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Psychological Determinants of Turkish Farmers' Health and Safety Behaviors: An Application of the Extended Theory of Planned Behavior

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Abstract: Background: Structural and behavioral factors are among the causes of occupational accidents in agriculture. The SACURIMA Cost network developed a questionnaire to measure the determinants of farmers' safety behavior based on the extended theory of planned behavior (TPB). Extended TPB adds subjective norms, subjective control, physical barriers and safety culture to TPB. Objective: The aim of this study is to test the psychometric properties of the "Farmers Safety Behaviors questionnaire" developed by the SACURIMA Cost network. Methods: A Turkish version of the questionnaire was applied to 305 farmers producing six different agricultural products in Turkey. The tool consists of 64 items measuring the determinants of four risk-related behaviors (fall prevention, machine handling, chemical-pesticide use, and animal handling) in a single extended TPB model. Results: The alpha values for the six dimensions ranged from 0.69 to 0.89. The confirmatory factor analysis results for all dimensions were at acceptable levels (CFI range = 0.93–0.99; RMSEA range = 0.03–0.09). Four path models were used to test the behaviors and their predictors, and the results were found to be predictive. The criterion and known groups' validity analyses results were sufficient. Conclusion: The "Farmers Safety Behaviors Questionnaire" is a valid and reliable tool to measure the determinants of occupational safety behaviors in Turkish farmers.

Keywords: theory of planned behavior; psychometrics; occupational health; farmers

Citation: Baydur, H.; Eser, E.; Sen Gundogan, N.E.; Ayhan, E.; Eser, S.; Dede, B.; Hazneci, E.; Öztekin, Y.B.; Ekuklu, G.; Cevizci, S.; et al. Psychological Determinants of Turkish Farmers' Health and Safety Behaviors: An Application of the Extended Theory of Planned Behavior. *Agriculture* **2023**, *13*, 967. https://doi.org/10.3390/agriculture13050967

Academic Editors: Xiangming Fang and Gioacchino Pappalardo

Received: 19 February 2023
Revised: 17 April 2023
Accepted: 25 April 2023
Published: 27 April 2023

1. Introduction

Farming is widely recognized as a hazardous and unhealthy occupation. Worldwide, at least 170,000 agricultural workers are killed each year [1]. In Europe, approximately 20–25% of the nearly 3500 workplace fatalities recorded annually are related to agriculture [2]. The non-fatal accident rate in agriculture is approximately 1500 accidents per 100,000 workers [3], and between 2010 and 2019, the agricultural sector has seen the highest increase in occupational accidents among all business sectors [2]. Nearly a third of the injuries in agriculture happen during machinery maintenance and repair, with tractor accidents resulting from jumping, slipping or falling from the tractor access point being the

most common cause of injuries on farms. Other causes of injuries or health problems among farmers include falls, exposure to hazardous chemicals, and animal-related accidents [4–9].

The causes of work accidents can be classified into two main types: structural and behavioral factors [10]. Structural factors refer to those that exist in the work environment, such as working conditions, equipment and technology, or the nature, volume, and processes involved in the work. Behavioral factors, on the other hand, are unsafe practices performed by workers that can lead to accidents, such as unsafe handling of machines or animals, failure to wear protective gear, or non-adherence to safety guidelines.

Effective prevention of occupational accidents can only be achieved when both types of factors, structural and behavioral, are taken into consideration [11]. Yet while efforts to prevent occupational accidents by addressing structural factors through increasing the safety of equipment and improving the conditions of work have been relatively successful, addressing unsafe behavior remains a challenge. Research has shown that farm safety education programs can be effective in promoting safer behavior [12–14], but certain conditions must be fulfilled. One key condition is that education goes beyond just providing information about potential risks and addresses the range of factors that can influence farmers' decisions to behave safely, such as attitudes, perceived norms, perceived risks, competences, habits, or the safety culture within the farmers' community.

Psychological factors are elucidated in health behavior models, but only very few farm safety education programs are based on such models [15]. Of the various behavioral models that have been developed to explain behaviors of people in specific situations, one of the most widely used is the theory of planned behavior (TPB), developed by Ajzen (1991) [16,17]. This model aims to explain intentional behavior (i.e., behavior which a person chooses to perform) by referring to a cognitive reflection process involving different beliefs. When applied to safety behavior, it would hold that a person's safe behavior is based on his or her intention to perform that behavior, and that this intention is in turn influenced by attitudes towards the behavior (based on the expected outcomes and their subjective value), subjective norms (or the belief of what other people think about the behavior or do themselves), and subjective control (or the subjective belief whether or not one is capable of performing the behavior). The TPB has been found effective in explaining and predicting a range of health-related behaviors such as smoking, healthy eating, engaging in physical activity, or participating in health screening. Studies based on TBP have been mostly carried out in industrial enterprises [18–20], but have been very rarely done in the occupational sectors that concern the whole society, such as agriculture, having occupational hazards. A small number of studies have also applied the model to safety behavior in agriculture [15,21], showing that the use of the model allows for a better prediction of the intentions and/or of the safety behaviors of interest. Therefore, this study may provide an opportunity to examine the impact of TPB determinants on occupational accidents in the agricultural environment where TPB has not been adequately studied and where major occupational accidents occur in many countries.

However, as the TPB only considers individual determinants of safety behavior and does not take account of factors in the social and physical environment that can also influence safety behavior, some authors have suggested the extension of the model by adding other variables, such as habits, moral norms, physical or social barriers that may impede safe behaviors, or "cues to action", i.e., elements in the environment that may act as a stimulus to act on an intended behavior. Another potential contributor to safety behavior in agriculture is safety culture [22,23]. Safety culture is defined as the combination of employees' perceptions, beliefs and attitudes towards the overall safety of the work environment [24]. It also includes behaving in a way that prioritizes workers' own safety as well as the safety of those around them. Briefly, safety culture refers to how occupational safety is managed in the working environment. The core TPB model is primarily used in the industrial sector, and there are fewer studies using the extended TPB model. One of the two main points that distinguishes our study from these studies is that this study is

conducted on farmers, and the other is that the extended TPB model we used in this study includes safety culture and barriers.

To date, the determinants of safe behavior in agriculture have not been sufficiently addressed. As a result, interventions to prevent accidents and injuries on farms may lack effectiveness. Well-targeted, evidence-based interventions to improve health, safety and risk management in agriculture must start from an identification of the behaviors that are unsafe, as well as of the factors that determine these safety behaviors and practices. Therefore, there is a need for adequate and well-validated tools to measure these concepts.

A questionnaire measuring farmers' safety behaviors and its determinants, based on an extended version of the theory of planned behavior, was developed by the SACURIMA COST Action Network (CA16123). This network was a coalition of organizations working on Occupational Safety and Health in the Agriculture sector in 39 countries between 2017 and 2021 [25]. One of the several purposes of the SAUCURIMA COST Action Network was to determine the safety practices of farmers and investigate the variables that affect them. The measure that was developed to that effect is a self-report survey questionnaire consisting of 81 questions measuring the respondent's injury history, safety practices with regard to the four key risk behaviors (fall prevention, machinery handling, handling chemicals and pesticides, and animal handling), the socio-cognitive determinants underlying these practices as represented in the TPB (expectancy based attitudes, perceived norms, perceived control, behavioral intentions), safety culture, and physical obstacles to safety practices. A previous version of this questionnaire had been developed and validated by Colémont and Van den Broucke [23]. The questionnaire was applied to a sample of 1642 farmers from twelve different countries, revealing that all four of the safety behaviors are to a significant extent determined by socio-cognitive factors such as attitudes, perceived social norms and perceived control, but also by factors in the social and physical environment, notably the safety culture within the farmers' community and perceived obstacles. The preliminary psychometric properties of the questionnaire based on the data of the twelve participating countries are reported in the SACURIMA COST Action report. The highest dimension score for the four behaviors, which were the main focus of the study, was obtained from the animal handling and chemical and pesticide handling dimensions and, fall prevention and chemical/pesticide handling were the behaviors that best predicted accident experience from these four behaviors in the SACURIMA study [26].

The present study aimed to test the psychometric properties of the "Farmers Safety Behaviors Questionnaire" that was developed for the SACURIMA COST Action Network using data collected from farmers in Turkey.

2. Materials and Methods

2.1. Procedure and Study Design

The study was conducted in two phases. In the first phase, the survey questionnaire developed for the SACURIMA COST Action Network was translated into Turkish and checked for cross-cultural fit and applicability. In the second phase, data were collected from Turkish farmers to examine the psychometric properties, including reliability and validity of the Turkish version of the questionnaire.

2.2. Translation and Adaptation

For the translation and adaptation into Turkish, four consecutive steps were followed: (1) development of a consensus Turkish version based on the two independent forward translations, (2) a backward translation of the consensus forward version by a bilingual person, (3) cognitive interviews with five farmers to ensure conceptual clarity of the tool and to find incomprehensible words, phrases or response scales and correct them as needed, and development of a field trial version of the tool, and (4) application of the field trial version to the farmers [27].

2.3. Instrument

The "Farmers Safety Behaviors questionnaire" consists of 64 items measuring four risk-related behaviors (fall prevention, machine handling, chemical-pesticide use and animal handling), as well as the determinants of these behaviors (attitude towards behavior (ATB), subjective norms (SN), perceived behavioral control (PBC) and behavioral intention (BI)) included in the theory of planned behavior (TPB). Safety culture (SC) (5 items) and barriers (B) (7 items) are included in the instrument in addition to these determinants. The questions regarding behavior and their determinants had to be answered using Likert-type scales (1 = never, 5 = always for the behaviors; and 1 = strongly disagree, 5 = strongly agree for the socio-cognitive and safety culture items). For three of the four safety practices and their socio-cognitive determinants, the questions were preceded by a filter question (Do you work with machines/chemicals and pesticides/animals on your farm–yes/no), that allows farmers who do not work with these items to skip parts of the questionnaire and save time.

The item characteristics and numbers of these four behaviors are as follows:

- There are 12 items in the instrument about "fall Prevention": four items are related to the "measured reported behavior" (for example: read manual carefully;) and there are two additional items each for "attitudes toward behavior", "subjective norm", "perceived behavior control" and "behavior intention" in the instrument.
- "Machine handling" consists of four items on "measured reported behavior" (e.g., make sure floors are always dry) and two items each for "attitudes towards behavior", "subjective norm", "perceived behavior" and "behavior intention". The total number of items is also 12.
- The tool consists of 15 items on "chemical-pesticide use": five of them deal with "measured reported behavior" (e.g., read the instructions through before I start working). The tool also includes three items for "attitudes towards behavior", three items for "subjective norm", two items for "perceived behavioral control" and two items for "behavioral intention".
- "Animal handling" scale consists of 13 items and four of them deal with "measured reported behavior" (e.g., use restraining or handling facilities). The tool also includes three items for "attitudes towards behavior", two items for "subjective norm", two items for "perceived behavioral control" and two items for "behavioral intention".

2.4. Sample and Data Collection

Using Rouquette and Falissard's [28] recommendation for sample size determination for validation studies, a sample size of 300 participants was considered sufficient. Using a convenience sampling approach, a total of 305 farmers were selected from six different regions of Turkey, representing the diversity of major agricultural activities in the country. The inclusion criteria for participation in the study were 18 years old or older, earning a living from agriculture, and having sufficient cognitive competences. If more than one farmer from the same family or a farm volunteered for the study, only one was allowed to participate. Female farmer participation was encouraged.

Table 1 summarizes the key sociodemographic characteristics of the study participants. The majority of the participants were male (74.8%), with a mean age of 44.9 $\pm$ 13.8 years. About 4.6% of the farmers were illiterate, while 31.1% had primary education (5 years) and 64.3% had higher education (8 years or more). Nearly all the participants (93.2%) had not received any vocational training courses. The majority of the farmers produced subsistence agriculture (64.6%) and were working full-time in agriculture (68.9%). The main farm activities included viticulture, horticulture, hazelnut, tea and rice farming, olive and various fruit growing, and animal husbandry. The majority of the participants (79.0%) were owners of the land they cultivated. In the last ten years, 23.9% of the participants reported having had a work accident, while 19.7% reported having witnessed accidents.

Table 1. Sociodemographic characteristics of participants.

Variables	Freq.	%
Age		
Mean (SD)	44.9 (13.8)	
Median (min–max)	44 (20–81)	
Gender		
male	228	74.8
female	77	25.2
Education		
Illiteracy	14	4.6
Primary	95	31.1
Secondary	74	24.3
High school	89	29.2
University	33	10.8

2.5. Ethical Issues

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Manisa Celal Bayar University, School of Medicine, Ethic Committee of Health Sciences (protocol code 20.478.486 and date of approval 3 November 2020). Informed consent was obtained from all subjects involved in the study.

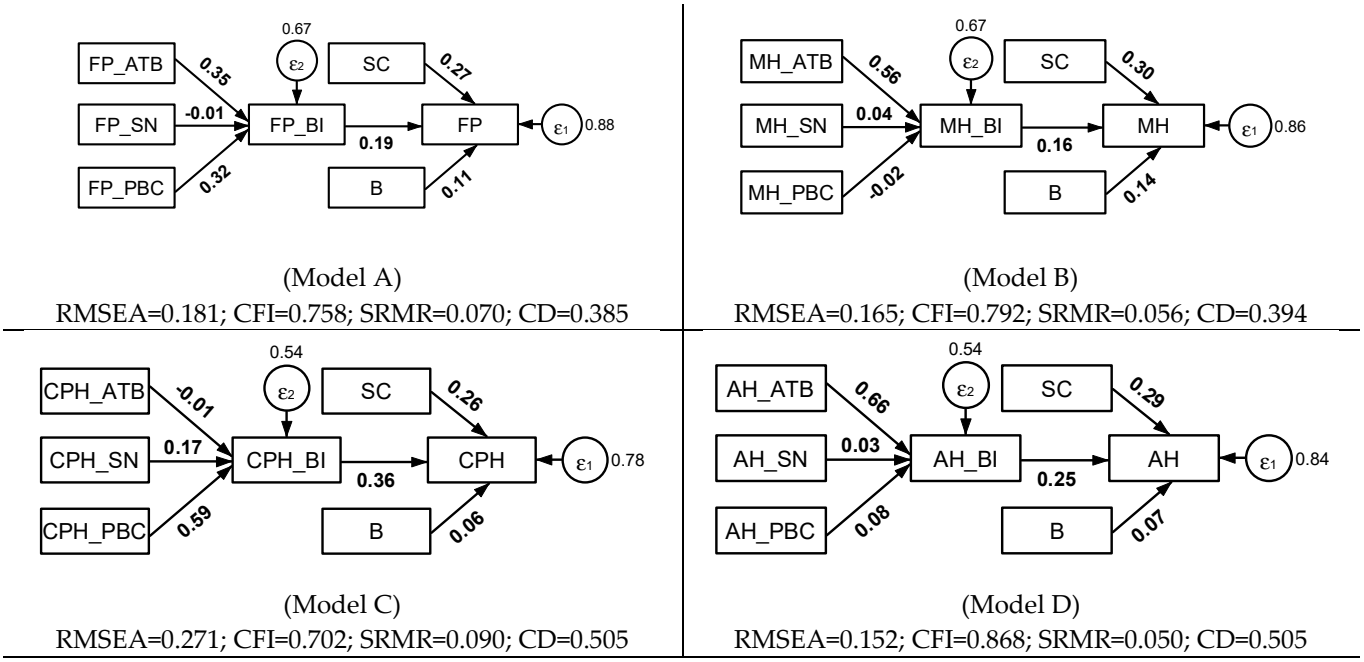
2.6. Statistical Analyses

Data analyses involved two parts. First, the distribution properties of the scale were verified, and reliability analyses were performed. The scale score distributions were assessed by skewness and kurtosis, whereby both should be within the +2 to −2 range when the data are normally distributed [29,30]. The floor and ceiling effects of each scale, taking 20% as a threshold percentage for floor and ceiling effects were calculated [31]. The internal consistencies of the scales were assessed using Cronbach's alpha values (overall and if item deleted alpha values) and item-total correlations [32,33].

In the second step, validity analyses were performed to assess both the construct and criterion validity of the instrument. The construct validity of the scale was tested through two main approaches: (1) Confirmatory factor analysis (CFA) and Path Analyses with Structural Equation Modeling (SEM); and (2) Known groups' validity analysis. For the interpretation of the CFA results, several fit index results were considered, including the root mean square error of approximation (RMSEA), comparative fit index (CFI), standardized root mean square residuals (SRMR) and Chi-square/df. Good fit values were assumed for $0 \leq \text{RMSEA} \leq 0.05$; $0.97 \leq \text{CFI} \leq 1.00$; $0 \leq \text{SRMR} \leq 0.05$; $0 \leq \chi^2/\text{df} \leq 2$ and acceptable fit values: $0.05 < \text{RMSEA} \leq 0.08$; $0.95 \leq \text{CFI} < 0.97$; $0.05 < \text{SRMR} \leq 0.10$; $2 < \chi^2/\text{df} \leq 3$ were assumed [34,35]. Diagonally weighted least square was used as an estimate in the CFA [36]. Known groups validity analysis involved the testing of three hypotheses: scale scores were expected to be better for participants with a higher formal education, those with a vocational training, and those who own the land. The extended planned behavior model, which forms the conceptual basis of the questionnaire, was tested through SEM analysis. The analysis results of the scores of the structures and dimensions that make up the conceptual model are presented in Figure 1.

Finally, criterion validity was tested with work accident history which was considered as the dependent variable and the variables of the extended TPB as independent variables, by using *t*-test and Cohen's effect size [37]. The dependent variable, occupational accident, was assessed with the following question: "In the last 10 years, while working in fields such as farming, animal husbandry, etc., have you ever experienced an injury accident?". The response options were recorded as yes or no. TPB scores were calculated to include each behavior (fall prevention, machine handling, chemical and pesticide handling, animal handling) and its components (attitude towards behavior, subjective norms, perceived behavioral control and behavioral intention). Other dimensions (safety culture

and barriers) were calculated as a separate score and used as independent variables in statistical comparisons.



FP: Fall Prevention; MH: Machine Handling; CPH: Chemical and Pesticide Handling; AH: Animal Handling; ATB: Attitudes Toward Behavior; SN: Social Norms; PBC: Perceived Behavior Control; BI: Behavior Intention; SC: Safety Culture; B: Barriers
Model A: Fall prevention behavior and influencing components; Model B: Machine handling behavior and influencing components
Model C: Chemical and Pesticide Handling behavior and influencing components; Model D: Animal Handling behavior and influencing components
RMSEA=Root Mean Square Error of Approximation; CFI=Comparative Fit Index; SRMR=Standardized Root Mean Square; CD=Coeffience of Determination

Figure 1. Conceptual framework of the farmers safety behaviors scale and the path analyses for theory of planned behavior with SEM.

All descriptive analyses and reliability analyses were performed using SPSS for Windows v. 25.0. For testing the construct validity, Jasp v. 0.16.4 was used, and for the SEM and convergent validity analyses we used Stata v. 14. The largest acceptable Type 1 error was set at 0.05 for all statistical analyses.

3. Results

3.1. Scale Composition and Reliability

The descriptive statistics of the subscales of the questionnaire are presented in Table 2. As this table indicates, the skewness and kurtosis of the dimension scores were lower than 1.5 for all dimensions, except for the behavior intention. The floor and ceiling effect percentages of all dimensions is below 15%. The skewness and kurtosis values and the percentages of floor and ceiling effects were all within acceptable limits. In addition, the distribution characteristics of each item of the scale are presented in Supplementary Table S1.

Table 2. Descriptive statistics of the scales.

Scales	Number of Items	Valid	Mean (SD)	Median(IQR)	Skew.	Kurt.	Floor (%)	Ceiling (%)
FP	12	305	4.25 (0.53)	4.00 (4.33–4.58)	−0.845	1.627	0.0	13.4
MH	12	247	3.85 (0.52)	3.58 (3.83–4.25)	−0.099	−0.119	0.3	2.0
CPH	15	250	4.13 (0.60)	3.80 (4.13–4.60)	−0.802	0.836	0.0	6.9
AH	13	222	4.09 (0.45)	3.78 (4.00–4.39)	−0.078	−0.043	0.0	2.6
SC	5	305	2.83 (0.93)	2.20 (2.80–3.40)	0.448	−0.347	0.7	3.3
B	7	305	3.73 (0.83)	3.14 (3.86–4.29)	−0.699	0.198	0.3	4.9
Overall	64	297	3.90 (0.43)	3.65 (3.89–4.18)	−0.280	0.536	0.0	0.0

FP: fall prevention; MH: machine handling; CPH: chemical and pesticide handling; AH: animal handling; SC: safety culture; B: barriers.

The Cronbach's alpha values for the four behavioral scales of fall prevention, machine handling, chemical and pesticide handling, and animal handling sub-dimensions are 0.843, 0.688, 0.888 and 0.716, respectively, as shown in Table 3. The Alpha values for safety culture and barriers were 0.777 and 0.799, respectively, and the overall Cronbach's alpha value was 0.920.

Table 3. Confirmatory factor analysis results (summary fit indices for dimensions and total scale).

Scales	χ^2/df	CFI	GFI	RMSEA	Stan.RMR	Cronbach's Alpha
FP	1.35	0.98	0.97	0.03	0.06	0.843
MH	2.21	0.93	0.96	0.07	0.08	0.688
CPH	1.17	0.99	0.98	0.03	0.06	0.888
AH	1.26	0.98	0.96	0.04	0.07	0.716
SC	3.91	0.98	0.99	0.09	0.06	0.777
B	1.90	0.98	0.99	0.05	0.06	0.799

FP: fall prevention; MH: machine handling; CPH: chemical and pesticide handling; AH: animal handling; SC: safety culture; B: barriers. χ^2/df: Chi-square/degree of freedom; CFI: comparative fit index; GFI: goodness of fit index; RMSEA: root mean square error of approximation; Stan.RMR: standardized root mean residual.

3.2. Scale Validity

3.2.1. Factorial Validity

The results of the confirmatory factor analysis, which are presented in Table 3, demonstrate that the goodness-of-fit results for the CFA of behaviors and predictive components are at an acceptable level. Specifically, the CFA results for each component are as follows:

- Fall Prevention: χ^2/df =1.35; CFI = 0.98; GFI = 0.97; RMSEA = 0.03 and Std.RMR = 0.06;
- Machine handling: χ^2/df = 2.21; CFI = 0.93; GFI = 0.96; RMSEA = 0.07 and Std.RMR = 0.08;
- Chemical-pesticide handling: χ^2/df = 1.17; CFI = 0.99; GFI = 0.98; RMSEA = 0.03 and Std.RMR = 0.06;
- Animal handling: χ^2/df = 1.26; CFI = 0.98; GFI = 0.96; RMSEA = 0.04 and Std.RMR = 0.07.

The goodness of fit values for safety culture (SC) and barriers (B) scale are as follows:

- Safety culture: χ^2/df = 3.91; CFI = 0.98; GFI = 0.99; RMSEA = 0.09 and Std.RMR = 0.06;
- Barriers: χ^2/df = 1.90; CFI = 0.98; GFI = 0.99; RMSEA = 0.05 and Std.RMR = 0.06.

Overall, all dimensions have sufficient confirmation of the intended structure in terms of goodness of fit and error level.

3.2.2. Predictive Validity

Conceptual analyses were performed to test whether the relationships between the behavioral determinants and safety behaviors predicted by the extended theory of planned behavior could be confirmed. Four models were created for each type of behavior (i.e., falls Prevention, machine handling, chemical-pesticide handling and animal handling) and their

determinants. In each model, behavior and its determinants of attitude, norm, control and intention variables, safety culture and barriers dimensions were tested in the SEM model. The results are presented in Figure 1.

As this table shows, the assumptions of the theory of planned behavior are to a large extent confirmed. Behavior intention (BI) and safety culture (SC) predicts safe behavior in all four models.

The results indicate that in the "fall prevention" dimension, both attitude towards behavior (ATB) and perceived behavioral control (PBC) predict intention, but not subjective norms (SN). In the "machine handling" and "animal handling" dimensions, only attitude towards behavior (ATB) predicts intention, while subjective norms (SN) and perceived behavioral control (PBC) do not. In the "chemical-pesticide" dimension, subjective norms (SN) and perceived behavioral control (PBC) predict intention, but not attitude towards behavior (ATB).

Furthermore, as hypothesized in the extensions to the TPB, safety culture (SC) also contributes directly to the prediction of safe behavior whereas barriers (B) could only predict safe behavior in "fall prevention" and "machine handling".

3.2.3. Known Groups Validity

"Vocational training" of the farmers has a large effect size on chemical-pesticide safety behavior (ES:0.81, $p < 0.001$) and "Land ownership" has a large effect size on animal handling safe behavior (ES:0.59, $p < 0.001$). Official school education only had an effect on animal handling (ES:0.32, $p < 0.05$) as shown in Table 4.

Table 4. Known groups validity and criterion validity results.

Independent Variables	Education		Vocational Training		Land Ownership (No-Yes)		Did You Experience Any Accident? (No-Yes) [#]	
Dimensions	**Mean Diff. [##]**	**Effect Size**	**Mean Diff. [##]**	**Effect Size**	**Mean Diff. [##]**	**Effect Size**	**Mean Diff. [##]**	**Effect Size**
FP	0.032	0.060	−0.149	−0.283	−0.068	−0.128	0.288	0.561 **
MH	0.063	0.122	−0.122	−0.237	0.102	0.197	0.173	0.338 *
CPH	−0.022	−0.037	−0.472	−0.810 **	−0.187	−0.316 *	0.337	0.583 **
AH	0.143	0.324 *	−0.047	−0.106	−0.256	−0.590 **	0.049	0.108
SC	0.542	0.609 **	0.371	0.402	−0.518	−0.574 **	−0.175	−0.189
B	−0.219	−0.265 *	−0.260	−0.313	0.087	0.104	0.415	0.508 **
Total	0.075	0.180	−0.122	−0.293	−0.125	−0.299 *	0.185	0.450 **

* $p < 0.05$; ** $p < 0.001$; Effect Size: 0.2 Low; 0.5 Medium; 0.8 High. [#] Criterion validity; [##] Independent sample *t*-test, mean differences and effect size.

3.2.4. Criterion Validity

The criterion validity of the instrument was tested using experience of a work accident as a dependent variable. In the past 10 years, the work accident experience rate among the farmers who participated in the study was 23.9%. Moderate to high Cohen's effect size values was obtained for fall prevention (ES:0.56, $p < 0.001$), machine handling (ES:0.34, $p < 0.05$) and chemical-pesticide handling (ES:0.58, $p < 0.001$) but a very small effect size for animal handling (ES:0.11, $p > 0.05$). Significantly high ES values were obtained for barriers (ES:0.51, $p < 0.001$) whereas safety culture had a very weak effect on Work Accident Experience (ES:0.19, $p > 0.05$) (see Table 4).

4. Discussion

The aim of this study was to adapt the questionnaire developed for the SACURIMA COST Action Network [26] that was based on the theory of planned behavior, to measure the determinants of safe behavior in farmers for use in Turkish, and to test the validity and reliability of the Turkish version.

Descriptive results showed that the skewness and kurtosis values of the dimensions are below ±1.5 and within acceptable limits [29] which indicates a homogeneous distribution of the dimension scores and floor and ceiling percentages are below 20% [31]. The alpha values indicating the internal consistency of the six dimensions of the scale show sufficient internal consistency results between 0.69 to 0.84 [32,38].

Item analysis was performed by calculating "If item deleted alpha" values and "item-total correlations". These analyses were used to assess the contribution of each item to the variance of its corresponding dimension (refer to Supplementary Table S2). Results showed that the contribution of five items to their respective dimensions was insufficient based on the "if item deleted alpha" values. These items are the 19th item in the "machine handling" dimension; Items 46 and 56 in the "Perceived behavior Control" dimension; and the 81st item in the "barriers" dimension. Item 19 referred to the "Power Takeoff (PTO)" of the machines—mostly tractors—which may not be familiar to some respondents. Similarly, item 56 pertained to the "ventilation of barns", which might not be well understood by livestock farmers who do not work in large farms since family farms in Turkey typically house animals in semi-open barns rather than closed barns.

Since the psychosocial underlying factors of the four different behaviors, which are the main causes of occupational accidents among farmers, are different, the TPB structures were analyzed separately for each behavior and behavioral intention in this study. Construct validity of each of the four dimensions of behaviors were evaluated based on the results of confirmatory factor analysis and known groups validity analyses. Goodness-of-fit values obtained for the dimensions FP, MH, CPH and AH were all sufficient according to the acceptability criteria (e.g., $\chi^2/df < 2.0$, CFI and GFI > 0.95, RMSEA and StdRMR < 0.08) in the published literature [34,35]. The CFI values obtained were also found to be satisfactory for "safety culture" and "barriers" dimensions that are the determinants of occupational health and safety behavior of farmers. However, the RMSEA for SC may not be considered to be at an acceptable level (0.09). This may be due to the low number of items ($n = 5$) in SC.

Structural equation modelling (SEM) analyses were also performed in order to present the direct and indirect effects of some predictors for each of the four behaviors (see Figure 1 and Supplementary Table S3). In these SEM analyses, not only were "behaviors" taken as endpoints, but also the scale structure was tested, including behavioral intention and its predictors in each behavior model. Therefore, the predictive effects of attitude towards behavior (ATB), perceived behavioral control (PBC), and subjective norms (SN) on behavior intention (BI); and the predictive effects of "BI", "SC" and "B" on behavior were evaluated for each of the four-behavior models.

Our findings are consistent with the study of Colémont and Van den Broucke (2008), which reported that ATB predicts all four behaviors, with one exception that ATB did not predict chemical-Pesticide handling (CPH) in our study, This may be due to Turkish farmers not yet developing an attitude towards exposure to chemicals and pesticides, as the visible signs of exposure take a long time to emerge in humans. We also found that ATB and perceived behavioral control (PBC) significantly predicted fall prevention (FP), while subjective norms (SN) had no significant effect on FP behavior intention. Bagheri et al. also reported that the determinant with the highest correlation with safe behavior among TPB structures is the farmer's attitude towards the behavior [21]. Our study found that perceived attitude (ATB) was the only determining factor for both MH and AH, while perceived control and subjective norm had no decisive influence on either behavior. The lack of determinant effect of PBC on behavior intention (especially for MH and AH), which we detected in our study, has also been shown in other studies [23,39,40]. However, a study conducted in cattle farms by João Augusto Rossi Borges et al. concluded that all three components of TPB (e.g., ATB, PBC and SN) significantly correlated with behavior intention [41].

We found safety culture (SC) is a significant predictor for all of the four behaviors whereas barriers (B) only predicted FP and MH to some extent. These findings confirmed the positive effect of safety culture on safe working behaviors in farmers which was the main

hypothesis of the SACURIMA group while developing the questionnaire. The significant beta values of safety culture and barrier—which are the elements of the extended TPB model—for four different behaviors reveals the advantage of the extended model over the core model.

The known group validity was demonstrated in our study by examining the demographic and socioeconomic variables of farmers, such as education level, vocational training status, and land ownership. Based on previous research [42,43], we hypothesized that farmers with higher levels of education, vocational training, and land ownership would have higher scores compared to those who do not possess these characteristics.

While the level of education affects only animal handling (AH) and the level of vocational education only affects pesticide use (CPH), land ownership of land affects both AH and CPH. None of the known variables has a significant effect on fall prevention (FP) and machine handling (MH). The level of school education and land ownership have significant effects on safety culture. Assuming that land ownership is associated with better income and education, we can conclude that the safety culture is better than among the wealthier and more educated farmers. The very small number of farmers that have received vocational training in Turkey explains the ineffectiveness of vocational training on the safety culture. We can say that higher socioeconomic status of farmers has a positive effect on safety culture and on TPB determinants.

The criterion validity of the instrument was assessed by "work accident experience" which is the main outcome of safety work. The results of the criterion validity analyses revealed that scale scores of behaviors related to fall prevention, machine handling and chemical-pesticide handling were significantly sensitive to the experience of work accident among farmers. However, it is worth noting that the lower incidence of animal husbandry among farmers may explain why animal handling was not affected by the work accident experience.

In this study, similar to the parent (SACURIMA) study, the highest dimension scores for the four behaviors were obtained from the animal handling and chemical and pesticide handling dimensions with an average score of around 4.23 in this study. Additionally, similar to the SACURIMA study, fall prevention and chemical and pesticide handling were the behaviors that best predicted accident experience. The SACURIMA project used a linear regression approach to explain behavior and behavioral intention in their psychometric analyses, while our study used path analysis in addition to classical psychometric analyses. Beta values obtained in linear regression analysis examining the determinants of behavior and behavioral intention reported in the SACURIMA study are significantly consistent with the path analysis findings used in our study. Perceived behavior control has not been found to be an effective factor in taking precautions against machine accidents, both according to the results of SACURIMA and according to the results of our study. This may explain why machinery accidents are the most common in the agricultural sector. Unlike the SACURIMA results, in our study, subjective norm was not found to be effective in both fall prevention and animal handling behaviors. Subjective norm was found to be effective only on safe chemical and pesticide use behavior in our study. From these findings, we understand how important it is to develop social norms on other risky behaviors in agriculture in Turkey.

Strengths and Limitations

In this study, the success of the extended TPB model was studied instead of the core TPB model. Testing the core TPB model in farmers is the subject of other research.

The study was a cross-sectional study, so it may not fully demonstrate the changes over time that can be obtained from longitudinal studies. The general education level of the farmers participating in the study may have a higher education level than the rural population in Turkey which might bias the results of the study. Furthermore, the consistency of the change over time could not be measured due to the dispersion of the research area and the difficulty in reaching the respondents repeatedly. Despite all these

limitations, the fact that the research was applied in different agricultural sectors, enabled it to represent a wide area of the country.

5. Conclusions

Firstly, the Turkish version of the Farmers Safety Behaviors Scale that was developed on the extended TPB model, is sensitive to past accidents in farmers indicating the criterion validity is provided. Secondly, SEM analyses showed that the extended TPB model outperformed the core model in all four behaviors (fall prevention, machine handling, animal handling and chemical/pesticide handling) of farmers. Finally, safety culture and barriers were found to be significant factors affecting these behaviors.

In developing safe behaviors to protect farmers from occupational accidents, not only should the main model components such as behavior control, subjective norms, attitudes towards the behavior, and behavioral intention be taken into account, but also the safety culture in society and financial and cultural barriers.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/agriculture13050967/s1, Table S1: Items descriptive statistics; Table S2: Cronbach's alpha scores, item–total correlations; Table S3: SEM Analyses: Direct and indirect effect of the determinants of the TPB on safety behavior.

Author Contributions: Conceptualization, H.B., E.E., S.V.d.B. and N.E.S.G.; methodology, H.B., E.E., S.V.d.B. and N.E.S.G.; formal analysis, H.B., E.E., S.V.d.B. and N.E.S.G.; investigation, H.B., E.E., S.V.d.B., N.E.S.G., E.A., S.E., B.D., E.H., Y.B.Ö., G.E. and S.C.; data curation, H.B., E.E., S.V.d.B., N.E.S.G., E.A., S.E., B.D., E.H., Y.B.Ö., G.E. and S.C.; writing—original draft preparation, H.B., E.E. and S.V.d.B.; writing—review and editing, H.B., E.E., S.V.d.B., N.E.S.G., E.A., S.E., B.D., E.H., Y.B.Ö., G.E. and S.C.; supervision, H.B., E.E. and S.V.d.B.; project administration, E.E. and S.V.d.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Manisa Celal Bayar University, School of Medicine, Ethic Committee of Health Sciences (protocol code 20.478.486 and date of approval 3 November 2020).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are available on request.

Acknowledgments: The researchers thank the farmers who participated in the study.

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

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