacts on their crops. Results also indicate that farm size and household income influence farmers' perception to precipitation and temperature variability, while availability of water resources also influence farmers' adaptation decisions.

Keywords: adaptation strategies; precipitation and temperature variability; Iran; paddy fields

1. Introduction

Agriculture plays an important role in the global gross domestic product (GDP) and provides employment for 1.3 billion people (i.e., 22% of the world's population). In many developing countries, increasing agricultural production has been one of the most important priorities for agricultural development programs [1]. Agriculture is the most important economic sectors in Iran and is highly dependent on climate. The impact of global climatic change on agriculture, and especially precipitation and temperature variability (PTV), has recently become an issue of increasing importance. Drought, lower precipitation and higher temperatures are the most costly natural disasters in Iran. Iran has experienced 27 drought occurrences in the past 40 years [2,3]. While some aspects of climate change, such as increased precipitation, may bring localized benefits, there will also be a range of adverse impacts including reduced water availability, more frequent extreme weather events, and lower productivity of some crops, resulting in the reduction of farmers' income [4,5]. PTV will be followed by economic shocks on prices, supply, demand, trade, comparative advantages, and consumers' and producers' welfare [6]. Hence, farmers need to apprehend the impact of PTV and the scope of adaptation strategies in paddy fields.

According to Udmale et al. [7], many of the environmental impacts, such as increases in average atmospheric temperature, were perceived by most farmers, and these perceptions are formed and reinforced through both everyday experiences and various outside sources. A better understanding of farmers' perceptions on PTV, their ongoing adaptation measures, and other related factors is important for informing policies that are aimed at promoting successful adaptations in the agricultural sector [8,9]. Farm practices are modified in response to various external triggers such as new market opportunities or failures, and also in response to PTV [10].

Adaptation is one policy option for alleviating the negative impacts of PTV at the farm level. Economic constraints and barriers to adaptation such as social acceptance, workload, biodiversity, and many others limit farmers' adaptation. These actions include strategies such as alterations in crop management (e.g., planting dates or crop varieties), land use, and land management (e.g., fallowing, irrigation and water harvesting, soil and water conservation measures, or tillage practices) and livelihood strategies (e.g., change in the mix of crops or livestock produced, combination of farm and nonfarm activities, or temporary or permanent migration) [9,11,12]. One important issue in agricultural adaptation to PTV is the manner in which farmers update their expectations of the future climate in response to unusual weather patterns [13]. Another important issue related to adaptation in agriculture is how perceptions of PTV are translated into agricultural decisions. If farmers learn gradually about the change in precipitation and temperature, they will also learn gradually about the best techniques and adaptation options available. Farmers learn about the best adaptation options in three ways: (1) learning by doing; (2) learning by copying; and (3) learning from instruction [14]. Adaptation to PTV refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities [15].

Supplying more than 70% of human caloric intake in some countries and over 30% in Asia, rice (*Oryzasativa*) is one of the most important agricultural crops in the world. Iran together with India, Pakistan, Korea, China, Taiwan, and Thailand are some of the main rice-producing countries in Asia. In Iran, it is typically consumed at least once a day as part of the main meal and is the second main source of calories after wheat. The highest concentration of rice production in Iran is in the three northern provinces of Guilan, Mazandaran, and Golestan. Guilan province is the main rice-growing area in Iran and is one of the provinces that have attracted much attention regarding its agricultural products, especially rice [16,17]. Annually importing 1.7 Mt rice, Iran is the second largest rice importer after the Philippines. Therefore, efforts are immediately required to increase rice production [18]. Rice cultivation in Guilan—due to its higher water requirements, compared to other cereals—has been severely affected by PTV in recent years.

Guilan province is highly exposed to natural disasters as well as the potential impact of PTV. Climatic factors such as PTV could affect the paddy fields and are a major challenge to agricultural development. Although Guilan farmers have a low capacity to adapt to such changes, they have survived and adapted in various ways over time. A better understanding of how they have coped and how they perceive PTVis essential in creating incentives to enhance farm-level adaptation. The goal of PTV perception and adaptation strategies is to enhance communities' resilience towards various changes in their natural environment. Resilience is the capacity to maintain competent functioning in the face of major life stressors. A better understanding of farmers' ongoing adaptation measures and their perception toward PTV could not only improve policies and management decisions, but also increase the farm households' ability to adapt [9–19].

Reliable statistics indicate that Guilan province will face severe water shortage and drought in the future, and these problems, more than anything, will affect rice production [20]. In recent years, a number of studies have been conducted to assess farmers' attitudes, perception, and adaptation strategies to PTV. However, due to different study areas, results vary. Table 1 summarizes some related studies conducted over the past 10 years and their main results proposed by researchers such as Abid et al. [21], Jianjun et al. [9], Yu et al. [22], Smithet al. [23], Rogé et al. [24], Arbuckle Jr. et al. [25], Amdu et al. [26], Nizam [27], Nastis et al. [28], Sofoluwe et al. [29], Smith and Olesen [12], Tologbonse et al. [30], Deressa et al. [14], and Hassan and Nhemachena [31].

Table 1. Overview of integrated studies.

Author(s)	Year	Main Goal	Main Results
Abid et al.	2015	How farmers perceive climate change and how they adapt their farming in response to perceived changes in climate	Awareness of climate change is widespread throughout the area, and farm households make adjustments to adapt their agriculture in response to climate change
Jianjun et al.	2015	Examined the effects of farmers' risk preferences on climate change adaptation strategies in China	The level of education, farming experience, farm size, household income, and perception of climate change impacts influence farmers' adaptation decisions
Yuet al.	2014	How smallholder farmers perceive climate change and adapt their agricultural activities	Increased annual average temperature and decreased annual precipitation were correctly perceived by farmers, these perceptions enabled local farmers to make appropriate adaptations to cope with climate change
Smith et al.	2014	Perform comparative research regarding the climate change assumptions, risk perceptions, policy preferences, observations, and knowledge among rural Nevada's tribes and tribal environmental leaders, non-native ranchers and farmers, and America's general public	The majority of respondents believe that human activity is playing a significant role in climate change and is inevitable
Rogé et al.	2014	Describing an interdisciplinary methodology for helping small farmers prepare for climatic variability	Highlighted the depth of farmers' knowledge for dealing with climate change and were more interested in stabilizing fluctuations in yields over time rather than maximizing yield potential
Arbuckle Jr. et al.	2013	Examining the adaptation and mitigation actions, and how beliefs and concerns about climate change influence those actions	Farmers who were concerned about the impacts of climate change on agriculture and attributed it to human activities had more positive attitudes toward both adaptive and mitigation management strategies
Amdu et al.	2013	Examining the perception of farmers towards climate change, assessed local impacts of climate change on the agricultural sector, identified local innovations for climate change adaptation, and assessed the barriers and determinants of climate change adaptation options at the farm level	The perception of most farmers on temperature rise was in harmony with the trend analysis of temperature records, but there was a clear contradiction between the perception of the majority of farmers on precipitation volume and the trend analysis of the precipitation records
Nizam	2013	Identifying temporal precipitation and temperature variability in Anuradhapura district from 1941 to 2010 and determine farmers' perception to climate change	Farmers have already identified that climate is changing and they knew how to face these changes but they need more awareness about how to adapt to climate change
Nastis et al.	2012	Analyzing the economic costs of climate change in Greek agricultural productivity during the last 30 years and adaptation strategies	The adaptation to climate change involves both the restructuring of crops as well as changes in cultivation practices
Sofoluwe et al.	2011	Investigating the perception of farmers to climatic variable changes, adaptation methods adopted, and factors influencing the choice of adaptation methods	Most of the farmers were aware of the increase in temperature and decline in precipitation. Majority of them perceived a decline in the level of precipitation
Smith & Olesen	2010	Adaptation to climate change in agriculture	More options for adaptation to climate change have a positive impact on mitigation strategy
Tologbonse et al.	2010	Determine the farmers' perception of the effects of climate change and coping strategies in three agro-ecological zones of Nigeria	Farmers are fully aware of the effect of climate change, and planting of drought-resistant crops or varieties was the selected strategy
Deressa et al.	2009	Identifying the major methods used by farmers to adapt to climate change in the Nile Basin of Ethiopia, the factors that affect their choice of method, and the barriers to adaptation	The methods identified include use of different crop varieties, tree planting, soil conservation, early and late planting, and irrigation. The main barriers include lack of information on adaptation methods and financial constraints
Hassan & Nhemachena	2008	Analyzing determinants of farm-level climate adaptation measures in Africa	Specialized crop cultivation (mono-cropping) is the agricultural practice most vulnerable to climate change in Africa

The main aim of this study was to identify the paddy farmers' understanding of precipitation and temperature changes, how it impacts their farming, and their coping and adaptation strategies in Rasht County of Guilan province. In particular, this study was designed to meet the following objectives: (1) to describe the sociodemographic characteristics of paddy farmers; (2) to characterize their perception of precipitation and temperature changes; (3) to identify adaptation measures for precipitation and temperature changes; and (4) to determine the relationship between farmers' perception of precipitation and temperature changes and their sociodemographic characteristics. The next section provides a background of the case study area followed by a brief presentation of applied methodology, while data collection information is also outlined. Afterwards, summary statistics and a brief discussion of the findings are presented, ensued by the results of the bivariate analysis. Finally, the paper concludes. Below, Figure 1 briefly presents the general methodological framework of data collection, statistical analysis, and obtained results.

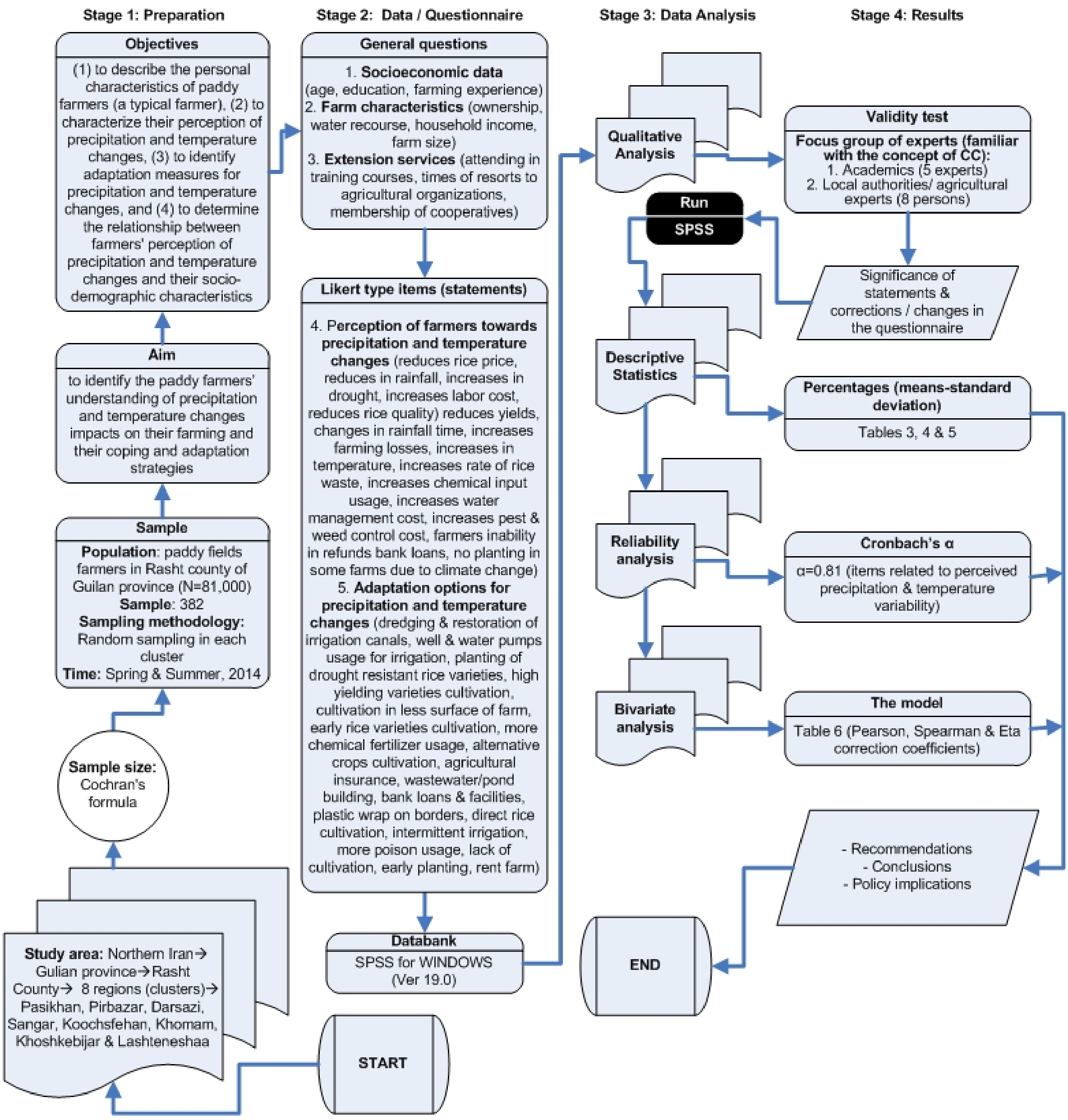

Figure 1. Methodological framework.

2. Employed Methodology

2.1. Study Area

The study area was Rasht County in Guilan province. This province was selected for its high percentage of rice cultivation. The province of Guilan, in the northern part of Iran, covers an area of 14,711 km^2 and has a population of 2,403,716. It has approximately 400,000 ha of agricultural land, 60% of which is allocated to rice cultivation. Guilan province has 230,000 ha of paddy fields with an annual production of 700,000 tons of white rice. This amounts to 30% of Iran's rice production. Guilan province is characterized by a temperate climate, adequate water supplies, and fertile soil with good texture and structure, making it a highly suitable area for rice cultivation. The capital of Guilan is Rasht County (Figure 2).

Rasht County is characterized by an average annual precipitation of 1500 mm and monthly average temperatures of 15.8 °C as well as 81% annual relative moisture. Because of its vast available lands and soil fertility, this county has been reputed to be one of the most suitable areas for rice cultivation during the past decades [32].

Figure 2. Location of Rasht County.

Monthly average precipitation, temperature, and daytime in Rasht County are shown in Table 2, while the annual mean precipitation and the annual mean temperature in Rasht County for2007–2014are shown in Figures 3 and 4, respectively. According to the World Meteorological Organization [33], during 2007–2014, the study area received annual precipitation ranging from 1824.8 mm in 2011 to 1178.6 mm in 2014, and annual temperature ranging from 14.2 °C in 2007 and 2008 to 15.4 °C in 2014.

Figure 3. Annual precipitation (mm) in Rasht County.

Figure 4. Annual temperature (°C) in Rasht County.

Table 2. Monthly weather average (2014).

Average Values	Annual	January	February	March	April	May	June	July	August	September	October	November	December
Temperature (°C)	15	5.5	5.5	8.9	12.8	18.9	21.7	23.9	23.9	20.6	16.7	12.8	7.8
Precipitation (mm)	1178.6 *	91.5	91.5	104.1	55.9	38.1	25.4	17.9	58.4	193	228.6	170.2	109.2
Daytime (h)	12.6	10.4	11.3	12.4	13.6	14.7	15.2	14.9	14	12.8	11.7	10.6	10.1

* Total precipitation in 2014, Source: [34].

Evidence that climate is changing—particularly that precipitation is reducing—in the study area is that precipitation input to Sefid-Roud dam in the autumn season has reduced in recent years. In the past 50 years, the highest amount was 1531 (million m^3) in 1995. In 2011 this amount reduced significantly to 116 (million m^3) and in the past years' autumn (2015), precipitation input to Sefid-Rouddam was 165 (million m^3) (Guilan Regional Water Authority). Sefid-Roud basin, which drains an area of approximately 56,700 square kilometers, is known as one of the most important basins that provide water for nine provinces of Iran and is the primary water source for many provinces, especially for Guilan province [35]. Thus, this reduction can have harmful effects on regional cultivation and creates an essential need to manage PTV impacts.

2.2. Data Collection

The research design of the study was a descriptive survey. The target population of this study was the paddy fields farmers in Rasht county of Guilan province (N = 81,000). First, Cochran's formula [36] was employed to determine the sample size, and then 382 farmers were selected (during spring and summer, 2014) to answer a questionnaire using the typical cluster sampling method. There were eight regions in Rasht County (namely Pasikhan, Pirbazar, Darsazi, Sangar, Koochsfehan, Khomam, Khoshkebijar, and Lashtenesha). Each region was considered as a cluster, and the population was divided into eight groups or clusters. Sampling in each cluster was done using random sampling. The instrument used in this study was a questionnaire (Appendix A) whose validity was confirmed by a panel of experts from university faculty members and agricultural experts of Guilan province, familiar with climate change [37]. Based on the proposed methodology [37], each expert gave his/her point of view about the validity of each statement and proposed some corrections or recasting of a few statements. On the basis of their views, some statements were deleted, some others were rephrased, and very few new ones were proposed.

The representativeness of the sample has been tested using mainly descriptive statistics. In particular, whether a number of statistics that are descriptive of a distribution are the same in the research sample and the population has been checked [38]. More specifically, tests have been conducted for: (a) mean difference; (b) median difference; (c) stochastic dominance; (d) variance difference; and (e) shape of the 13sociodemographic characteristics in the first part of the questionnaire (these data are available from the statistical service of Iran and other sources for the whole population of the study area). According to this procedure, the selected sample (n = 382) is almost ideal and representative, as in all the conducted tests there were no statistically significant differences between the research sample and the population.

From a technical-architectural point of view, the design process of the questionnaire is divided into three levels of functionality (Figure 1). These three levels consist of: (a) a section that provides information about sociodemographic characteristics of the respondents; (b) a section that investigates farmers' perception of precipitation and temperature changes on their farming (15 statements); and finally (c) a section that investigates farmers' adaptation measures for particular PTV (18 practices). Each one of these items (sections b and c) were scaled by a 5-level Likert-type scale, where strongly agree = 5 and strongly disagree = 1.

The main reason for this design is that when responding to a Likert questionnaire item, respondents specify their level of agreement or disagreement on a symmetric agree–disagree scale, assuming equal distances between each item and between each sequential possible answer [39]. Using reliability analysis for all the items, we can determine the extent to which these items are related to each other, to get an overall index of the internal consistency of the scale as a whole, and to identify items that had to be excluded from the scale. Having accepted the consistency of the items, the average rankings for each respondent were used as numerical values in multivariate analysis.

The questionnaire was administered through face-to-face interviews with the paddy farmers. Although expensive, face-to-face interviews provide the highest response rates and are better suited to collecting complex information. The interviews were conducted in a friendly manner and there was good cooperation with the respondents without any refusals. This approach enabled the interviewer to explain clearly the details of the questionnaire. The primary data were processed and statistically analyzed using the SPSS 19 Statistical Software Package. Descriptive and inferential statistics were employed to assess farmers' perceptions and adaptation measures toward the impacts of PTV.

3. Results and Discussion

3.1. Population Profile

Distribution of respondents' sociodemographic characteristics are shown in Table 3. As the results indicate, only 6.3% of farmers were younger than 40 years old, 39% of them were within the age range of 51–60, and respondents' average age was 55.9 years old. All of them were male and married. Respondents with elementary education had the highest prevalence in the sample (51%). Farmers with farming experience of more than 46 years had the highest frequency (38%) and those with 5–15 years had the lowest (1%). The mean experience of farmers was 42.3 years. About 89% of farmers had exclusively private land and 1% of them had leased land. Most of them (48%) used irrigation canals as their water resource. With regard to farm size, 57.8% of farmers had <1 ha and 42.2% had >1 ha and the farms' average size was 0.8 ha. Also, the majority of them (56%) reported average income ($3,786–$5,679). With regard to membership in cooperatives, 75.2% of farmers weren't members and 88% of farmers had not attended training courses during the past two years.

Table 3. Frequency distribution of farmers' sociodemographic characteristics.

Characteristics	Frequency	Percent/Valid	Mean	SD
Age (years)			55.9	9.9
Less than 40	24	6.3		
41–50	91	23.9		
51–60	149	39.0		
More than 60	118	30.1		
Farming Experience (years)			42.3	11.8
5–15	4	1.0		
16–25	46	12.0		
26–35	57	15.0		
36–46	130	34.0		
More than 46	145	38.0		
Level of Education				
Illiterate	46	12.0		
Elementary	195	51.0		
Secondary	134	35.1		
Collegiate	7	1.8		
Farm size				
Less than 1 ha	221	57.8		
More than 1 ha	161	42.2		
Farm ownership				
Private land	340	89.0		
Leased land	4	1.0		
Sharecropping 50:50	8	2.1		
Private and leased land	30	7.9		
Water resource				
Well	8	2.1		
Irrigation canal	183	48.0		
River	160	41.9		
Well and River	31	8.1		

Table 3. *Cont.*

Characteristics	Frequency	Percent/Valid	Mean	SD
Attended training courses				
Yes	46	12.0		
No	336	88.0		
Times requested information from agricultural organization				
None	222	58.1		
1–3 times	126	33.0		
More than 3 times	34	8.9		
Membership in cooperatives				
Yes	95	24.9		
No	287	75.1		
Annual household income				
Less than $3,786	126	33.0		
$3,786–$5,679	214	56.0		
More than $5,679	42	11.0		

3.2. Perception towards Precipitationand Temperature Variability

Perception towards PTV was assessed by 15 statements and the level of farmers' agreement was identified and scaled. Given that all questions have been measured according to a 5-point Likert scale, 2.5 was considered as the cut-off point. That is to say that if the mean value of a statement is greater than 2.5, respondents have a positive attitude toward this statement (they agree) while if the mean value of a statement is less than 2.5, respondents have a negative attitude toward this statement (they disagree). Mean scores close to 5 indicate strong agreement while, on the other hand, mean scores close to 1 indicate strong disagreement. In Table 4, the mean score and standard deviation for each statement are shown. Farmers strongly agree with 12 statements (out of 15), suggesting that farmers are aware that precipitation and temperature changes have indeed increased temperature, labor and management costs, drought, and rate of sickness, and have reduced rice quality, precipitation, and productivity.

Table 4. Paddy farmers' perception towards precipitation and temperature variability (PTV).

	Statements	Mean	SD
1	PTV increases farming losses.	4.31	0.465
2	Precipitation timing has been changed in recent years.	4.29	0.456
3	PTV increases labor cost in rice fields.	4.26	0.441
4	Precipitation has been decreased in recent years.	4.23	0.423
5	Temperature has been increased in recent years.	4.22	0.418
6	Drought has occurred more frequently in recent years.	4.22	0.462
7	PTV have reduced rice quality.	4.17	0.428
8	PTV have increased the costs of pest and weed control.	4.17	0.378
9	PTV have increased the rate of rice waste.	4.15	0.359
10	PTV have reduced rice yield.	4.15	0.386
11	PTV have increased the costs of water management.	4.14	0.349
12	PTV have reduced rice price due to the loss of the quality.	4.06	0.565
13	Temperature rise have resulted in farmers' inability to repay bank loans.	2.45	0.627
14	PTV have increased the application rate of chemical inputs.	2.41	0.534
15	PTV have resulted in the desolation of some farms.	2.11	0.567

3.3. Adaptation Measures towards PTV

To find the better measures towards PTV adaptation in Rasht County, respondents were asked to show to what extent each adaptation measure is useful and practical in their area. Mean scores revealed that early-maturing rice varieties, irrigation canals, drought-resistant rice varieties, early planting, agricultural insurance, plastic wrap, and pesticide usage are the major adaptation measures used by paddy farmers for counteracting the changing climate in Rasht county (Table 5). Agreement level with the other statements was below the cut-off point.

Table 5. Ranking of adaptation measures toward PTV.

	Adaptation Measures	Mean	SD
1	Cultivation of early-maturing rice varieties	4.48	0.502
2	Dredging and restoration of irrigation canals	4.33	0.473
3	Planting of drought resistant rice varieties	4.15	0.642
4	Early planting	4.08	0.394
5	Agricultural insurance	4.04	0.751
6	Plastic wrap on borders	3.48	1.010
7	Increase pesticide usage	2.69	0.615
8	Intermittent irrigation	2.47	0.771
9	Increase chemical fertilizer usage	1.53	0.674
10	Cultivation of high yielding varieties	1.41	0.714
11	Usage of wells and water pumps for irrigation	1.33	0.587
12	Alternative crops cultivation	1.27	0.510
13	Bank loans and facilities	1.23	0.649
14	Cultivate in less farm area	1.19	0.581
15	Stop cultivation	1.11	0.424
16	Wastewater (pond) building	1.04	0.243
17	Rent farm	1.03	0.171
18	Direct rice cultivation	1.00	0.000

3.4. Bivariate Analysis

Onwards, reliability analysis for 15 independent variables (Table 4) was used in order to determine the extent to which these variables are related to each other, to get an overall index of the internal consistency of the scale as a whole, and to identify items that had to be excluded from the scale. In fact, none of the independent variables were excluded. The value of Cronbach's alpha (α) reliability coefficient was found equal to 0.81, thus indicating that the "farmers' perception" scale is reliable. Friedman's two-way analysis of variance, with x^2 = 2.328 (α = 0.00), and Hotelling's T^2 = 1.112 (F = 28.16 and α = 0.00), indicated the significance in differences of item means. Having accepted the consistency of the 15 items, the average rankings for each respondent were used as the numerical values of the dependent variable "farmers' perception" which, along with the categories of thirteen other independent variables, are shown in Table 6.

Afterwards, Pearson, Spearman, and Eta correlation coefficients were estimated to assess the relation between farmers' sociodemographic characteristics (personal and production unit characteristics) and their perceptions. Pearson for measurable or continuous variables, Spearman for ordinal variables (or when one of the variables is quantitative), and Eta for nominal variables. Results in Table 6 indicate the relationship between farmers' sociodemographic characteristics and their perceptions towards PTV. Results indicate a positive relationship between farm size, household income, and farmers' perceptions. We can state that 4.84% (0.22^2) of the variation in "farmers' perception" is explained by "household income" and 4.00% (0.20^2) is explained by "farm size".

Table 6. Bivariate analysis (Pearson, Spearman, and Eta correlation coefficients).

Variable 1	Variable 2	Correlation Coefficient	Coefficients	*p*-Value
Household income	farmers' perception	Pearson	0.22 *	0.02
Farm size	farmers' perception	Pearson	0.20 *	0.04
Age	farmers' perception	Pearson	−0.08	0.42
Farming experience	farmers' perception	Pearson	0.07	0.50
Level of education	farmers' perception	Spearman	0.075	0.46
Farm ownership	farmers' perception	Eta	0.17	0.09
Water resource	farmers' perception	Eta	0.17	0.08
Gender	farmers' perception	Eta	0.11	0.09
Marital status	farmers' perception	Eta	0.12	0.08
Number of family members	farmers' perception	Pearson	−0.05	0.36
Membership in rural cooperatives	farmers' perception	Eta	0.16	0.06
Times requested information from agricultural organization	farmers' perception	Pearson	−0.08	0.44
Attending extension training courses	farmers' perception	Eta	0.13	0.07

* indicates statistical direct relation at the 5% level.

4. Conclusions

A very important outcome of this study is that questionnaire results regarding PTV are in complete agreement with the actual empirical data indicating that farmers' perceptions are valid (Table 2 and Figures 3 and 4). This is very important for developing successful adaptation strategies. Being dependent on natural resources, rice production in Rasht County is particularly vulnerable to PTV. Hence, perception of adaptation measures to PTV is a very important issue. Adaptation to PTV has been an important research topic, especially in agriculture, ever since PTV has been commonly recognized [40]. The present study is a preliminary effort to assess paddy farmers' perception of PTV and adaptation strategies in Rasht County, Guilan province, Iran. In this study, first the literature on related subjects was examined and classified, and then the primary framework based on 15 statements for farmers' perception of PTV and 18 statements for their adaptation strategies were proposed.

Among the key findings of the research analysis are the following: (1) Paddy farmers of Rasht County are aware of the increase in temperature and the decline in precipitation. This result is contrary to the research results reported by Tologbonse et al. [30], Sofoluwe et al. [29] and Amdu et al. [26]. On the other hand, Ogalleh et al. [41], Oluwatusin [42], Shameem et al. [43], Devkota [44], and Falaki et al. [45] revealed that farmers appear to be well aware of PTV, which is quite similar to our findings; (2) A diversity of adaptation strategies was employed by the Rasht County paddy farmers to counteract the impacts of PTV. Farmers are fully aware of possible adaptation options and strongly agree with planting of early-maturing, drought- and flood-tolerant varieties, reduction of water loss through irrigation canals, and agricultural insurance. The assessed adaptation strategies by Abid et al. [21], Fosu-Mensah et al. [46], Paudel et al. [47], and Oluwatusin [35] can be compared to the most important adaptation strategies assessed in the current paper; (3) assessment of adaptation options of Rasht County paddy farmers explicitly indicated that the farming community had tried to counteract the impact of PTV by employing local adaptation strategies; (4) a positive relationship was found between farm size and farmers' perception of PTV; (5) a positive relationship was found between household income and farmers' perception of PTV.

Farmers with larger farms can use multiple cropping and can integrate a livestock component, especially under dry-land conditions, to increase their income. Large farm sizes allow farmers to spread the risks of loss associated with changes in precipitation and temperature. The possibility of a reduction in water resources is a major threat in the paddy fields due to alterations in hydrologic cycles and changes in water availability, so most adaptation strategies in Rasht paddy fields are related to water and irrigation management. Some strategies here are suggested according to farmers' awareness of the impacts of PTV and appropriate adaptation strategies are proposed in order to increase rice quality and quantity in paddy fields.

According to farmers' tendency to grow varieties resistant to environmental conditions, it is recommended that research institutes study and report these varieties to farmers and farmers cultivate these crops with more confidence.

Regarding adaptation to PTV, it was found that paddy farmers who had farmed in years with more variable weather conditions had a higher tendency to use agricultural insurance, so it is suggested that the government implement comprehensive insurance of agricultural products to protect farmers against changing weather conditions.

Consequently, this study may provide interesting and initial observations and, in addition, it demonstrates verifiability. However, as a first systematic attempt to explore farmers' attitudes towards PTV and their adaptation strategies in paddy fields, our study was limited to a rather small region and a rather restrained amount of time for the observations. Therefore, any attempt to generalize our results should be done very carefully. Nevertheless, the observations made in this study provide a starting point for further research, which could extend the investigation to a more representative sample. For example, an interesting subject for further research is to extend the questionnaire and the analysis outside the study area to include more general climate change impacts.

Conclusively, taking into account the great importance of PTV as a principal change driver in agricultural areas, as well as the great contribution of the agricultural sector in the gross domestic product of the country, a study understanding farmers' perceptions and adaptation can prove extremely valuable. However, the results presented here are also great sources of information for policy makers and extension workers internationally. In particular, an extra purpose of this research is to assist policy makers, program planners, and extension and community workers to understand, implement, and promote developmental strategies in their respective countries. So, lessons learned here could well have resonance in many other countries well beyond the Rasht County in Guilan Province.

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Author Contributions: Mohammad Sadegh Allahyari designed and managed the research content and methodology, and wringing of results and conclusions, Sahereh Ghavami collected and analyzed the data. Zahra Daghighi Masouleh wrote the paper, interpreted results and made corrections. Anastasios Michailidis contributed in the statistical analysis and to the response to the reviewer comments. However, this work has been organized and has been written in an absolutely collaborative way and Stefanos A. Nastis involved the collection of secondary data, the authoring of results and conclusions and the editing for English of the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Questionnaire

Appendix A.1. Part 1: Socio-Demographic Characteristics

a1. Age: years

a2. Gender: Female Male

a3. Marital status: Single Married

a4. Level of education: Illiterate Elementary Secondary Collegiate

a5. Number of family members:
a6. Farming experience: years
a7. Annual household income: Rials
a8. Membership in rural cooperatives: Yes No
a9. Times requested information from agricultural organization: times
a10. Attending extension training courses: Yes No
a11. Water resource: Well Irrigation canal River Well and river
a12. Farm size: ha
a13. Farm ownership: Private land Leased land Sharecropping 50:50 Private and leased land

Appendix A.2. Part 2: Perception of Farmerstowards Precipitation and Temperature Changes

The following set of questions asks your perception of farmers towards precipitation and temperature changes. Please indicate your answer by circling the most appropriate response. Any change (increase or decrease) should be considered during the last 4 years.

	Items/Statements	Strongly Agree	Agree	Neither Agree/Nor Disagree	Disagree	Strongly Disagree
b1	Temperature and precipitation changes have already caused increase in farming losses					
b2	Precipitation time has changed in recent years					
b3	Temperature and precipitation changes have already caused increase in labor cost					
b4	Precipitation has reduced in recent years					
b5	Temperature has increased in recent years					
b6	Drought has increased in recent years					
b7	Temperature and precipitation changes have already caused reduction in rice quality					
b8	Temperature and precipitation changes have already caused increase in pest and weed control costs					
b9	Temperature and precipitation changes have already caused increase in rate of rice waste					
b10	Temperature and precipitation changes have already caused reduction in rice yield					
b11	Temperature and precipitation changes have already caused increase in water management costs					
b12	Temperature and precipitation changes have already caused reduction in rice price					
b13	Temperature and precipitation changes have already caused farmers inability to refund bank loans					
b14	Temperature and precipitation changes have already caused increase in usage of chemical inputs					
b15	Temperature and precipitation changes have already caused no planting in some farms					

Appendix A.3. Part 3: Adaptation Options for Precipitation and Temperature Changes

The following set of questions asks about adaptation measures toward precipitation and temperature changes. Please indicate your answer by circling the most appropriate response. Any change (increase or decrease) should be considered during the last 4 years.

	Indicators	Strongly Agree	Agree	Neither Agree/Nor Disagree	Disagree	Strongly Disagree
c1	Cultivate early-maturing rice varieties in dry and low precipitation years					
c2	Helping to farm water supply by dredging and restoration of irrigation canals					
c3	Prefer to plant of drought resistant rice varieties in drought conditions					
c4	Do early planting in warmer weather					
c5	Tendency to agricultural insurance in climate changes conditions					
c6	Usage of plastic wrap on borders for prevention of farm water waste					
c7	Increase pesticide usage in dry and low rainfall years					
c8	Usage of intermittent irrigation in warm and dry conditions					
c9	Increase chemical fertilizer usage in dry and low precipitation years					
c10	Prefer to cultivation of high yielding varietiesin drought conditions					
c11	Usage of wells and water pumps for irrigation in dry and low precipitation years					
c12	Alternative crops cultivation instead of rice in drought conditions					
c13	Receive Bank loans and governmental facilities in dry and low precipitation years					
c14	Cultivate in less farm area in dry and low precipitation years					
c15	Prefer to stop cultivation in dry and low precipitation years					
c16	Usage of wastewater (pond) building or irrigation in dry and low precipitation conditions					
c17	Prefer to rent farm in dry and low precipitation years					
c18	Do direct rice cultivation in dry and low precipitation years					

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