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Modeling Pro-Environmental Behavior Among Iranian Agricultural and Natural Resources Students Using an Extended Theory of Planned Behavior

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Abstract

Environmental crises increasingly threaten human well-being and ecological systems, and many contemporary environmental problems are directly or indirectly related to human behavior. This study modeled the factors underlying pro-environmental behavior among Iranian agricultural and natural resources students using an extended theory of planned behavior (EXP-TPB). A descriptive-correlational survey was conducted among students at the Khuzestan University of Agriculture and Natural Resources in southwestern Iran during the 2022–2023 academic year (N = 1,753). Using proportionate stratified random sampling, 161 students were selected; data were collected through face-to-face interviews using a 46-item, five-point Likert instrument and analyzed using partial least squares structural equation modeling (PLS-SEM) in SmartPLS. The model showed that attitude, subjective norms, perceived behavioral control, and environmental concern jointly explained 61.9% of the variance in environmental intention, while behavioral intention and perceived behavioral control explained 40.3% of the variance in pro-environmental behavior. Environmental concerns and environmental values also explained 41.2% of the variance in environmental attitude. The findings support the usefulness of an extended TPB framework for understanding students' pro-environmental behavior and highlight the importance of educational and institutional interventions that strengthen environmental concern, favorable attitudes, supportive norms, and perceived behavioral control.

Keywords: pro-environmental behavior; behavioral intention; environmental attitude; agricultural and natural resources students; theory of planned behavior; extended theory of planned behavior.

1. Introduction

Environmental degradation is among the most pressing public and policy challenges facing current generations (Miller et al., 2022; Brick et al., 2024). A broad range of environmental pressures—including climate change, air pollution, water scarcity, deforestation, natural-resource depletion, and biodiversity loss—threaten ecological integrity and human well-being (Wolf et al., 2022). Because many of these pressures are directly or indirectly shaped by human behavior, understanding the determinants of pro-environmental behavior has emerged as an important research priority (Tian & Liu, 2022; Lange, 2023; Takshe et al., 2023).

Environmental challenges are also highly salient in Iran, where soil and water degradation, ecosystem decline, and air pollution have become major sustainability concerns (Bondori & Khosravipour, 2023; Yazarloo, 2023). These pressures underscore the need for both effective environmental governance and stronger pro-environmental behavior among citizens and institutions. According to the 2022 Environmental Performance Index (EPI), Iran ranked 133rd among 180 countries, with an overall score of 34.50, indicating substantial environmental performance challenges (Wolf et al., 2022).

Air pollution is another major concern. IQAir reported an annual average PM2.5 concentration of 35.5 μg/m³ for Iran in 2022, far exceeding the World Health Organization annual guideline value of 5 μg/m³ (IQAir, 2022; World Health Organization, 2021). More broadly, effective environmental protection in Iran depends on the actions and cooperation of multiple stakeholders, including the general public, universities, businesses, and government institutions (Bondori et al., 2019). Education and training—particularly within higher education—can therefore play an important role in strengthening pro-environmental attitudes and behavior (Dewi, 2018; Ntanos et al., 2018; Shafiei & Maleksaeidi, 2020; Bondori & Jamshidi, 2021). Universities are especially important because they shape knowledge, attitudes, and professional norms among students who may later assume influential roles in public policy, research, education, and development (Ahmad et al., 2015; Naderlou & Shams, 2017; Damghanian et al., 2020; Torroba Diaz et al., 2023). Accordingly, students need to develop an understanding of environmental problems and recognize their role in addressing these challenges (Zsóka et al., 2013; Arı & Yılmaz, 2017; Janmaimool & Khajohnmanee, 2019). Two focused analyses from the broader research project have previously examined environmental concern in relation to environmental attitude and the roles of environmental knowledge and information sources in shaping environmental attitude (Bondori et al., 2024, 2025). The present study extends beyond these earlier analyses by integrating seven constructs within an EXP-TPB framework, with behavioral intention and pro-environmental behavior as the principal endogenous outcomes.The present study therefore modeled the factors underlying the pro-environmental behavior of Iranian agricultural and natural resources students using an extended theory of planned behavior.

1.1. Theoretical framework

Pro-environmental behavior can be defined as behavior that minimizes harm to the environment and maximizes environmental benefits (Chan et al., 2022). Understanding such behavior has attracted considerable attention because many environmental problems are directly or indirectly shaped by everyday human actions (Tian & Liu, 2022; Ayalon, 2024). Behavior change, particularly changes in social attitudes and beliefs, is also a central topic in social psychology (Afzal Khani, 2020).

Numerous theories and models have been developed to explain the factors that influence behavior, including Rogers' diffusion of innovations theory, Davis et al.'s technology acceptance model, and Ajzen's theory of planned behavior (TPB). TPB, proposed by Ajzen (1991), is widely used to explain the determinants of behavior in specific contexts (Hounnou et al., 2024). Its central premise is that behavior is most proximally determined by behavioral intention, which in turn is shaped by attitude toward the behavior, subjective norms, and perceived behavioral control (Ajzen, 1991).

Attitude toward a behavior refers to a positive or negative evaluation of that behavior and is influenced by an individual's beliefs about its likely outcomes. Subjective norms refer to perceived social pressure to perform or avoid a behavior and are shaped by normative beliefs about the expectations of important others (Ajzen, 1985, 1991). Perceived behavioral control refers to an individual's perception of their capacity to perform a behavior and of the barriers and facilitating conditions surrounding that behavior. It can influence behavior directly and indirectly through behavioral intention (Ajzen, 1991). Behavioral intention reflects the strength of an individual's willingness to perform a target behavior (De Leeuw et al., 2015). TPB has been applied in diverse contexts, including climate-change adaptation (Hounnou et al., 2024), green agricultural practices (Xu et al., 2024), pesticide-use intentions (Bagheri, Bondori, Allahyari, et al., 2019), integrated crop management (Bagheri, Bondori, & Damalas, 2019), online shopping behavior (González et al., 2021), organic-food purchase intentions (Kaur & Kaur, 2024), waste-bin use (Boakye et al., 2024), and sustainable food consumption (Alam et al., 2020; Arya et al., 2024).

Research has demonstrated that TPB can explain and predict a variety of pro-environmental behaviors (Niaura, 2013; De Leeuw et al., 2015; Botetzagias et al., 2015; Correia et al., 2022; Hidalgo-Crespo & Amaya-Rivas, 2024). In the basic TPB model, attitude, subjective norms, and perceived behavioral control are expected to influence students' intentions to protect the environment. Accordingly, the following hypotheses were formulated:

- Hypothesis 1: Environmental attitude is related to students' environmental intention.
- Hypothesis 2: Subjective norms are related to students' environmental intention.
- Hypothesis 3: Perceived behavioral control is related to students' environmental intention.
- Hypothesis 4: Students' environmental intention is related to their pro-environmental behavior.

- Hypothesis 5: Perceived behavioral control is related to students' pro-environmental behavior.

Although TPB has demonstrated substantial success in predicting behavior, researchers have extended the model by adding theoretically relevant constructs to improve its explanatory and predictive power (Sobhani et al., 2018; Imani et al., 2021). Ajzen (1991) explicitly noted that additional predictors may be incorporated when they make a meaningful contribution beyond the core TPB constructs. Accordingly, the present study added two constructs—environmental values and environmental concern—to the basic TPB model.

Environmental concern is another factor that may influence pro-environmental behavior. It generally refers to concern about environmental problems and their consequences (Albayrak et al., 2013). Environmental concern is associated with environmental values and attitudes and may consequently influence behavioral intentions and behavior (Diaz-Rainey & Tzavara, 2012; Biswas & Roy, 2015). Individuals with greater environmental concern tend to report more favorable environmental attitudes and stronger intentions to engage in environmentally responsible behavior (Sobhani et al., 2018). Similar relationships have been reported in studies of green-product purchase intentions (Abbasi et al., 2019; Rahimnia et al., 2017; Yadav & Pathak, 2016; Paul et al., 2016; Wandani et al., 2024). Accordingly, two additional hypotheses address environmental concern as a predictor of environmental attitude and intention.

- Hypothesis 6: Environmental concern is related to students' environmental attitude.
- Hypothesis 7: Environmental concern is related to students' environmental intention.

Many scholars regard values as fundamental orientations or guiding principles that organize beliefs and attitudes and guide behavior. In environmental psychology, value-based models likewise emphasize the role of values, beliefs, and norms in shaping attitudes and behavior (Klöckner, 2013).

Shin et al. (2017) found that environmental values significantly influenced environmental attitudes. Other research has likewise linked environmental values with ecological attitudes and behavior (López & Cuervo-Arango, 2008; Klöckner, 2013). These findings provided the basis for the following hypothesis.

- Hypothesis 8: Environmental values are related to students' environmental attitudes.

Students are often regarded as intellectual leaders and agents of cultural change in society. Strengthening their pro-environmental behavior is therefore important for environmental protection. The overall aim of the present study was to model the factors influencing the pro-environmental behavior and behavioral intentions of agricultural and natural resources students in Khuzestan Province, southwestern Iran. Based on the theoretical background outlined above, the conceptual framework of the study was developed by extending TPB, as shown in Figure 1.

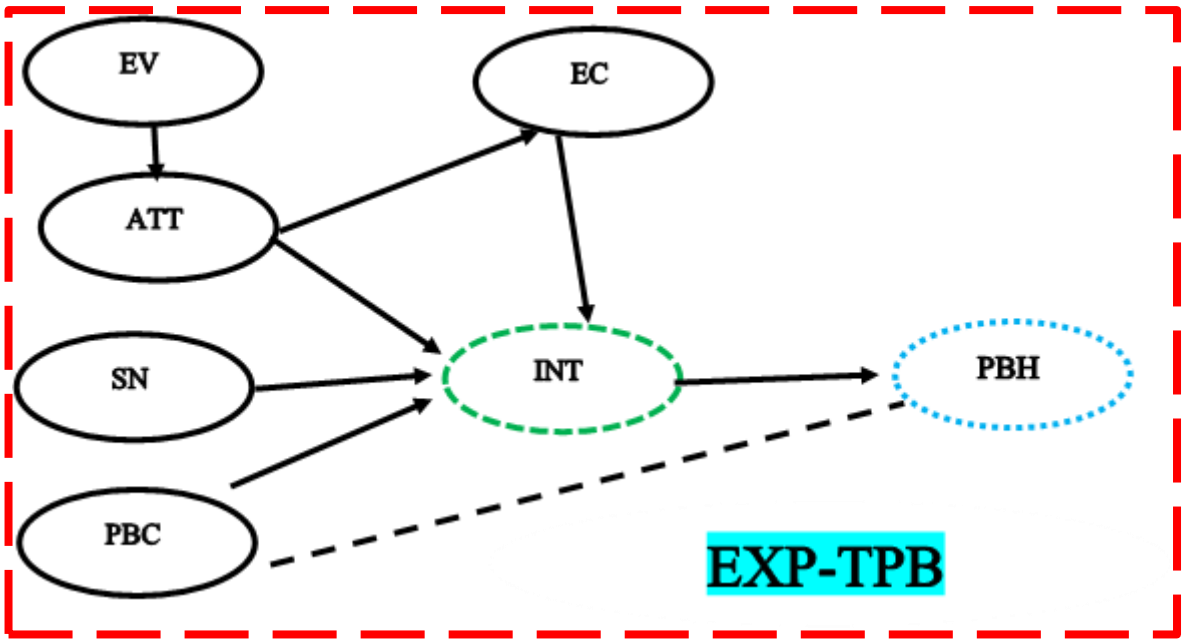


Figure 1. Conceptual framework of the study based on the extended TPB (EV = environmental values, EC = environmental concern, ATT = attitude, SN = subjective norms, PBC = perceived behavioral control, INT = intention, PBH = behavior).

2. Materials and methods

2.1. Study area

The Khuzestan University of Agriculture and Natural Resources is a public educational institution in Mollasani County, Khuzestan Province, southwestern Iran (Figure 2). The university was established in 1965 as Ahvaz Agricultural College and, until 2005, operated independently of Shahid Chamran University of Ahvaz under the name Khuzestan University of Agricultural Sciences and Natural Resources, while continuing its activities in Mollasani County. It is one of the major centers for agricultural education and research in southern Iran. The university has 92 faculty members and 1,753 students enrolled in bachelor's, master's, and PhD programs. It comprises four faculties and 14 academic departments offering 53 fields of study.

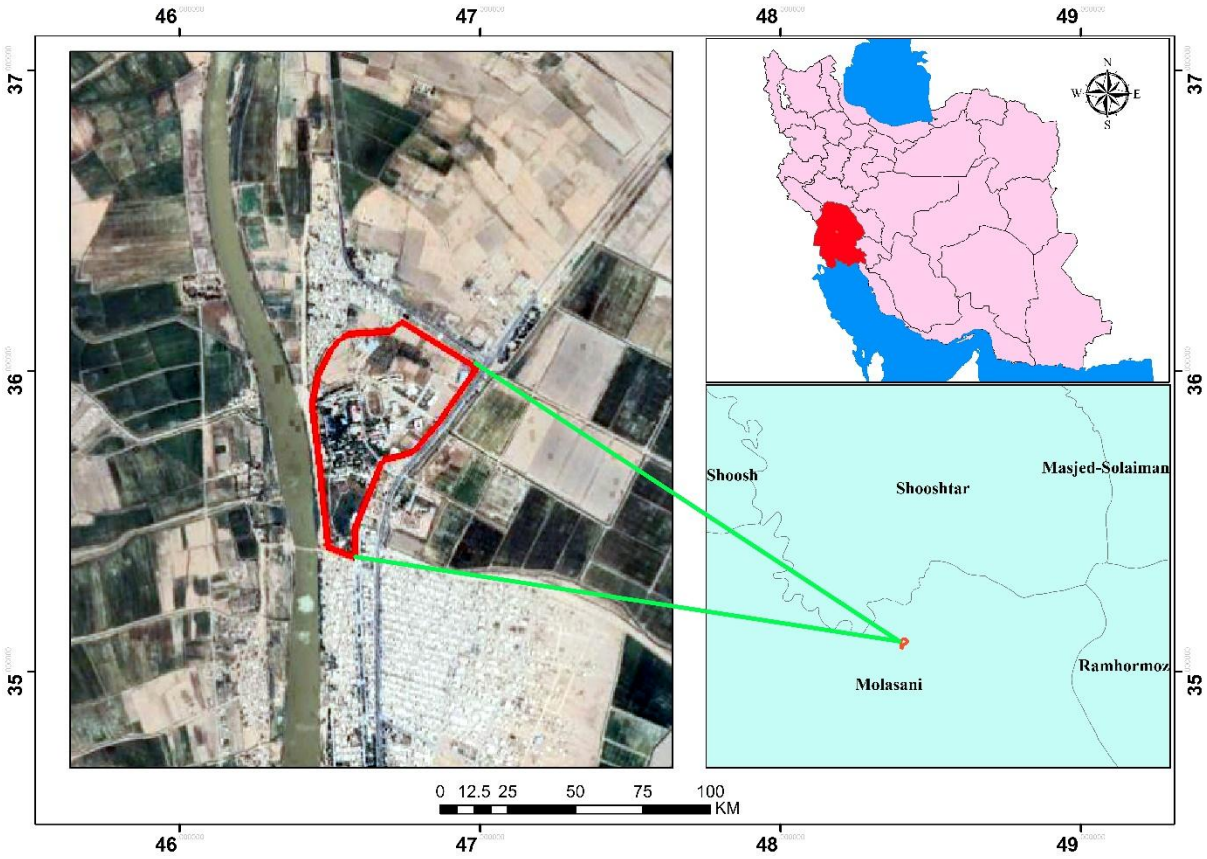


Figure 2. Geographic location of the Khuzestan University of Agriculture and Natural Resources in Iran

2.2. Sample selection

The study population comprised students enrolled at the Khuzestan University of Agriculture and Natural Resources during the 2022–2023 academic year (N = 1,753). The initial sample size was calculated as 138 using Cochran's formula (Cochran, 1977) and was increased to 161 to improve statistical precision. Proportionate stratified random sampling was used by educational level (bachelor's, master's, and PhD), and participants were randomly selected within each stratum.

2.3. Data collection

This study used a descriptive-correlational design. Data were collected from students through face-to-face interviews. The research instrument included a section on demographic characteristics and 46 closed-ended items measuring seven constructs: environmental values, subjective norms, perceived behavioral control, attitude, environmental concern, intention, and pro-environmental behavior. Items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The present analysis draws on data collected within a broader survey project conducted among agricultural and natural resources students during the 2022–2023 academic year. Two focused analyses derived from this research project have been published previously. Bondori, Forouzani, and Ghasemzadeh (2025) examined the specific relationship between

environmental concern and environmental attitude, whereas Bondori, Forouzani, and Ghasemzadeh (2024) examined the roles of environmental information sources and environmental knowledge in relation to environmental attitude. The present study addresses a distinct research question by testing an extended Theory of Planned Behavior model that integrates environmental values, environmental concern, attitude, subjective norms, perceived behavioral control, behavioral intention, and pro-environmental behavior. Findings reported in the previous publications are not treated as novel findings here; overlapping constructs are included only where required for estimation of the integrated EXP-TPB model, and the related publications are explicitly acknowledged and cited.

2.4. Data analysis

SPSS version 26 and SmartPLS were used to analyze the data. Partial least squares structural equation modeling (PLS-SEM) was conducted in SmartPLS to assess the measurement and structural models and test the study hypotheses. Convergent validity was evaluated using average variance extracted (AVE), with values of 0.50 or higher generally considered acceptable (Fornell & Larcker, 1981). Measurement-model adequacy was interpreted jointly across AVE, composite reliability, Cronbach's alpha, and rho_A rather than on the basis of a single indicator.

The rho_A coefficient was used to assess internal consistency reliability, with values of 0.70 or higher considered acceptable (Mehmetoglu, 2012). Cronbach's alpha and composite reliability (CR) were also examined, using 0.70 as the minimum acceptable threshold. These indices provide complementary evidence regarding the reliability of the measurement model (Hulland, 1999). The goodness-of-fit (GoF) index was calculated as shown in Equation (1).

$$GOF = \sqrt{\overline{communalities} \times \overline{R^2}}$$

The GoF index is based on the average communality and the mean coefficient of determination (R^2). Values of 0.10, 0.25, and 0.36 have been proposed as small, medium, and large benchmarks, respectively (Wetzels et al., 2009). The GoF value in the present study was 0.45 (Table 1).

Levels of pro-environmental behavior, intention, and environmental attitude were classified using the interval of standard deviation from the mean (ISDM) method. The four classification rules are presented in Equations (2)–(5). Each variable was subsequently summarized using the frequency and percentage of respondents in each category.

Very low or very negative: $\text{Min} \leq A < \text{Mean} - \text{SD}$ (2)
Relatively low or relatively negative: $\text{Mean} - \text{SD} \leq B < \text{Mean}$ (3)
Relatively high or relatively positive: $\text{Mean} \leq C < \text{Mean} + \text{SD}$ (4)
High or positive: $\text{Mean} + \text{SD} \leq D < \text{Max}$ (5)

Table 1. Validity, reliability, and goodness-of-fit indices for the model

Construct	Cronbach's alpha	rho_A	CR	AVE	R^2	Mean AVE	Mean R^2	GOF
ATT (Attitude)	0.795	0.796	0.851	0.449	0.412			

EC (Environmental concern)	0.792	0.792	0.849	0.446	-	0.45	0.47	0.45
EV (Environmental values)	0.72	0.724	0.817	0.474	-			
INT (Intention)	0.832	0.832	0.872	0.46	0.619			
PBC (Perceived behavioral control)	0.827	0.828	0.874	0.536	-			
PBH (Behavior)	0.754	0.759	0.827	0.411	0.403			
SN (Subjective norms)	0.711	0.716	0.806	0.41	-			

3. Results

3.1. Descriptive statistics

The mean age of the study sample was 24.46 years (SD = 6.18), with a range of 18–49 years. Female students comprised 55.9% of the sample and male students 44.1%. With respect to educational level, 67.1% were bachelor's students, 23.6% were master's students, and 9.3% were PhD students. Most respondents (79.5%) reported being satisfied with their field of study.

Table 2. Frequency distribution of the demographic characteristics of the study participants

Variable	Levels	n	Percentage
Age (years) Mean = 24.46 Minimum = 18 SD = 6.18 Maximum = 49	<30	140	87.0
	From 30 to 40	17	10.5
	>40	4	2.5
Gender	Male	71	44.1
	Female	90	55.9
Marital status	Single	134	83.2
	Married	27	16.8
Residence	Rural area	17	10.6
	Urban area	144	89.4
Educational level	Bachelor's degree	108	67.1
	Master's degree	38	23.6
	PhD	15	9.3
Satisfaction with the field of agriculture	Yes	128	79.5
	No	33	20.5

Distribution of students' pro-environmental behavior

Pro-environmental behavior encompasses actions that individuals take to reduce harm to or benefit the environment. Students' pro-environmental behavior was measured using seven items. As shown in Table 3, the highest mean scores were obtained for "I try to save water in my home or student dormitory" (4.04), "I never throw away garbage in nature; if I see litter, I collect it" (3.81), and "I put kitchen waste that can be composted in the garden" (3.78).

Distribution of students' environmental intention

Students' environmental intention was measured using eight items. As shown in Table 3, the highest mean scores were obtained for "In the future, I plan to work as a natural resources assistant to protect forests" (3.98), "I intend to cooperate with community and student organizations that support

environmental protection" (3.80), and "I am willing to commit to taking action to protect the environment" (3.80).

Distribution of students' environmental attitude

Environmental attitude refers to favorable or unfavorable evaluations of the environment. Students' environmental attitudes were measured using seven items. According to Table 3, the three highest-scoring items were "Plants and animals have the right to live like humans" (4.01), "Intervening in nature has harmful consequences" (3.91), and "Many activities associated with modern life are harmful to the natural environment" (3.89).

Distribution of students' environmental subjective norms

Subjective norms reflect perceived social pressure from important referents to perform or avoid a behavior. Students' environmental subjective norms were measured using six items. According to Table 3, the highest-scoring items were "As an educated person, I am expected not to leave garbage in rivers or natural areas when I go on recreational outings" (3.96), "University personnel expect me, as an educated member of society, not to litter on campus" (3.93), and "My family expects me to conserve water at home" (3.89).

Distribution of students' perceived behavioral control

Perceived behavioral control reflects students' perceived ability and control over performing environmental actions. Students' perceived behavioral control was measured using six items. According to Table 3, the highest-scoring items were "I am not embarrassed to pick up litter and put it in a bin when I see it on campus or elsewhere" (4.06), "I can conserve water when bathing and washing dishes" (4.01), and "I am confident that I can engage in activities aimed at protecting the environment" (3.89).

Distribution of students' environmental concern

Environmental concern refers to apprehension or worry about environmental problems and their consequences (Albayrak et al., 2013). Students' environmental concern was measured using seven items. As shown in Table 3, the highest-scoring items concerned the drying of wetlands in Iran (4.22), warmer summers relative to previous years (4.08), and dust events in different provinces over the past few years (3.82).

Distribution of students' environmental values

Environmental values reflect fundamental orientations and principles that help organize beliefs and attitudes and guide behavior (Klöckner, 2013). As shown in Table 3, the highest mean scores were obtained for prohibiting the construction of fish farms on the banks of rivers and springs (4.32), protecting all living creatures (3.95), and avoiding environmentally harmful use of chemical fertilizers to increase yields (3.78).

Table 3. Descriptive statistics of the study variables related to the environment

Construct/ variable	Number of statements	Statements	Mean	SD

Attitude (ATT)	7		3.84	1.14
		Plants and animals have the right to live like humans.	4.01	1.02
		Intervening in nature has harmful consequences.	3.91	1.04
		Many activities associated with modern life are harmful to the natural environment.	3.89	1.10
		If things continue like this, we will soon witness a major environmental disaster.	3.84	1.15
		To reduce waste, the use of disposable containers should be minimized.	3.79	1.23
		I will protest against people who harm the environment.	3.76	1.26
		I am interested in helping to clean the university and maintain its green spaces.	3.69	1.18
Behavior (PBH)	7		3.77	1.09
		I try to save water in my home or student dormitory.	4.04	0.915
		I never throw away garbage in nature; if I see litter, I collect it.	3.81	1.04
		I put kitchen waste that can be composted in the garden.	3.78	1.28
		In cold seasons, instead of turning on heating devices early, I try to wear warmer clothing.	3.75	1.01
		I pay close attention to recycling and reusing waste materials, such as plastic bags and bottles**.**	3.69	1.05
		If I observe an environmental problem, I report it to the relevant organizations and institutions.	3.68	1.25
		I talk to others about environmental issues and share what I know with them.	3.64	1.14
Environmental values (EV)	4		3.89	1.09
		All living creatures are worth protecting.	3.95	1.13
		Keeping animals in cages should be prohibited.	3.51	1.11
		Farmers should not use chemical fertilizers to increase yields when doing so is harmful to the environment.	3.78	1.17
		Construction of fish farms on the banks of rivers and springs should be prohibited.	4.32	.97
Environmental concern (EC)	7		3.80	1.30
		Unless human behavior toward nature changes, the environment will face a disaster.	3.72	1.30
		Garbage along rivers, lakes, and seashores in tourist areas always concerns me.	3.58	1.46
		Garbage along streets and around the university always concerns me.	3.51	1.32
		Warmer summers than in previous years are a cause for concern.	4.08	1.19
		The floods and damage to infrastructure in the summer of 2022 were an environmental disaster and a source of concern.	3.73	1.42
		Dust events in different provinces over the past few years are a cause for concern.	3.82	1.30
		The drying of wetlands in Iran is an environmental disaster and a cause for concern.	4.22	1.12
	6		3.81	1.17

Subjective norms (SN)		Under social pressure, I feel the need to conserve energy.	3.57	1.16
		University professors who are important to me think that I should conserve electricity and water.	3.70	1.33
		University personnel expect me, as an educated member of the community, not to litter on campus.	3.93	1.11
		As an educated person, I am expected not to leave garbage in rivers or natural areas when I go on recreational outings.	3.96	1.15
		My family expects me to conserve water at home.	3.89	1.12
		As an educated person, my university friends expect me to conserve water while doing laundry, showering, and brushing my teeth.	3.83	1.20
Perceived behavioral control (PBC)	6		3.91	0.918
		I feel that I have full control over my actions that affect the environment.	3.80	0.89
		I can conserve water when bathing and washing dishes.	4.01	0.87
		I am confident that I can engage in activities aimed at protecting the environment.	3.89	0.88
		I am not embarrassed to pick up litter and put it in a bin when I see it on campus or elsewhere.	4.06	0.87
		I am confident that I can separate dry and wet waste at university.	3.87	0.99
		I feel able to speak out against people who harm the environment.	3.87	1.01
Intention (INT)	8		3.76	1.38
		I intend to cooperate with community and student organizations that support environmental protection.	3.80	1.14
		In the future, I plan to serve as a natural resources assistant to help protect forests.	3.98	0.96
		I am willing to commit to taking action to protect the environment.	3.80	1.14
		I plan to engage in more environmentally friendly activities in the near future.	3.75	1.07
		I plan to participate in university conferences and seminars on nature conservation.	3.76	1.06
		I plan to save electricity and water in the near future.	3.68	1.24
		In the near future, I plan to collect litter on campus, in the city, and in natural areas.	3.70	1.18
		In the near future, I plan to separate dry and wet waste in the student dormitory and at home.	3.63	1.28

Levels of Iranian students' behavior, intention, and attitude toward the environment

Responses used to classify students' behavior, intention, and attitude ranged from 1 (strongly disagree) to 5 (strongly agree). Using the ISDM method, each variable was classified into four levels. As shown in Figure 3, students' behavior was classified as very low (21.1%), low (19.3%), moderate (38.5%), and high (21.1%). Environmental intention was classified as

very low for 18.6% of students, low for 26.6%, moderate for 41.0%, and high for 14.3%. Environmental attitude was classified as very low for 21.1% of students, low for 19.3%, moderate for 46.0%, and high for 13.7%.

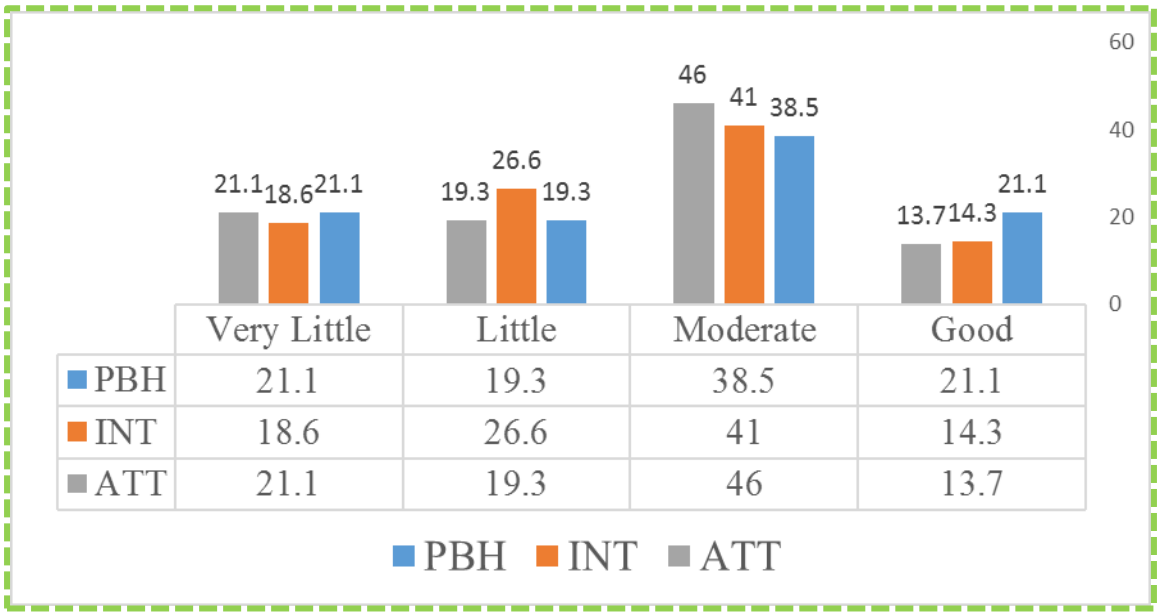


Figure 3. Distribution and levels of ATT (attitude), INT (intention), and PBH (behavior) among Iranian students toward the environment

Correlation analysis

Pearson correlation coefficients were calculated to examine associations among the study variables. As shown in Table 4, all reported associations were positive and statistically significant, with the corresponding significance levels indicated in the table. Behavioral intention, perceived behavioral control, subjective norms, environmental concern, attitude, and environmental values were each positively associated with pro-environmental behavior. These constructs were also positively interrelated in patterns broadly consistent with the proposed conceptual model.

Table 4. Correlations among constructs influencing students' pro-environmental behavior and attitudes

Variable	PBH	INT	PBC	ATT	SN	EC	EV
Behavior (PBH)	-						
Intention (INT)	0.609**	-	-	-	-	-	-
Perceived behavioral control (PBC)	0.482**	0.539**	-	-	-	-	-
Attitude (ATT)	0.354**	0.564**	0.389**	-	-	-	-
Subjective norms (SN)	0.486**	0.655**	0.471**	0.451**	-	-	-
Environmental concern (EC)	0.539**	0.657**	0.390**	0.570**	0.514**	-	-

Environmental values (EV)	0.479**	0.531**	0.405**	0.566**	0.503**	0.580**	-

** $p < 0.01$; * $p < 0.05$.

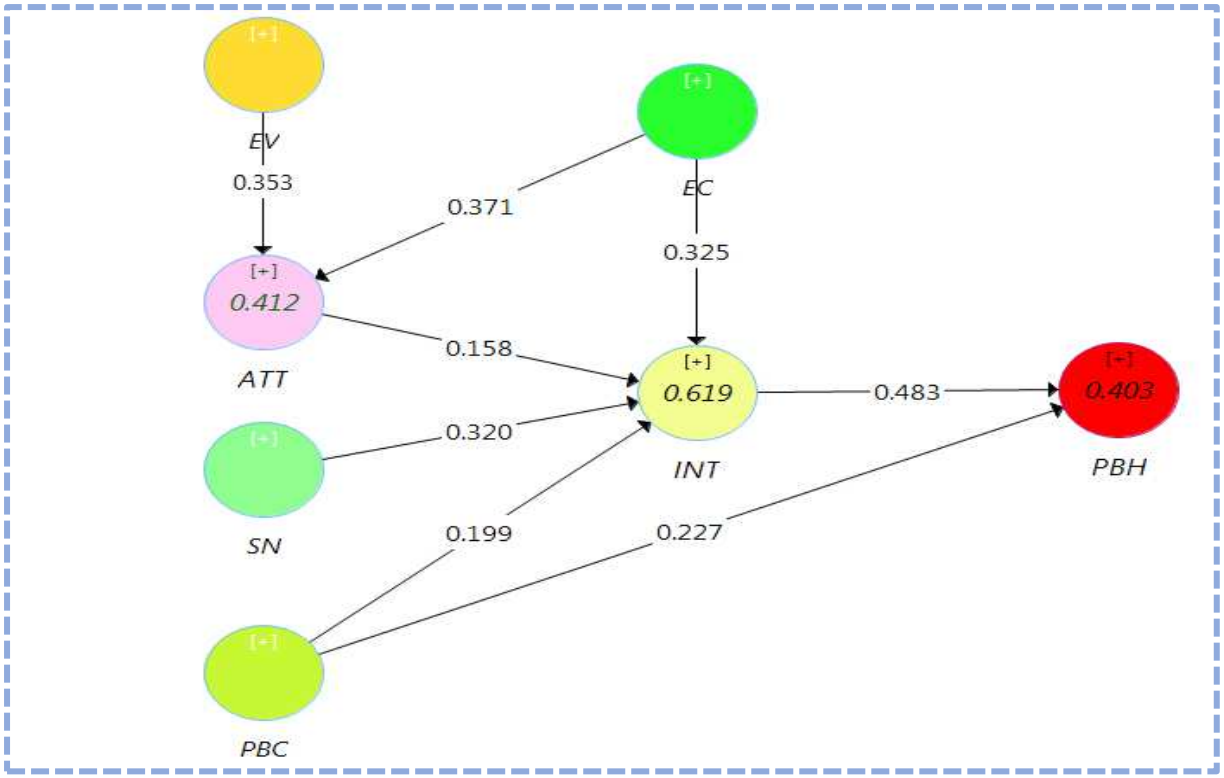
Table 5 presents the direct, indirect, and total effects in the structural model. Attitude positively affected environmental intention (β = 0.158, t = 2.212, $p < 0.05$), supporting Hypothesis 1. Subjective norms (β = 0.320, t = 4.588, $p < 0.01$) and perceived behavioral control (β = 0.199, t = 3.317, $p < 0.01$) also positively affected intention, supporting Hypotheses 2 and 3. Environmental intention (β = 0.483, t = 6.648, $p < 0.01$) and perceived behavioral control (β = 0.227, t = 2.610, $p < 0.05$) positively affected pro-environmental behavior, supporting Hypotheses 4 and 5. Environmental concern positively affected both attitude (β = 0.371, t = 4.158, $p < 0.01$) and intention (β = 0.325, t = 4.202, $p < 0.01$), supporting Hypotheses 6 and 7. Environmental values positively affected attitude (β = 0.353, t = 4.207, $p < 0.01$), supporting Hypothesis 8. All eight hypothesized structural relationships were supported.

Table 5. Direct and indirect effects on Iranian students' pro-environmental behavior and intention

Dependent variable	Independent variable	Direct effect	t-value	Indirect effect	Total effect	R^2
Attitude (ATT)	Environmental values (EV)	0.35	4.20**	-	0.35	0.41
	Environmental concern (EC)	0.37	4.15**	-	0.37	
Intention (INT)	Environmental concern (EC)	0.32	4.20**	0.059	0.37	0.61
	Subjective norms (SN)	0.32	4.58**	-	0.31	
	Perceived behavioral control (PBC)	0.19	3.31**	-	0.19	
	Attitude (ATT)	0.15	2.21*	-	0.15	
Behavior (PBH)	Intention (INT)	0.48	6.64**	-	0.48	0.40
	Perceived Behavioral Control (PBC)	0.22	2.61*	0.096	0.31	

** $p < 0.01$; * $p < 0.05$.

Figure 4 summarizes the structural path model and the explained variance of the endogenous constructs. The model explained 41.2% of the variance in attitude, 61.9% of the variance in intention, and 40.3% of the variance in pro-environmental behavior.


[+]
EV
0.353
[+]
EC
0.371
0.325
[+]
0.412
ATT
0.158
[+]
0.619
INT
0.483
[-]
0.403
PBH
[+]
SN
0.320
0.199
0.227
[+]
PBC

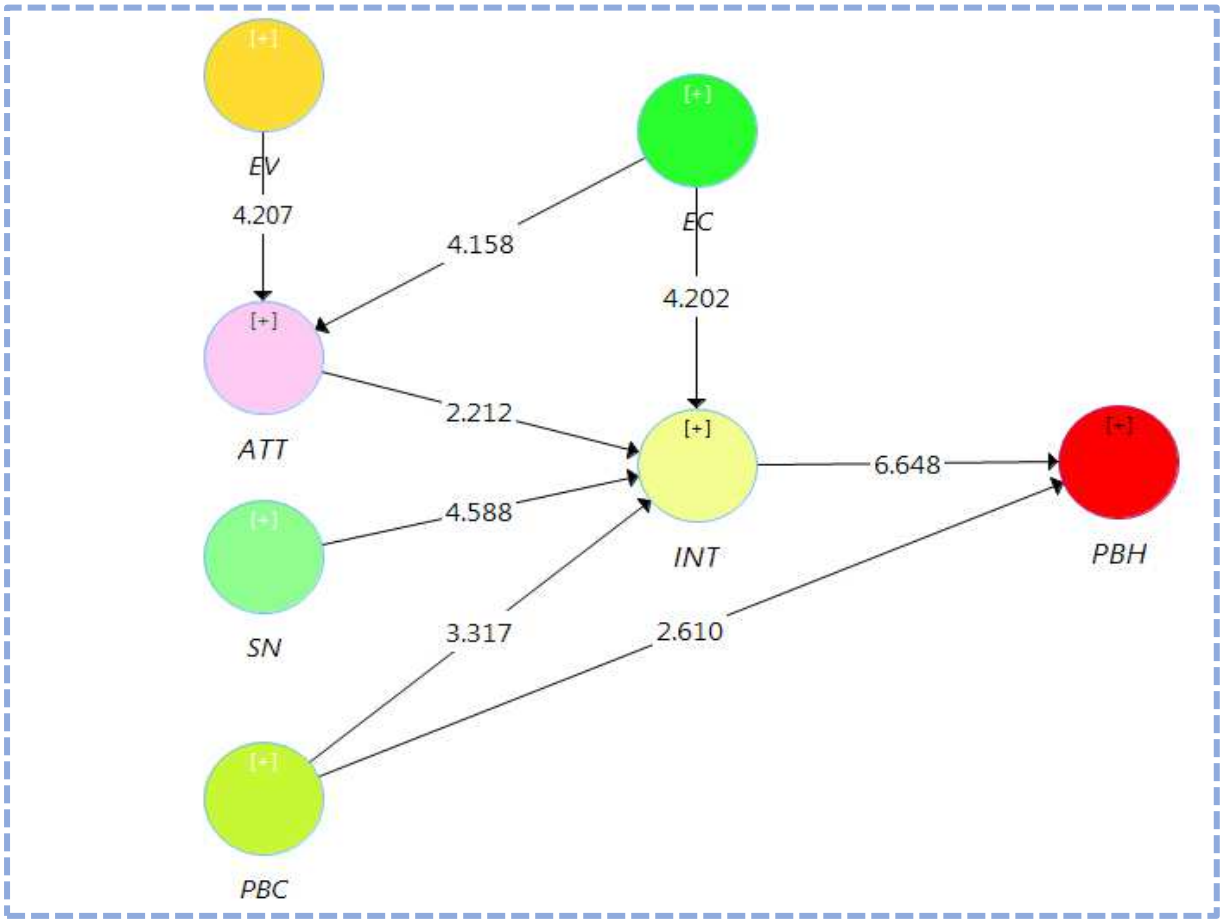

[+]
EV
4.207
[+]
EC
4.158
4.202
[+]
ATT
2.212
[+]
6.648
[-]
PBH
[+]
SN
4.588
INT
3.317
2.610
[+]
PBC

Figure 4. Structural path model based on the extended TPB (EV = environmental values, EC = environmental concern, ATT = attitude, SN = subjective norms, PBC = perceived behavioral control, INT = intention, PBH = behavior).

4. Discussion

Environmental sustainability is a major global challenge, and environmentally responsible behavior is central to efforts to address it (Miller et al., 2022; Tian & Liu, 2022). University students are a particularly important group because higher education can strengthen environmental knowledge, attitudes, and behavioral intentions, while students may subsequently transfer these orientations into professional and community settings (Bondori & Jamshidi, 2021; Janmaimool & Khajohnmanee, 2019). The present study therefore applied an extended TPB to explain pro-environmental behavior among Iranian agricultural and natural resources students. Overall, students reported relatively favorable environmental attitudes, a finding consistent with previous studies of student and rural populations (Ahmadi et al., 2020; Bondori & Jamshidi, 2021; Eshaghi et al., 2017; Ghobadi et al., 2016; Moradi, 2017; Nadem Souraki et al., 2023; Naderlou & Shams, 2017).

In the present study, environmental intention, attitude, subjective norms, perceived behavioral control, environmental concern, and environmental values were positively associated with pro-environmental behavior, broadly consistent with previous research (Bondori et al., 2021; Botetzagias et al., 2015; Hejazi & Eshaghi, 2014; Imani, Bondori, & Norozi, 2023; Izadi et al., 2023; Nosrati et al., 2023; Safa et al., 2020; Sojasi Qeidary & Azizi, 2016). This pattern is also consistent with evidence from university students in Thailand, where greater environmental-system knowledge was associated with more favorable environmental attitudes and pro-environmental behavior (Janmaimool & Khajohnmanee, 2019). The structural model further indicated that environmental concern ($\beta = 0.371$) and environmental values ($\beta = 0.353$) positively affected environmental attitude and jointly explained 41.2% of its variance. These findings support Hypotheses 6 and 8 and are consistent with previous evidence linking values, concern, and attitudes with pro-environmental orientations (Behzadi et al., 2022; Hemayatkhah Jahromi et al., 2017; Mahdavi et al., 2019; Safa et al., 2020; Shahpasand et al., 2021; Swaim et al., 2014; Yazdani & Shams, 2022). A focused analysis of environmental concern and environmental attitude based on the same broader research project has been reported previously (Bondori et al., 2025). The present study differs from that earlier analysis by examining these constructs within an extended TPB framework in which environmental concern and environmental values are modeled simultaneously as antecedents of attitude, while attitude is subsequently linked with behavioral intention and pro-environmental behavior. Accordingly, the contribution of the present analysis lies in evaluating these relationships as part of an integrated behavioral model rather than re-examining the previously reported bivariate relationship in isolation.

Environmental education can help strengthen students' intentions to protect the environment by shaping knowledge, attitudes, perceived norms, and perceived behavioral control. In the present model, environmental concern ($\beta = 0.325$), subjective norms ($\beta = 0.320$), perceived behavioral control ($\beta = 0.199$), and attitude ($\beta = 0.158$) positively affected environmental intention and together explained 61.9% of its variance. These results support Hypotheses 1, 2, 3, and 7 and are broadly consistent with previous applications of TPB and related models (Abbasi et al., 2019; Goh et al., 2017; Hemayatkhah Jahromi et al., 2017; Hidalgo-Crespo & Amaya-Rivas, 2024; Imani, Bondori, & Norozi, 2023; Izadi et al., 2023; Rastegar & Maleki, 2018; Safa et al., 2020; Vicente-Molina et al., 2013).

Environmental intention had the strongest direct effect on students' pro-environmental behavior (β = 0.483), supporting Hypothesis 4. This finding is consistent with previous studies in which behavioral intention was an important proximal predictor of pro-environmental action (Hejazi & Eshaghi, 2014; Hemayatkhah Jahromi et al., 2017; Hidalgo-Crespo & Amaya-Rivas, 2024; Imani, Bondori, & Norozi, 2023; Safa et al., 2020; Savari, 2022).

Perceived behavioral control also positively affected students' pro-environmental behavior (β = 0.227), supporting Hypothesis 5. This result is consistent with previous TPB-based studies (Botetzagias et al., 2015; Greaves et al., 2013; Han, 2015; Hejazi & Eshaghi, 2014; Hemayatkhah Jahromi et al., 2017; Safa et al., 2020).

4.1. Practical recommendations

The findings suggest several practical actions for universities. First, agricultural and natural resources students can be mobilized as peer educators and environmental ambassadors through student-led extension campaigns, green clubs, service-learning, and community outreach, allowing universities to extend pro-environmental knowledge, attitudes, and practices beyond the classroom. Second, faculty members, university staff, and student leaders can reinforce supportive subjective norms by visibly modeling environmentally responsible behavior and integrating environmental responsibility into teaching and campus communication. Third, because intention was the strongest direct predictor of behavior, universities should create regular opportunities for students to translate intentions into action through campus conservation projects, recycling programs, environmental volunteering, and applied seminars. Finally, perceived behavioral control can be strengthened by reducing practical barriers through accessible recycling facilities, water- and energy-saving infrastructure, clear behavioral guidance, and institutional incentives for sustainable practices.

5. Conclusion

This study extended the theory of planned behavior by incorporating environmental concern and environmental values to explain pro-environmental behavior among Iranian agricultural and natural resources students. All eight hypothesized relationships were supported. Attitude, subjective norms, perceived behavioral control, and environmental concern jointly explained 61.9% of the variance in environmental intention, while environmental intention and perceived behavioral control explained 40.3% of the variance in pro-environmental behavior. Environmental concerns and environmental values also explained 41.2% of the variance in environmental attitude. Environmental intention emerged as the strongest direct predictor of behavior, underscoring the importance of converting favorable motivations into feasible environmental action. Overall, the findings demonstrate the added explanatory value of integrating environmental concern and values with the core TPB constructs in this educational context.

5.1. Implications for further research

Future research should test the extended model across multiple universities and regions to assess its generalizability and should consider longitudinal or experimental designs to strengthen causal interpretation. Environmental knowledge and information-source uses were examined separately within the broader research project and were therefore not included as constructs in the present EXP-TPB model. Future research could integrate these variables directly with the TPB constructs within a single confirmatory framework to assess their incremental explanatory contribution to intention and behavior. Future studies could also complement self-reported measures with observed pro-environmental behaviors to reduce common-method and social-desirability concerns.

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Author contributions: A. B.: Writing draft, Data collection, **M.S.A.:** Advisor, Methodology, Data analysis, writing draft, revision. **A. S. M. and F. Gh.:** Revised version, Data analysis, **J. S.** and **S. B.:** Methodology, Data analysis, writing draft.

Declarations

Ethics approval

The study protocol was deemed exempt from requiring formal ethics approval by the Institutional Review Board (IRB) of Khuzestan University of Agriculture and Natural Resources (Mollasani, Ahvaz, Iran), because the study involved no invasive procedures, no biological sampling, and no collection of identifiable personal data, and participation was voluntary with verbal informed consent. The need for ethics approval was therefore waived by the named committee.

Ethical accordance

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and the institutional guidelines of Khuzestan University of Agriculture and Natural Resources. Verbal informed consent was obtained from all participants, confidentiality and anonymity were assured, and all interviews were recorded and transcribed with personal identifiers removed.

Consent to publish

Not applicable.

Consent to participate

Verbal informed consent was obtained from all individual participants included in the study.

Clinical trial: Not applicable.

Declaration of Generative AI and AI-assisted technologies in the writing process:

During the preparation of this work, the authors used ChatGPT Plus-6 for proofreading and language improvement. After using this tool, the authors reviewed and edited the content as necessary and took full responsibility for the content of the publication.

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