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Greenhouse Cucumber Growers' Behavior Analysis in the Optimal Consumption of Fuel in Iran: Application of Logical Approach

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Abstract

Excessive consumption of fuel in greenhouse crops has caused irreparable damage to the environment and ultimately human health. Therefore, the present study highlights the need to change mental patterns regarding the type and method of optimal fuel consumption. The present study aimed to psychologically analyze greenhouse keepers' environmental behavior using the Theory of Planned Behavior (TPB). This study is descriptive-correlational. The statistical population of the research consisted of greenhouse cucumber growers in Kerman province, Iran (4946 people), of whom 356 were selected as a sample using the cluster sampling method. The sample size was estimated using the Karjesi and Morgan table. Data were collected using a structured and researcher-made questionnaire, and its validity and reliability (α= 0.91-0.94) were confirmed using various indices. Smart-PLS3 software was utilized to test the research hypotheses. The research findings indicated that the effects of three variables attitude, subjective norm, and perceived behavioral control on intention were statistically significant. Additionally, based on the results of structural equation modeling, intention significantly mediated the relationship between dependent and independent variables. Furthermore, the independent variables were able to account for 32% and 51% of the variance in behavioral intention and environmental behavior of greenhouse keepers in optimal fuel consumption, respectively. Given that sustained intrinsic motivation or strong intentions are necessary for maintaining long-term behavior, it is recommended that policies and programs focusing on the development and evaluation of behavioral interventions to promote fuel consumption behaviors be broadly centered on strengthening the intentions of greenhouse keepers. Under favorable conditions and with incentives, individuals are more likely to engage in optimal fuel consumption. The findings of this study provide valuable insights for government agencies, policymakers, agricultural extension and education agents, and researchers interested in devising strategies to reduce fossil fuel consumption.

Keywords: Behavior assessment, Behavior change, Environmental behavior, Theory of planned behavior.

Introduction

The limitations of water and soil, population growth, increased food demand, and the pressure of time have directed scientists' attention towards addressing food shortages by enhancing yield per unit area (Momeni & Rahmati, 2011). Greenhouse cultivation stands out as one of the innovative techniques in this regard (Momeni & Rahmati, 2011). Despite the benefits greenhouses offer to societies, their excessive fuel and energy consumption pose a significant concern (Momeni & Rahmati, 2011). The heightened use of fossil fuels has exacerbated contemporary society's worries, given the irreversible damage it inflicts on the environment and human health (Bijani *et al.*, 2017). Various factors, such as the low cost and accessibility of fuel (Lal, 2010), fuel subsidies (Mousavi-Avval *et al.*, 2011), and expanding agricultural cultivation areas, have notably influenced fuel consumption (Lal, 2010). Moreover, elements affecting farmers' and non-farmers' decision-making processes regarding fuel usage include policies, regulations, management and economic factors, public awareness, attitudes, and behaviors (Behroozeh *et al.*, 2022; Özesmi & Özesmi, 2003). Given the pivotal role of human behavior in the development process (Zamani, 2016), it becomes imperative to focus on optimizing fuel consumption behavior and conducting related studies among the populace (Olbrich *et al.*, 2012)."

Most of the challenges and problems facing the environment can be seen as consequences of human behavior (Cascante *et al.*, 2015). Indeed, human behavior has the potential to exacerbate or ameliorate environmental issues (Paytakhti Oskooe *et al.*, 2019). According to many experts, the primary factor contributing to environmental issues can be attributed to the psychological framework of human behavior (Feola & Binder, 2010). Hence, achieving incremental improvements in energy consumption behaviors that are both successful and efficient requires a comprehensive understanding of the factors influencing behavior (Scott *et al.*, 2015). Furthermore, achieving sustainable fuel consumption in the agricultural sector to protect the environment requires not only technological advances but also necessitates a fundamental change in human behavior (Bourdeau, 2004). Changing consumer behavior is a multifaceted issue that includes cultural, social, and psychological dimensions and necessitates significant changes in people's cognitive frameworks regarding energy consumption (Stephenson *et al.*, 2010). Therefore, it is necessary to determine the psychological conditions under which consumption patterns are formed (Izadbakhsh, 2015) so that it can facilitate accurate and efficient fuel resource consumption and thereby ensure the sustainability and preservation of energy resources (Salehi *et al.*, 2022). This study focuses on the optimal fuel consumption behavior of farmers in greenhouse cultivation systems. In general, there have been limited studies on fuel consumption behavior, especially among greenhouse keepers. Thus, the present research examines behavior related to optimal fuel consumption using the theory of planned behavior.

Based on the data, the agricultural greenhouses in Iran cover an estimated area of about 6,630 hectares (Heidari & Omid, 2011). Green cucumbers, among other greenhouse products, are widely recognized as a significant vegetable in Iranian agriculture (Heidari et al., 2011). Iran holds the third position globally in cucumber production, following China and Turkey, with an annual yield exceeding two million tons (Heidari & Omid, 2011). Situated in the southern part of Iran, Kerman province (Figure 1) boasts unique climatic conditions that make it an exceptional region for greenhouse farming, encompassing approximately 1200 hectares of greenhouse space (Momeni & Rahmati, 2011). This province has gained prominence as one of Iran's primary producers of greenhouse cucumbers (Saei, 2019). However, energy expenses represent the largest cost for cucumber cultivation in greenhouses (Heidari & Omid, 2011), with over 80% of this energy consumption attributed to fossil fuels (Momeni & Rahmati, 2011). Consequently, the present study delved into cucumber cultivation practices within the greenhouses of Kerman province.

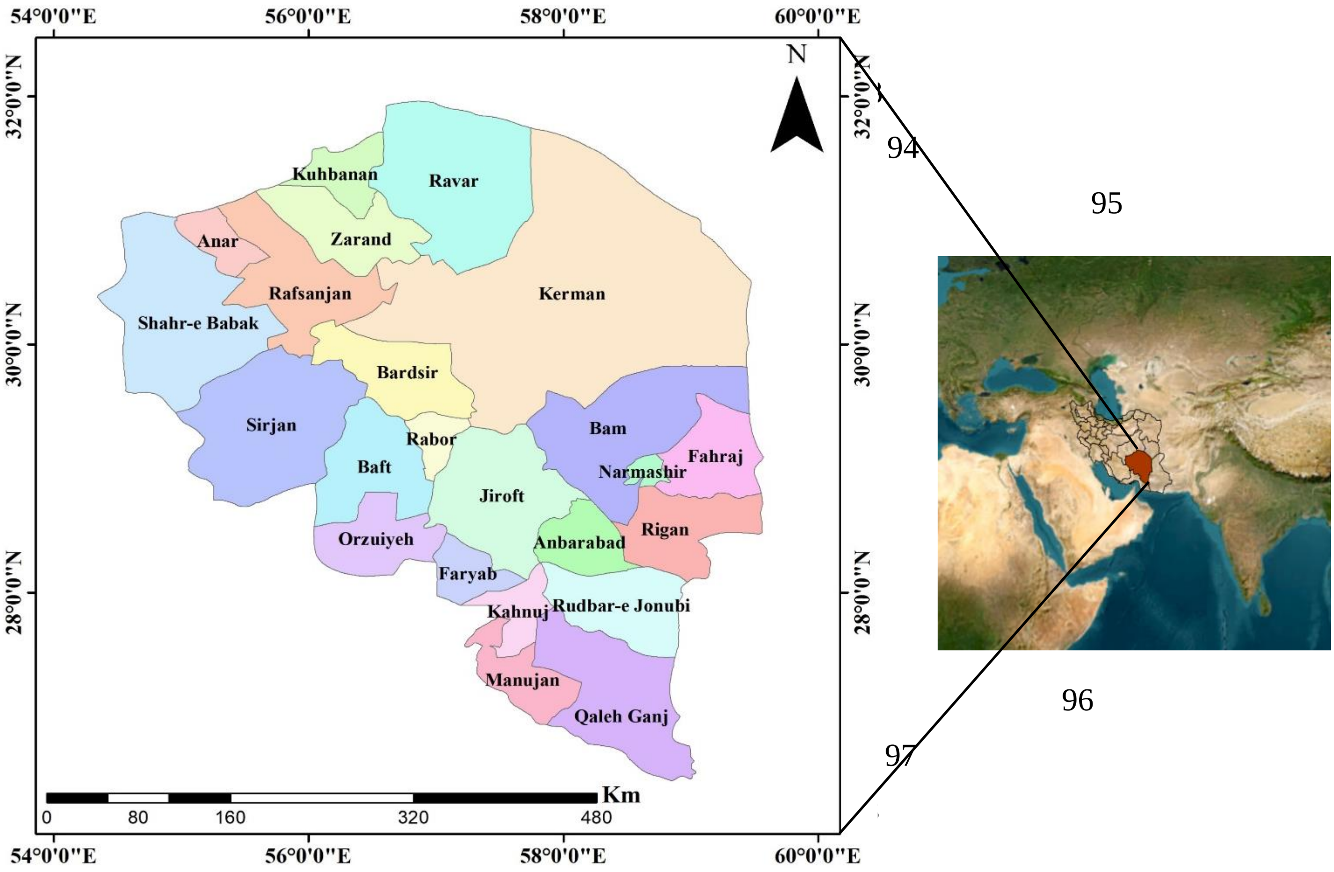

Figure 1. **The site of the study area.**

Much of the research conducted in the domain of fuel and energy consumption within the agricultural sector has predominantly taken a technical approach, with limited exploration of the subject from a social and psychological standpoint (Haji & Hayati, 2022). However, the potential of behavioral sciences to address environmental issues and develop effective interventions appears promising. Environmental psychology, an interdisciplinary field, delves into the influence and interplay between individuals and the environment surrounding them (Gifford *et al.*, 2011). In recent years, various theories have emerged aimed at investigating human behavior patterns in agriculture and environmental contexts. Researchers have examined a range of behavioral theories, including the theory of rational action proposed by Fishbein and Ajzen, the theory of planned behavior introduced by Ajzen, the norm activation theory presented by Schwartz, and Stern's value-belief-norm theory, to explore general patterns of human behavior (Haji & Hayati, 2022). Among these, the theory of planned behavior (TPB) stands out as one of the most renowned behavioral-psychological theories. Widely used to assess factors influencing people's intentions and behavior, TPB underscores the psychological determinants of various human behaviors and serves as a model for understanding a wide array of environmental behaviors, such as soil conservation, water conservation, sustainable transportation, waste recycling, and energy conservation (Ajzen, 1991; Wauters *et al.*, 2010; Clark & Finley, 2007; Cai *et al.*, 2019; Kumar, 2019; Wang *et al.*, 2016). Considered a refinement of the theory of reasoned action formulated by Fishbein and Ajzen in 1975, TPB is widely recognized as one of the most comprehensive theories for predicting behavior in specific contexts (Koen *et al.*, 2013). Klöckner (2013), in a meta-analysis, revealed that nearly 40% of all articles published in the realm of environmental psychology employ TPB as the theoretical foundation of their research. In this study, the theory of planned behavior is utilized to effectively comprehend the predictive factors associated with farmers' behavior concerning optimal fuel consumption in greenhouses. Within this theoretical framework, human behavior is influenced by intentions, which are in turn shaped by the three primary factors of attitude, subjective norms, and perceived behavioral control (Ranjbar *et al.*, 2020).

Subjective norms serve as benchmarks for assessing the influence of social expectations and the impact of others on individual behavior (De Buijn, 2010). Put simply, these norms represent individuals' perceptions shaped by external influences, compelling them to conform to specific behavioral patterns (Wauters *et al.*, 2010). When individuals encounter social expectations prescribing certain actions, they are more inclined to engage in those behaviors (Chen, 2015). Consequently, subjective norms are defined as the perceived social pressure regarding the adoption or avoidance of a particular behavior (Wauters *et al.*, 2010). Experimental research has demonstrated that subjective norms exert a significant influence on pro-environmental behavioral intentions, such as optimal energy consumption (Ru *et al.*, 2019).

Attitudes can be described as intricate and cohesive belief systems that fundamentally predispose individuals to engage in specific behavioral actions and reactions, influencing various aspects of human behavior (Salehi & Emamgholi, 2012). The impact of attitude on future behavior can yield either positive or negative outcomes, potentially resulting in feelings of contentment or discontentment (Fielding *et al.*, 2008). When farmers hold a more favorable attitude toward conserving fuel resources, their behavioral intentions tend to lean towards reduced fuel consumption, and vice versa (Ru *et al.*, 2019). Numerous studies have affirmed that attitude serves as a crucial predictor of behavioral intention (Wauters *et al.*, 2010; Wang *et al.*, 2016).

In the Theory of Planned Behavior (TPB), behavioral intention serves as a pivotal factor in an individual's actual behavior, shaped by both voluntary and involuntary processes (Fielding *et al.*, 2008). Generally, behavioral intentions are more strongly predictive than actual actions, indicating that intention is closely tied to predictive factors rather than real behavior (Ru *et al.*, 2019). Perceived Behavioral Control (PBC) pertains to an individual's subjective assessment of the ease or difficulty associated with carrying out a specific behavior (De Leeuw *et al.*, 2015). As per the provided definition, the higher the perceived level of behavioral control, the more motivated individuals are to execute the desired behavior (Kiriakidis, 2017). Some empirical studies argue that PBC stands as the most significant determinant of behavioral intention (Ru *et al.*, 2019). Additionally, PBC is viewed as a proxy for actual control, which may directly impact behavior (Haji & Hayati, 2022). Figure 2 illustrates that, in line with Ajzen's theory of planned behavior, attitude, subjective norm, and perceived behavioral control collectively influence the intention to achieve optimal fuel consumption in cucumber greenhouses. According to this theory's fundamental tenet, individuals possessing a positive attitude and subjective norm regarding optimal fuel consumption, coupled with a strong perception of control, are more inclined to engage in behaviors conducive to achieving optimal fuel consumption. Hence, research hypotheses were proposed based on the framework depicted in Figure 2:

H1. Farmers' attitude towards optimal fuel consumption in greenhouses has a positive effect on their behavioral intention.

H2. Farmers' subjective norms regarding optimal fuel consumption in greenhouses have a positive effect on their behavioral intentions.

H3. Farmers' perceived behavioral control towards optimal fuel consumption in greenhouses has a positive effect on their behavioral intention.

H4. Farmers' perceived behavioral control towards optimal fuel consumption in greenhouses has a positive effect on their behavior.

H5. Farmers' intention toward optimal fuel consumption in greenhouses has a positive effect on their behavior.

Based on the literature, it has been observed that while there have been some studies conducted on fuel consumption in Iran (Momeni & Rahmati, 2011; Heidari *et al.*, 2011; Behroozeh *et al.*, 2022; Salehi *et al.*, 2024), the majority of them have focused on technical and economic aspects. Therefore, there has been no comprehensive research investigating fuel consumption from a social perspective in the study area. Hence, the current study endeavors, employing the theory of planned behavior, to scrutinize the behavior of greenhouse keepers regarding optimal fuel consumption by altering cognitive patterns.

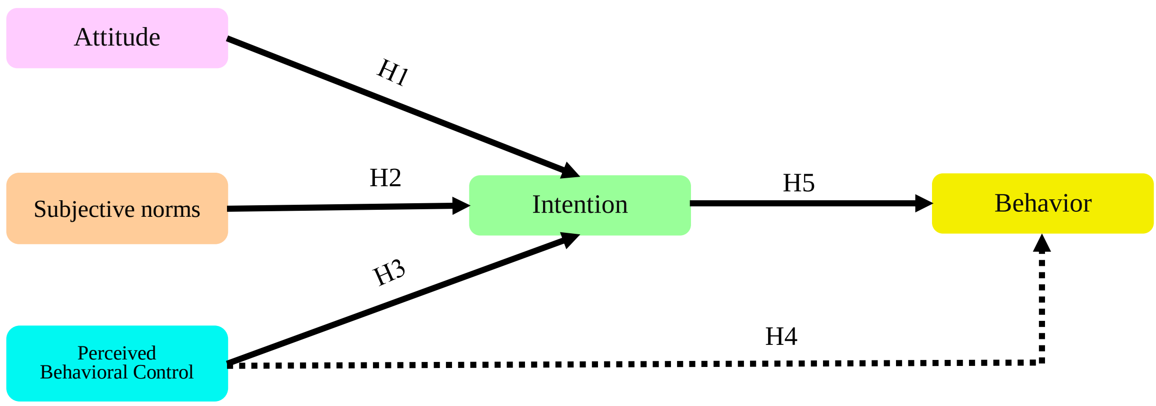

Figure 2. Causal chain of variables in TPB theory (Ajzen, 1991).

Materials and methods

This research is characterized by its practical objective and is classified as field research based on the level of control exerted over the variables. Concerning the data collection method, this study is categorized as descriptive research. Furthermore, with regard to the paradigmatic framework, it aligns with the positivist paradigm, specifically falling under the category of quantitative research (Creswell & Creswell, 2017). This study employed two research methodologies, namely documentary analysis and survey studies, to gather information. The primary objective was to analyze the fuel consumption behavior of agricultural greenhouse owners in Iran, with a focus on optimizing fuel consumption. The target group for this study comprised individuals who own cucumber farming greenhouses in the province of Kerman, Iran. According to data provided by the Agricultural Jihad Organization, their numerical count amounts to 4,946. The determination of the sample size was based on the chart provided by Krejcie and Morgan (1970), which indicated an equivalent of 356 greenhouses. Considering the widespread distribution of cucumber-growing greenhouses across the province and recognizing that Jiroft, Kahnouj, Anbar Abad, and Qaleh Ganj counties collectively account for 92.81% of all cucumber-producing greenhouses in the province, two-stage cluster sampling was employed. To accomplish this, the study region was initially divided into two clusters: large-scale (counties with a cultivated area of land above 100 hectares) and small-scale (counties with a cultivated area of land below 100 hectares). In the second stage, Jiroft was selected from the highly-dense cluster and Kerman from the less dense cluster due to their diverse climatic conditions. Additionally, the number of samples in each cluster was determined based on proportional allocation. To reflect the perspective of greenhouse keepers, data for this research were collected through a researcher-made questionnaire inspired by related studies. The face-to-face method was used to collect survey data, with an interview group formed beforehand. This group consisted of four individuals who were fully acquainted with the culture, language, and customs of the local people. Since most interviewees had minimal education, the group of interviewers occasionally translated questions during face-to-face surveys. After the briefing session with the interviewers, research data were collected. The average duration of data collection in each face-to-face interview was 40 minutes. The first part of the questionnaire segment pertained to the individual attributes of the greenhouse proprietors under investigation, including gender, educational attainment, agricultural background, and level of cultivation expertise.

The second component pertains to the assessment of the constructs within the theory of planned behavior (Attitude: 1- Optimum consumption of fuel makes people healthy (At1), 2- Optimum consumption of fuel leads to the production of healthier products (At2), 3- In my opinion, humans do not have more rights to use resources than other creatures such as plants, animals, etc (At3), 4- Optimum consumption of fuel makes the environment healthier (At4), 5- If I don't use fuel to heat my greenhouse, my production rate will decrease (At5) and 6-Preservation of non-renewable fuel sources (such as diesel, gaz, etc.) depends on their optimal consumption (At6). Subjective norms: 1- If my close friends and acquaintances use fuel optimally, I will also be encouraged to use fuel optimally (No1), 2- I feel that agricultural experts expect me to use fuel optimally in my greenhouse (No2), 3- Reference people and groups such as local leaders, popular organizations, etc. encourage me to use fuel efficiently (No3), 4- The sources of information that others use for optimal fuel consumption are important to me (No4), 5- Greenhouse owners who use fuel efficiently have lower production costs (No5), 6- I believe that the government should specify fines for people who use various types of fuel excessively (No6). Perceived Behavioral Control: 1- I believe that optimal fuel consumption is entirely up to me (Co1), 2- The decision to use optimal fuel in my greenhouse is under my control (Co2), 3- I believe that various issues and problems cannot prevent optimal fuel consumption in my greenhouse (Co3), 4- It is easy for me to understand how to use fuel optimally (Co4), 5- Optimum consumption of fuel is easy for me (Co5), 6- If I want, I can act on the optimal consumption of fuel in my greenhouse (Co6). Intention: 1- I have a desire to be fuel efficient in my greenhouse in the future (In1), 2- I am in the process of planning for optimal fuel consumption in our greenhouse (In2), 3- I seriously recommend the optimal consumption of fuel to other greenhouse owners (In3), 4- I am going to attend classes to learn how to use fuel optimally (In4), 5- I intend to use fuel optimally for the health of humans and other creatures (In5), 6- I plan to use fuel optimally in my greenhouse to protect the environment (In6). Behavior: 1- I pay attention to the cracks and small holes in the greenhouse cover (Be1), 2- I use insulated doors, windows and ventilation valves (Be2), 3- I use a thermometer in the greenhouse (Be3), 4- I use thermostatic heaters in the greenhouse (Be4), 5- I use energy saving curtains (thermoscreen curtains) in the greenhouse (Be5), 6- The entrance to my greenhouse is a waiting room (Be6), which were evaluated using a five-point Likert scale ranging from "completely agree" (scored as 5) to "completely disagree" (scored as 1). The data were analyzed using both descriptive and inferential methods. The descriptive portion of the analysis employed frequency distribution data, percentages, minimum and maximum values, as well as the standard deviation. The ISDM technique was employed to assess the overall state of the components within the model of planned behavior among cucumber growers regarding achieving optimal fuel consumption. This particular approach is frequently chosen as a viable choice for qualitatively describing research variables (Shariatzadeh & Bijani, 2022). This approach involves converting received points into four distinct levels: negative, relatively negative, relatively positive, and positive. The conversion process is as follows: the average, denoted as "mean," is calculated, along with the standard deviation from the average, denoted as "SD."

A< Mean-Sd	Negative	1
Mean-Sd≤ B< Mean	Relatively Negative	2
Mean≤ C< Mean+Sd	Relatively Positive	3
D ≥Mean+Sd	Positive	4

In the inferential part, structural equation modeling based on partial least squares (SEM-PLS) was also used to test the hypotheses. This method aids in the simultaneous evaluation of both the measurement model and the structural model. Third-generation PLS, as a structural equation model, is an effective method for discovering relationships between latent variables measured by observed variables (Haji & Valizadeh, 2024). A two-step approach was employed to conduct SEM and evaluate whether the proposed research framework fits the data. In the first stage, the results of the measurement model (external) were presented to assess the reliability and validity of the structural criteria. In essence, the measurement model evaluates the degree of compatibility between the theoretical model and the experimental research model. The second stage involves evaluating the structural model (internal) and assessing the causal correlation between the latent variables presented in the conceptual model (Savari *et al.*, 2021). Data analysis was conducted using SPSS22 and Smart PLS3 software.

Results and Discussion

Demographic Properties

Upon analysis of the demographic characteristics of the greenhouse owners under investigation, it was observed that the mean cultivation area of cucumber greenhouses in the designated region is 12,952.25 square meters. Furthermore, the mean duration of cucumber greenhouse cultivation among the participants under investigation was observed to be 8.83 years, with a standard deviation of 3.564. Additionally, the average number of years of education completed by the respondents was found to be 11.12 years, with a standard deviation of 5.24. Furthermore, the study revealed that 6% of the participants, including 22 individuals, were female, while the remaining 94% of the sample, consisting of 334 individuals, were male.

Leveling of the components of the planned behavior model

The analysis of the components of the planned behavior model among cucumber greenhouse owners, as presented in Table 1, indicates that greenhouse owners generally hold favorable attitudes and perceive good social norms towards optimal fuel consumption. However, despite these behaviors, the greenhouse owners' perceived intention and behavioral control toward achieving optimal fuel consumption are generally unfavorable. The behavior of optimal fuel consumption is associated with the lowest overall average (2.36). Hence, despite the presence of a favorable attitude and prevailing social norms, the greenhouse owners under investigation tend to deviate from optimal fuel consumption in their actual behavior. The behavior of greenhouse owners reflects their current actions and provides insight into their attitudes and intentions regarding plans for optimizing fuel consumption. Consequently, by addressing and overcoming perceptual barriers among greenhouse owners through promotion and removal strategies, the likelihood of achieving optimal fuel consumption is highly promising.

Table 1. **Leveling the situation of TPB model variables among the studied farmers.**

Variable	Mean *	Sd	levels	Frequency	Percent
Behavior	2.36	0.931	Negative	51	14.3
			Relatively Negative	188	52.8
			Relatively Positive	35	9.8
			Positive	82	23
Intention	3.97	1.03	Negative	54	15.2
			Relatively Negative	147	41.3
			Relatively Positive	92	25.8
			Positive	63	17.7
Perceived Behavioral Control	2.39	0.663	Negative	60	16.9
			Relatively Negative	142	39.9
			Relatively Positive	79	22.2
			Positive	75	21.1
Subjective Norms	4.35	0.974	Negative	79	22.2
			Relatively Negative	76	21.3
			Relatively Positive	139	39
			Positive	62	17.4
Attitude	3.68	0.948	Negative	73	20.5
			Relatively Negative	67	27.2
			Relatively Positive	125	35.1
			Positive	61	17.1

Assessment of the research structural model

In order to check the fit, validity and reliability of the research constructs, namely attitude, subjective norms, perceived behavioral control and the intention of greenhouse owners regarding their behavior in optimal fuel consumption, various indicators were used (Suggested value: SRMR<0.1, D-G1>0.05, D-G2>0.05, NFI>0.90). Upon comparing the acquired values of the fit with the desired values, it is evident that all of these values fall within the standard range (Estimated value: SRMR=0.08, D-G1=3.05, D-G2=1.92, NFI=0.72). Consequently, it can be inferred from the presented indicators that the model employed to examine the behavior of farmers about optimal fuel consumption exhibits a favorable fit.

Unidimensionality

This step was assessed by factor loading and t-values. According to the values presented (Table 2), it can be claimed that the factor loading values presented for selected markers were statistically significant (above 0.7) and at the one percent error level (P<0.01). The results confirmed the unidimensionality of the selected markers. Therefore, it can be concluded that the markers were selected correctly for the evaluation of research structures that measure exactly the same component.

Reliability and validity

In this step, the Combined Reliability (CR), Cronbach's alpha, and Average Variance Extracted (AVE) were examined. The results presented in Table 2 indicated that the CR of all the structures in the proposed research model was more than 0.90 and their Cronbach's alpha coefficients were more than 0.90. Moreover, the AVE for all structures of the proposed research model was above 0.70. Therefore, all latent variables had high reliability and validity, meaning that the items measuring the research structures were carefully selected and allowed the experiment to be repeated.

Table 2. The results of fit of measurement models.

Variable	Variable	λ	t	Reliability and validity statistics
Attitude	At1	0.835	56.865	**AVE: 0.732 CR: 0.942 a: 0.927**
	At 2	0.866	55.225	
	At 3	0.822	32.149	
	At 4	0.802	36.844	
	At 5	0.920	107.264	
	At 6	0.885	76.597	
Behavior	Be1	0.793	27.142	**AVE: 0.700 CR: 0.933 a: 0.914**
	Be2	0.808	29.782	
	Be3	0.814	33.015	
	Be4	0.899	63.033	
	Be5	0.891	83.384	
	Be6	0.808	25.525	
Perceived Behavioral Control	Co1	0.788	30.416	**AVE: 0.760 CR: 0.950 a: 0.936**
	Co2	0.913	79.832	
	Co3	0.856	59.916	
	Co4	0.889	77.069	
	Co5	0.935	130.050	
	Co6	0.842	51.278	
Intention	In1	0.878	65.509	**AVE: 0.773 CR: 0.953 a: 0.941**
	In2	0.917	99.031	
	In3	0.827	43.804	
	In4	0.865	58.913	
	In5	0.916	114.340	
	In6	0.868	62.908	
Subjective Norms	No1	0.745	14.893	**AVE: 0.710 CR: 0.936 a: 0.923**
	No2	0.783	22.780	
	No3	0.756	15.789	
	No4	0.932	81.172	
	No5	0.877	56.918	
	No6	0.939	115.575	

Discriminant validity

Diagnostic validity exists when questions measuring one variable are distinct or distinguishable from questions measuring other variables. Based on statistics, the research variables are of adequate diagnostic validity if the root mean of the calculated AVE variance between them is greater than the correlation between them (Fornell, 1992). According to the results presented in Table 3; it can be seen that the root mean of the extracted variance for the research structures ($0.84 < AVE < 0.88$) was more than the correlation between them ($0.26 < r < 0.68$). This result confirmed the diagnostic validity of the structures in the proposed research model.

Table 3. **Correlations with square roots of the AVEs.**

Constructs	Attitude	Behavior	Control	Intention	Norm
Attitude	0.86[a]				
Behavior	0.32**	0.84[a]			
Perceived Behavioral Control	0.45**	0.52**	0.87[a]		
Intention	0.39**	0.68**	0.45**	0.88[a]	
Subjective Norms	0.31**	0.26**	0.26**	0.43**	0.84[a]

[a] The square roots of AVE estimate. **Correlation is significant at the <0.01 level.

Test of the research hypotheses

At this stage, the results of the final effect of variables on farmers' behavior in optimal fuel consumption are presented (Table 4). Consequently, the bootstrapping approach was employed to examine the research hypotheses. The findings indicated that all research hypotheses were validated under Ajzen's model of the theory of planned behavior. Based on the findings of this study, the research variables incorporated in this model can account for 51.1% of the variance seen in farmers' behavior about optimal fuel consumption.

Table 4. Results of research hypotheses.

Hypothesis	λ	t	Result	VIF	R^2	Q^2
H1: Attitude →Intention	0.156	2.654	Confirm	1.232		
H2: Subjective Norm → Intention	0.301	6.1	Confirm	1.125	0.326	
H3: Perceived Behavioral Control → Intention	0.304	5.346	Confirm	1.284		**0.33**
H5: Intention → Behavior	0.555	11.148	Confirm	1.255		
H4: Perceived Behavioral Control →Behavior	0.264	4.658	Confirm	1.256	0.511	

The study utilized structural equation modeling (SEM) to evaluate the hypotheses and explore the relationship and impact of attitude, subjective norms, perceived behavioral control, and behavioral intention on the dependent variable, namely optimal fuel consumption behavior among owners of cucumber greenhouses. Figures 3 and 4 illustrate the research route model, demonstrating standardized and statistically significant factor loadings. According to the analysis, the coefficient for the attitude variable is determined to be 0.16, with a corresponding t-value of 2.65. These results suggest that attitude significantly influences the intention to achieve optimal fuel consumption, with a confidence level of 99%. Therefore, the first research hypothesis was confirmed. Several other researchers (Wauters *et al*., 2010; Wang *et al*., 2016; Haji *et al*., 2021) have also concluded that a significant correlation exists between individuals' attitudes and their behavioral intentions. According to the theory of planned behavior, behavior is not directly influenced by attitude, but rather through the mediating factor of behavioral intention, which ultimately explains behavior (Bamberg & Moser, 2007). Hence, to bring about any alteration in the intention to achieve optimal fuel consumption among greenhouse owners, it is imperative to transform their attitudes towards excessive fuel consumption and its ramifications on human health and the environment. Recognizing the interdependence between the preservation of non-renewable fuel supplies and their optimal consumption is crucial.

The subjective norm, which has a coefficient of 0.30 and a t-statistic value of 6.1 at the 99% confidence level, demonstrates a statistically significant and beneficial impact on the intention for optimal fuel consumption. This finding confirms the second hypothesis. The findings of this study align with those reported by Wang *et al* (2016) and Ru *et al* (2019), indicating that the mean score for subjective norms (4.35) surpasses the mean score for perceived behavioral control (2.39). This observation supports the notion that optimal fuel consumption by others has a favorable impact, particularly for greenhouse owners. Hence, if the peers of greenhouse owners endorse the concept of optimal fuel use, it is likely to foster a greater intention towards optimal fuel consumption among them. This result is consistent with findings obtained by other scholars (Bond *et al.*, 2009) across diverse disciplines. In contrast, the variable of perceived behavioral control has a coefficient of 0.30 and a t-statistic value of 5.35, signifying a statistically significant impact on the intention to engage in optimal fuel consumption at a confidence level of 99%. This variable has also had a significant impact on the behavior of optimal fuel consumption, as evidenced by a coefficient of 0.26 and a t-statistic value of 4.66. Accordingly, the third and fourth hypotheses of the study were confirmed as well. Several other researchers (Ru *et al.*, 2019; Fielding *et al.*, 2008; Haji & Hayati, 2022) have similarly concluded that a notable correlation exists between perceived behavioral control and both intention and behavior. If the greenhouse owners feel that they have control over the way to consume non-renewable fuel resources, they will have a positive intention towards optimal fuel consumption. In other words, greenhouse owners who see themselves as accountable for optimal fuel consumption and implement effective strategies in this regard will inherently engage in more supportive behaviors towards fuel consumption.

Moreover, the coefficient of 0.56 was utilized to estimate the intention of achieving optimal fuel consumption. The results indicated that the intention of greenhouse owners had a significant impact on their behavior regarding optimal fuel consumption, with a 5% error level. This finding confirms the final hypothesis of the study. Additionally, several other researchers (Ru *et al.*, 2019; Haji *et al.*, 2021; Haji & Hayati, 2022) have also concluded that a significant relationship exists between individuals' intentions and their subsequent behaviors.

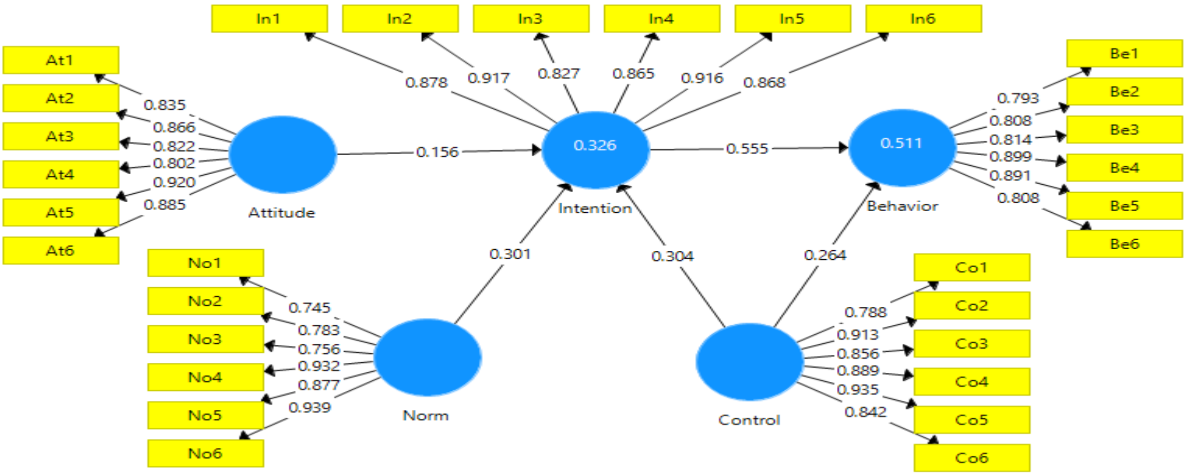

Figure 3. **Path model with standardized factor loadings.**

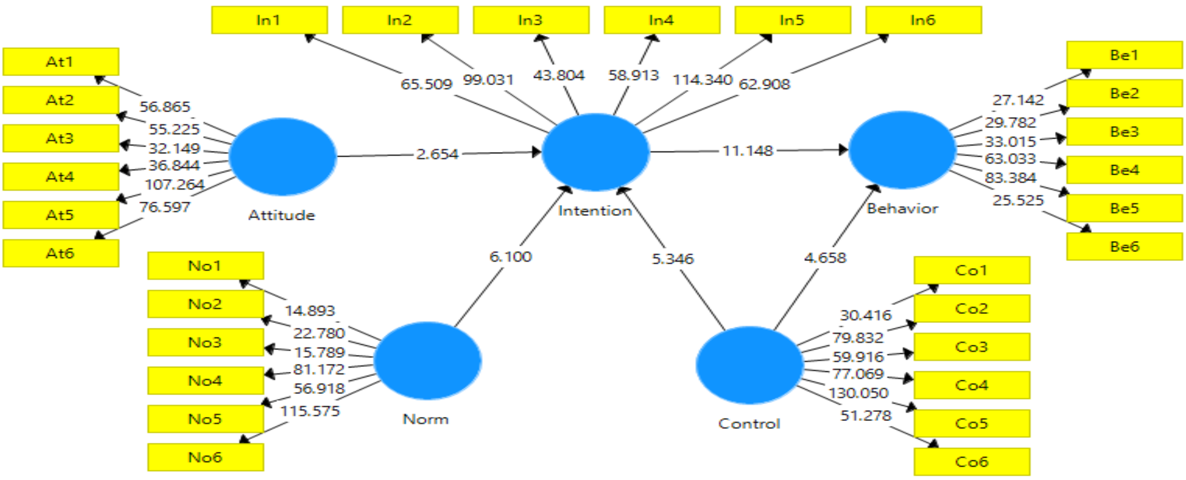

Figure 4. **Path model with *t*-values.**

Conclusions

This study employed the planned behavior model to examine the intention and behavior associated with achieving optimal fuel consumption in agricultural greenhouses. The farmers under study exhibited a favorable attitude and intention, coupled with behavioral control, in their efforts to achieve optimal fuel consumption. This observation indicates an appropriate context for achieving maximum efficiency in fuel consumption. However, in practical application, it was observed that the fuel consumption situation among the greenhouse owners was suboptimal. According to the findings, it has been determined that intention is the primary determinant in explaining the behavior associated with achieving optimal fuel consumption. Hence, employing the training and implementation of effective fuel consumption practices and experience observed among greenhouse owners can serve as a potential resolution to this issue. The findings of the study indicated that farmers exhibit a generally favorable attitude towards achieving optimal fuel consumption, as evidenced by their positive attitudes and intentions in this regard. Hence, the limited adoption of optimal fuel consumption strategies might be attributed, in part, to the greenhouse owners' incapacity to employ such techniques. Consequently, providing support to greenhouse owners who prioritize healthy production practices can potentially influence their attitudes, resulting in increased focus on minimizing fuel consumption and mitigating environmental pollution. Furthermore, the establishment of an association for greenhouse owners can facilitate the sharing of knowledge and perspectives among greenhouse owners in the region. This platform can prove invaluable in disseminating successful strategies for enhancing energy consumption efficiency in agricultural greenhouses. In contrast, considering the high average of subjective norms, greenhouse owners are largely influenced by influential people around them. Hence, the provision of extension training to prominent farmers and influential individuals within the local community can serve as a pivotal factor in broadening the awareness of all farmers about the implementation and utilization of optimal fuel consumption techniques in agricultural greenhouses.

Considering the suboptimal fuel consumption behavior observed within the greenhouses under study, policymakers aiming to improve fuel efficiency should prioritize strategies that encourage the adoption of environmentally conscious practices and their integration among greenhouse owners. Achieving this goal can involve utilizing agricultural extension and training field agents. Therefore, authorities have the ability to share information and skills with other entities regarding the optimal use of fuel resources. This can be accomplished through providing educational and promotional services, which include spreading effective practices used by efficient units and improving managerial expertise and experience across different units.

The consideration of socio-cultural factors associated with and impacting optimal fuel consumption is crucial within the agricultural sector. The primary focus of this endeavor lies in promoting a culture that prioritizes optimal fuel usage. In this regard, several effective strategies for promoting this culture in agriculture include transitioning from a purely quantitative-based selection of sample producers, which often leads to indiscriminate fuel consumption, to a more comprehensive approach considering both quantitative and qualitative aspects of fuel consumption.

To improve fuel efficiency, organizing an agricultural greenhouse festival to promote energy efficiency is proposed. This initiative would involve disseminating timely and comprehensive information to greenhouse owners through promotional agents and local and regional media channels. Additionally, efforts would be made to plan and develop educational-promotional courses relevant to this topic. Moreover, the implementation of incentive programs for greenhouse owners, gradually phasing out agricultural input subsidies, and targeted allocation of agricultural subsidies are significant factors in fostering a culture of optimal fuel consumption.

Promoting civil responsibility for fuel consumption in agriculture is also crucial. In this context, the informative contribution of extension officers from agricultural organizations can be highly valuable. Enlightenment programs can effectively persuade farmers to recognize that prevailing challenges and concerns regarding environmental degradation and the generation of harmful products stem from excessive energy use in the agricultural sector. Therefore, individuals have the capacity to contribute to resolving this issue by assuming responsibility for both environmental preservation and human well-being.

Research Limitations and pathway for future studies

There were several significant limitations in the research process. This study focused on analyzing the behavior of greenhouse growers regarding the optimal consumption of fuel, specifically examining cucumber greenhouse producers. Therefore, exploring the fuel consumption behavior of other greenhouse owners, such as those cultivating tomatoes, eggplants, strawberries, etc., could provide a fresh perspective on optimal fuel consumption practices. The primary reason for the limited access to other greenhouse owners and their inability to grow various crops in greenhouses is geographical constraints. Therefore, future studies are recommended to include additional farmers involved in cultivating various greenhouse crops, such as eggplants, tomatoes, strawberries, and so on, to comprehensively analyze optimal fuel consumption behavior. Analyzing the behavior of cucumber-growing greenhouses in terms of optimal fuel consumption, based on the theory of planned behavior, is crucial for understanding the disparities and orientations of agricultural policies across different regions and with diverse types of greenhouse crops. However, future researchers may consider employing other behavioral models or a combination of behavioral models to investigate optimal fuel consumption behavior based on the specific focus of their study.

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تحلیل رفتار خیارکاران گلخانه ای در مصرف بهینه سوخت در ایران: کاربرد رویکرد منطقی

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چکیده

مصرف بی رویه سوخت در محصولات گلخانه ای آسیب های جبران ناپذیری به محیط زیست و در نهایت سلامت انسان وارد کرده است. بنابراین، مطالعه حاضر نیاز به تغییر الگوهای ذهنی در مورد نوع و روش مصرف بهینه سوخت را برجسته می کند. پژوهش حاضر با هدف تحلیل روانشناختی رفتار محیطی گلخانه داران با استفاده از تئوری رفتار برنامه ریزی شده (TPB) انجام شد. این پژوهش توصیفی- همبستگی است. جامعه آماری پژوهش را پرورش دهندگان خیار گلخانه ای استان کرمان (4946 نفر) تشکیل می دادند که از بین آنها 356 نفر به روش نمونه گیری خوشه ای به عنوان نمونه انتخاب شدند. حجم نمونه با استفاده از جدول کرجسی و مورگان برآورد شد. داده ها با استفاده از پرسشنامه ساختاریافته و محقق ساخته جمع آوری شد و روایی و پایایی آن (α= 0/94-0/91) با استفاده از شاخص های مختلف تأیید شد. برای آزمون فرضیه های تحقیق از نرم افزار Smart-PLS3 استفاده شد. یافته های پژوهش نشان داد که تأثیر سه متغیر نگرش، هنجار ذهنی و کنترل رفتاری ادراک شده بر قصد از نظر آماری معنادار است. علاوه بر این، بر اساس نتایج مدل‌سازی معادلات ساختاری، قصد به‌طور معناداری رابطه بین متغیرهای وابسته و مستقل را واسطه‌ای کرد. همچنین متغیرهای مستقل توانستند به ترتیب 32% و 51% از واریانس نیت رفتاری و رفتار محیطی گلخانه داران را در مصرف بهینه سوخت به خود اختصاص دهند. با توجه به اینکه انگیزه درونی پایدار یا نیات قوی برای حفظ رفتار بلندمدت ضروری است، توصیه می‌شود که سیاست‌ها و برنامه‌هایی با تمرکز بر توسعه و ارزیابی مداخلات رفتاری برای ترویج رفتارهای مصرف سوخت به طور گسترده بر تقویت نیات گلخانه‌داران متمرکز شوند. در شرایط مساعد و با انگیزه، افراد تمایل بیشتری به مصرف بهینه سوخت دارند. یافته‌های این مطالعه بینش‌های ارزشمندی را برای سازمان‌های دولتی، سیاست‌گذاران، عوامل ترویج و آموزش کشاورزی و محققان علاقه‌مند به ابداع استراتژی‌هایی برای کاهش مصرف سوخت‌های فسیلی ارائه می‌کند.