Multi-Dimensional Appraisal of Integrated Pest Management Adoption: Evidence of Pistachio Growers in Kerman Province, Iran

M. Mohammadrezaei¹, and D. Hayati²*

ABSTRACT

Integrated Pest Management (IPM) is well known as a pro-environmental technology in agriculture. Therefore, investigating adoption of IPM mechanisms is crucial for agricultural products such as pistachio in Iran. The main purpose of this study was to assess the role of factors affecting IPM adoption by pistachio growers in Kerman Province. Survey was the research method and it was executed using researchers-designed questionnaire. Totally, 225 pistachio growers were selected as sample size, using two-stages random cluster sampling method. Validity of the questionnaire items was entirely approved by a panel of experts. Cronbach’s alpha coefficient was used for reliability approval. Findings revealed that individual factors including age, education, farming experience, motivations, participation and innovative spirit in conjunction with economic factors such as income, and technological costs affect IPM adoption procedure. In addition, educational services along with IPM technical knowledge and environmental attitude positively changed IPM adoption. The result of structural equation modeling illustrated that education, innovative spirit, life motivation, welfare motivation, income, technological costs, educational services and IPM technical challenges can significantly predict IPM technical knowledge by direct effects. Indeed, IPM technical knowledge promotes environmental attitude and directly improves IPM adoption. Some practical recommendations are presented based on the research findings.

Keywords: Environmental attitude, IPM, IPM adoption, IPM technical knowledge, Structural Equation Modeling (SEM).

INTRODUCTION

Nowadays, producing organic food is one of the main objectives in conservational policies and environmental sustainability (Naglova and Vlasicova, 2016). Accordingly, pro-environmental technologies such as Integrated Pest Management (IPM) are being designed and developed by the research sector in agriculture (Lamichhane et al., 2015; Kalmar et al., 2014). IPM is introduced as an ecological pest control method to decrease using chemical insecticides (Lamichhane et al., 2015; Eneh, 2011). IPM has been utilized since 30 years ago in Asia (Benjamin et al., 2016). Although IPM has been developed for a long time (Timprasert et al., 2014), it is a new technology in Iran (Hedjazi and Sharifi, 2014), where pistachio is one of the most important agricultural products (Villano and Mehrabi Boshrabadi, 2010) and the main agricultural export (Sedaghat, 2011). Kerman Province covers almost 67.4 percent of pistachio planted area in Iran. Furthermore, using chemical
Pesticides in growing pistachios is common among farmers and threatens the nut healthiness as well as confronts that crop with problems regarding export health standards (Sedaghat, 2011). Accordingly, utilizing conservational technologies in order to reduce chemical pesticides is critically needed in pistachio cultivation among pistachio growers in Kerman Province. Therefore, IPM can be useful for decreasing pesticides use among pistachios’ growers. Indeed, Villano and Mehrabi Boshrabadi (2010) imply that pistachio growers need to use new technologies for improving their farm efficiency. Recently, IPM has been presented to replace chemical insecticides among pistachio growers. Thus, IPM is a new technology for pistachio growers in Iran and understanding the procedure of IPM adoption is crucial to design IPM diffusion strategies for policymakers.

Rogers (2010) believes that adopting new technologies is a socio-psychological procedure among farmers. More importantly, the process of adopting new technology could be altered in various communities even for similar technologies (Rogers, 2010). As a result, IPM adoption is not simple among farmers who have used chemical inputs for a long time (Timprasert et al., 2014). The review of literature revealed that a wide range of factors have affected farmers’ IPM adoption. Hejazi and Sharifi (2014) emphasize that environmental and technical knowledge, could increase farmers’ intention to use IPM. Accordingly, diffusion of IPM needs technical educations. Farmers Field School (FFS) is largely used as an educational method for IPM (Davis et al., 2012) and a number of studies mention that IPM and FFS are accomplished by each other (Mancini et al., 2007). Besides, environmental attitude is an indispensable factor to enhance IPM adoption (Van den Berg and Jiggins, 2007). Educational services including mass media, workshops, and FFS (Mancini et al., 2007; Davis et al., 2012) can significantly enhance environmental knowledge and attitude towards IPM application (Van den Berg and Jiggins, 2007). Knowledge and environmental attitude are assumed to be affected by educational services, then they will affect IPM adoption. In other words, Individual factors such as age, farming experiences, education (Toleubayev et al., 2011), motivation (Sanyal et al., 2008) and farmers’ participation in rural activities as well as innovative spirit are effective on IPM adoption (Mancini et al., 2007; Anandajayasekeram et al., 2007). There is also some evidence that confirms that utilizing IPM is influenced by economic factors, including income, technical costs (Meissle et al., 2011), farm size, as well as technological factors (a process in conducting IPM, including the number of used workforces, difficulty, etc.) (Kalmar et al., 2014). Consequently, IPM adoption is likely related to farmers’ individual and productivity setting. As a result, IPM adoption is intricate, because various ranges of factors could be differently related to this process. Therefore, past studies have separately considered factors affecting IPM adoption, while a comprehensive assessment of factors affecting of IPM adoption is undeniably needed for understanding IPM adoption procedures among pistachio growers.

The main purpose of this study was to assess the role of factors affecting IPM adoption by pistachio growers in Kerman Province, Iran, based on comprehensive adoption model.

**MATERIALS AND METHODS**

**Theoretical Framework of Study**

These factors are divided into individual’s factors (age, educational level, farming experience, motivations, participation and innovative spirit), educational factors, economic, and technological factors. In addition, IPM adoption has been
significantly influenced by IPM technical knowledge and environmental attitude. Hence, this question arises” how could all of these factors be assigned as a holistic framework in IPM adoption (to be analyzed by SEM)?” The main purpose of this study is to investigate factors affecting on IPM adoption among pistachios’ growers based on comprehensive adoption model. Based on theoretical framework, IPM adoption is depend on individual, educational, productivity, economic, technological factors (exogenous variables). The effect of exogenous variables on IPM adoption can be moderated by two moderator variables (IPM technical knowledge and environmental attitude) (Figure 1).

**Study Population and Area**

Kerman Province includes the main area of pistachio cultivation (Sedaghat, 2011). Within this province, Rafsanjan County is the main area of pistachio cultivation with 49.14 percent of pistachio gardens in Kerman Province. Pistachio growers utilizing IPM technologies in Kerman Province were purposively selected as the study population (N= 550). Totally, 225 pistachios’ growers were selected as sample group using Krejcie and Morgan (1970) estimating sample size method. Two stages random cluster sampling was conducted (based on proper allocation) as sampling method. The first stage was constructed by four clusters, including, Kerman and Zarand counties (10 percent of the sample size, n= 23), Sirjan County (12 percent of the sample size, n= 27), Bardsir County (8 percent of sample size; n= 18) and Rafsanjan County (70 percent of the sample size, n= 157). The second sampling stage was conducted by four clusters of Rafsanjan rural regions. According to Figure 2, pistachio growers were randomly selected from each cluster based on pistachio growers’ distribution among those regions.

**Study Design**

This study was a quantitative and non-experimental research using survey method. Questionnaire was used as data collection instrument. Extension specialists and researchers of Iran Pistachio Research Institution were advised to identify those questions which were related to practical IPM techniques. Face and content validity of the questionnaire were confirmed using a panel of experts. Besides, a pilot study was conducted to identify its reliability. The range of Cronbach’s Alpha coefficient was between 0.677 to 0.894, which was acceptable (Table 1). IPM adoption as dependent variable refers to the degree of IPM techniques application for at least more than one year. It was measured based on 10 open ended questions. The IPM adoption was scored between 0 (completely not adopted) to 100 (completely adopted). IPM adoption significantly influenced by IPM technical knowledge and environmental attitude.

![Figure 1. Theoretical framework (assumed factors affecting IPM adoption by pistachio growers).](image-url)
technical knowledge and environmental attitude were selected as moderator variables. IPM technical knowledge is considered as pistachio growers understanding of the precise utilization of IPM.

This study used twenty-four follow up open-ended questions to measure IPM technical knowledge (it ranged between 0 and 100). Environmental attitude shows the farmers’ opinions towards IPM environmental benefications. For instance, the role of IPM in decreasing chemical impact on the nature. It was constructed based on Van den Berg and Jiggins (2007) study using eleven ordinal items (Likert’s ordinal with 5 levels from 1 (completely disagree) to 5 (completely agree)). The range of environmental attitude was 11 to 55. Individual factors included farmers’ age (years), education (years of formal education), farming experience (years), innovative spirit (tendency to use new technologies and methods), participation in rural activities (four Likert ordinal items with five levels). Motivations including four aspects (life motivation, welfare motivation, self-identity motivation, and transcendence motivation) refer to the mental intention of adopting IPM. Life motivation refers to pistachio growers’ motivation towards using IPM for providing their life financial requirements. Welfare motivation relates to welfare gained from utilizing IPM. Self-identity motivation implies farmers’ use of IPM as a part of their identity among farmers’ society. Transcendence motivation refers to farmers’ motivation due to transcendence ambition. Likert ordinal was used for measuring those motivations and the range of life and transcendence motivations was 3 to 15 and for other motivations was 4 to 20. Indexing technique was used for free scaling motivations. Operational barriers,
which means the degree of IPM difficulties for 
farmers, was presented as technical factors. 
Economic factors were quantified using 
income (average of annual income), and 
technical costs (IPM technologies costs on 
average). Educational factors were measured 
by the number of farmers’ benefit of 
educational classes, workshops, FFS, 
educational movies and publications 
concerning IPM technologies.

Data Analysis

Mean scores and standard deviation were 
applied to describe the variables 
condition. The Pearson correlation technique 
was used to show the relationships between 
variables. Correlational tests were statistically 
needed prior to test causal relationships 
(Valizadeh et al., 2018) towards applying 
Structural Equation Modeling (SEM). It is 
useful to investigate the direct and indirect 
effects of variables on the dependent variable. 
In this method, exogenous variables should 
be determined. Individual factors, economic 
factors, technical factors, and educational 
factors were selected as exogenous variables 
in the model. IPM technical knowledge, 
environmental attitude as well as IPM 
adoption were considered as endogenous 
variables. Based on the theoretical model, 
SEM was used to show the power of 
exogenous variables in predicting IPM 
technical knowledge and environmental 
attitude. Then, IPM technical knowledge and 
environmental attitude (moderator variables) 
were carried out to show the degree of their 
predictive power on IPM adoption. Statistical 
software such as SPSS version 21 and Amos 
version 20 were used for data analysis.

RESULTS

Pistachio growers were aged about 46 years 
on average. They had about 22.8 years’ 
experience in pistachio cultivation. Pistachio 
growers’ education was about 8.8 years, on 
average. Descriptive analysis revealed that
Table 2. Descriptive statistics of variables (n= 225).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPM adoption (Ranged between 0 to 100)</td>
<td>56.50</td>
<td>23.16</td>
</tr>
<tr>
<td>Environmental attitude (Ranged between 0 to 100)</td>
<td>52.3</td>
<td>10.68</td>
</tr>
<tr>
<td>IPM technical knowledge (Ranged between 0 to 100)</td>
<td>55.11</td>
<td>19.47</td>
</tr>
<tr>
<td>Age (Years)</td>
<td>45.11</td>
<td>12.57</td>
</tr>
<tr>
<td>Farming experience (Years)</td>
<td>22.76</td>
<td>11.02</td>
</tr>
<tr>
<td>Education (Years)</td>
<td>8.76</td>
<td>4.05</td>
</tr>
<tr>
<td>Participation (Ranged between 4 to 24)</td>
<td>13.85</td>
<td>3.48</td>
</tr>
<tr>
<td>Innovative spirit (Ranged between 5 to 25)</td>
<td>14.20</td>
<td>5.82</td>
</tr>
<tr>
<td>Life motivation</td>
<td>10.05</td>
<td>2.61</td>
</tr>
<tr>
<td>Welfare motivation</td>
<td>11.09</td>
<td>2.22</td>
</tr>
<tr>
<td>Identity motivation</td>
<td>10.85</td>
<td>2.90</td>
</tr>
<tr>
<td>Transcendence motivation</td>
<td>8.84</td>
<td>2.24</td>
</tr>
<tr>
<td>Income (IRR)</td>
<td>8643333.33</td>
<td>4792020.43</td>
</tr>
<tr>
<td>IPM technical costs (IRR)</td>
<td>1677615.56</td>
<td>505392.43</td>
</tr>
<tr>
<td>Farm size (Ha)</td>
<td>3.23</td>
<td>2.46</td>
</tr>
<tr>
<td>IPM technical challenge (total) (ranged between 0 to 20)</td>
<td>6.32</td>
<td>2.62</td>
</tr>
</tbody>
</table>

had more knowledge about IPM. Life motivation and welfare motivation had positive correlation with IPM technical knowledge. Therefore, pistachio growers with greater life and welfare motivations had the highest IPM technical knowledge compared to the others. Innovative spirit and participation had positive correlation with IPM technical knowledge. A positive correlation between farm size and IPM technical knowledge was obtained. Therefore, pistachio growers with larger farm size had more IPM technical knowledge. IPM technical challenges and used educational services had positive correlations with IPM technical knowledge. Moreover, positive correlations were obtained between income and IPM technical knowledge and between technical costs and IPM knowledge.

Positive correlation between educational services and environmental attitude was explored. Income was positively correlated with environmental attitude and, ironically, technical costs and farm size were not correlated with environmental attitude. There was also a positive correlation between education and environmental attitude. Life motivation as well as welfare motivation had positive correlation with environmental attitude. Accordingly, those pistachio growers with higher life and welfare motivations had higher environmental attitude and vice versa. IPM technical challenges were negatively correlated with environmental attitude. Thus, it is expected that pistachio growers who felt more challenges in operating IPM had less environmental attitude.

The results of correlation analysis between moderator variables illustrated that both IPM technical knowledge and environmental attitude were positively correlated with each other. Thus, those pistachio farmers who had more technical knowledge had higher level of environmental attitude. IPM technical knowledge and environmental attitude were positively correlated with IPM adoption. The findings revealed that educational services had positive correlation with IPM adoption. There was also a positive correlation between income and IPM adoption. Consequently, pistachio growers with higher income had adopted IPM more than others. Age and farming experience had negative correlation with IPM adoption. Pistachio growers who had more education, participation, and innovation spirit had adopted IPM more than others. Pistachio growers with higher life and welfare motivations had higher IPM.
adoption. IPM technical challenge was negatively correlated with IPM adoption (Table 3).

Regarding correlation analysis outcomes, final causal model was extracted to assess logical relationships between variables. All significantly correlated variables (in IPM adoption) including moderator variables (IPM technical knowledge and environmental attitude) and exogenous variables (individual factors, economic factors, educational factors, technical factors) were inserted into this model. The relationship between IPM technical knowledge and environmental attitude was mutually assumed (Figure 3).

The discrimination of causal variables relationships with IPM technical knowledge showed that education, innovative spirit, life motivation (individual factors), educational services (educational factors) along with income (economic factors) were directly and positively related to IPM technical knowledge. Technical costs (economic factors) were directly but negatively related to IPM technical knowledge (Table 4).

Analyzing causal variables effects on environmental attitude demonstrated that innovative spirit, life and welfare motivations (individual factors) as well as IPM technical knowledge were positively related to environmental attitude based on direct effects. On the other hand, education, innovation spirit (individual factors), and income (economic factor) were positively related to environmental attitude based on indirect causal effects. Technical costs were also negatively related to environmental attitude by indirect effect (Table 5).

The investigation of casual relationship between exogenous and moderator variables with IPM adoption illustrated that welfare motivation, IPM technical knowledge, and environmental attitude were positively related to IPM adoption based on direct effects. Furthermore, education, innovative spirit, welfare motivation, educational services, and income had positive but indirect effects on IPM adoption. Moreover, a negative indirect effect was observed between technical costs and IPM adoption (Table 6).

![Figure 3. Causal IPM adoption model for inserting in SEM analysis.](image-url)
Table 3. Correlation matrix between variables.\(^*\)

<table>
<thead>
<tr>
<th>Variables</th>
<th>IPM adoption</th>
<th>Technical knowledge</th>
<th>Environmental attitude</th>
<th>Educational services</th>
<th>Age</th>
<th>Farm size</th>
<th>Education</th>
<th>Farming experience</th>
<th>Innovative spirit</th>
<th>Participation</th>
<th>Life motivation</th>
<th>Welfare motivation</th>
<th>Identity motivation</th>
<th>Transcendence motivation</th>
<th>Income</th>
<th>Technical costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPM adoption</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical knowledge</td>
<td>0.88**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental attitude</td>
<td>0.61**</td>
<td>0.59**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational services</td>
<td>0.71**</td>
<td>0.68**</td>
<td>0.44**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.19**</td>
<td>0.21**</td>
<td>0.002</td>
<td>-0.09</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm size</td>
<td>0.13</td>
<td>0.21**</td>
<td>0.04</td>
<td>0.14**</td>
<td>0.12</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>0.39**</td>
<td>0.41**</td>
<td>0.24**</td>
<td>0.31**</td>
<td>-0.67</td>
<td>-0.01</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farming experience</td>
<td>-0.17*</td>
<td>0.05</td>
<td>-0.04</td>
<td>0.81**</td>
<td>0.18*</td>
<td>-1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovative spirit</td>
<td>0.44**</td>
<td>0.42**</td>
<td>0.53**</td>
<td>0.35**</td>
<td>0.01</td>
<td>0.03</td>
<td>0.18**</td>
<td>-0.02</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>0.29**</td>
<td>0.27**</td>
<td>0.39**</td>
<td>0.23**</td>
<td>0.4</td>
<td>0.01</td>
<td>0.12</td>
<td>0.01</td>
<td>0.42*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life motivation</td>
<td>0.48**</td>
<td>0.49**</td>
<td>0.48**</td>
<td>0.41**</td>
<td>-0.11</td>
<td>-0.03</td>
<td>0.23**</td>
<td>-0.06</td>
<td>0.41**</td>
<td>0.21**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welfare motivation</td>
<td>0.26**</td>
<td>0.19**</td>
<td>0.29**</td>
<td>0.11</td>
<td>0.01</td>
<td>-0.07</td>
<td>0.05</td>
<td>0.02</td>
<td>0.24**</td>
<td>0.22**</td>
<td>0.32**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identity motivation</td>
<td>0.06</td>
<td>-0.02</td>
<td>-0.05</td>
<td>0.01</td>
<td>-0.09</td>
<td>-0.01</td>
<td>0.07</td>
<td>0.08</td>
<td>0.02</td>
<td>-0.04</td>
<td>0.21**</td>
<td>0.26**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transcendence motivation</td>
<td>0.14*</td>
<td>0.10</td>
<td>-0.01</td>
<td>0.21**</td>
<td>-0.06</td>
<td>0.01</td>
<td>0.005</td>
<td>0.01</td>
<td>0.01</td>
<td>0.12</td>
<td>0.20**</td>
<td>0.37**</td>
<td>0.44**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>0.56**</td>
<td>0.58**</td>
<td>0.39**</td>
<td>0.52**</td>
<td>0.05</td>
<td>0.22**</td>
<td>0.11</td>
<td>0.01</td>
<td>0.27**</td>
<td>0.29**</td>
<td>0.26**</td>
<td>0.19**</td>
<td>0.02</td>
<td>0.14**</td>
<td>0.14**</td>
<td>1</td>
</tr>
<tr>
<td>Technical costs</td>
<td>0.52**</td>
<td>0.54**</td>
<td>0.35**</td>
<td>-0.34**</td>
<td>0.16*</td>
<td>0.09</td>
<td>0.31**</td>
<td>0.12</td>
<td>-0.27**</td>
<td>-0.20**</td>
<td>-0.29**</td>
<td>-0.04</td>
<td>0.14**</td>
<td>0.06</td>
<td>-0.04</td>
<td>1</td>
</tr>
</tbody>
</table>

\(^*r = 0\) (no relationship); \(-0.3 \leq r < 0\) and \(0 < r \leq 0.3\) (Weak); \(-0.7 \leq r < 0.3\) and \(0.3 < r \leq 0.7\) (Average); \(-1 \leq r < 0.7\) and \(0.7 < r \leq 1\) (Strong) (Ratner, 2009). * \(P < 0.05\); ** \(P < 0.01\).
Table 4. Discrimination of exogenous variables effects on IPM technical knowledge.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Standard direct effect</th>
<th>Standard indirect effect</th>
<th>Standard total effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>0.162**</td>
<td>ns</td>
<td>0.162**</td>
</tr>
<tr>
<td>Innovative spirit</td>
<td>0.090***</td>
<td>ns</td>
<td>0.090***</td>
</tr>
<tr>
<td>Life motivation</td>
<td>0.139**</td>
<td>ns</td>
<td>0.139**</td>
</tr>
<tr>
<td>Educational services</td>
<td>0.315**</td>
<td>ns</td>
<td>0.315**</td>
</tr>
<tr>
<td>Income</td>
<td>0.283***</td>
<td>ns</td>
<td>0.283***</td>
</tr>
<tr>
<td>Technical costs</td>
<td>-0.235**</td>
<td>ns</td>
<td>-0.235**</td>
</tr>
</tbody>
</table>

* P < 0.05; ** P < 0.01; *** P < 0.001; ns: Non-significant.

Table 5. Discrimination of exogenous variables and IPM technical knowledge effects on environmental attitude.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Standard direct effect</th>
<th>Standard indirect effect</th>
<th>Standard total effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>ns</td>
<td>0.061***</td>
<td>0.061***</td>
</tr>
<tr>
<td>Innovative spirit</td>
<td>0.292***</td>
<td>0.034**</td>
<td>0.326**</td>
</tr>
<tr>
<td>Life motivation</td>
<td>0.137**</td>
<td>0.053***</td>
<td>0.190**</td>
</tr>
<tr>
<td>Educational services</td>
<td>ns</td>
<td>0.119**</td>
<td>0.119**</td>
</tr>
<tr>
<td>Income</td>
<td>ns</td>
<td>0.107***</td>
<td>0.107***</td>
</tr>
<tr>
<td>Technical costs</td>
<td>ns</td>
<td>-0.089**</td>
<td>-0.089**</td>
</tr>
<tr>
<td>Welfare motivation</td>
<td>0.109***</td>
<td>ns</td>
<td>0.109***</td>
</tr>
<tr>
<td>IPM technical knowledge</td>
<td>0.379***</td>
<td>ns</td>
<td>0.379***</td>
</tr>
</tbody>
</table>

* P < 0.05; ** P < 0.01; *** P < 0.001, ns: Non-significant.

Table 6. Discrimination of exogenous and moderator variables effects on IPM adoption.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Standard direct effect</th>
<th>Standard indirect effect</th>
<th>Standard total effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>ns</td>
<td>0.107***</td>
<td>0.107***</td>
</tr>
<tr>
<td>Innovative spirit</td>
<td>ns</td>
<td>0.088***</td>
<td>0.088***</td>
</tr>
<tr>
<td>Life motivation</td>
<td>ns</td>
<td>0.106***</td>
<td>.106***</td>
</tr>
<tr>
<td>Educational services</td>
<td>0.207***</td>
<td>0.209**</td>
<td>.416**</td>
</tr>
<tr>
<td>Income</td>
<td>ns</td>
<td>0.185***</td>
<td>.185***</td>
</tr>
<tr>
<td>Technical costs</td>
<td>ns</td>
<td>-0.156**</td>
<td>-0.235**</td>
</tr>
<tr>
<td>Welfare motivation</td>
<td>0.087***</td>
<td>0.011***</td>
<td>0.098***</td>
</tr>
<tr>
<td>IPM technical knowledge</td>
<td>0.626***</td>
<td>0.037**</td>
<td>0.662***</td>
</tr>
<tr>
<td>Environmental attitude</td>
<td>0.098***</td>
<td>ns</td>
<td>0.098***</td>
</tr>
</tbody>
</table>

* P < 0.05; ** P < 0.01; *** P < 0.001, ns: Non-significant.

Figure 4. Comprehensive IPM adoption models among pistachio growers (Chi square: 4.095, P > 0.05; RMSEA: 0.012; CFI: 1, NFI: 0.996).
DISCUSSION

Findings showed that pistachio growers had adopted IPM technologies on an average level. There were also some evidences emphasizing that full adoption of IPM technologies need at least five years (Eneh, 2011; Hedjazi and Sharifi, 2014; Van den Berg and Jiggins, 2007; Meissle et al., 2011). Since in this study, IPM technologies are being currently introduced to pistachio growers, it could be concluded that the procedure of IPM adoption among pistachio growers needs more time to be fully adopted.

There are some factors that facilitate this procedure or make it harder. Consequently, investigating how different factors could accelerate IPM adoption by pistachio growers was the main purpose of this study. It was found that different factors could affect IPM adoption, and this was illustrated through the Empirical model. In fact, previous studies mainly investigated the role of some factors such as income, technical costs (Meissle et al., 2011), farm size (Sheng et al., 2015), education, and farmers’ participation. But, almost all those studies ignored to investigate the simultaneous effect of several factors. It was found that individual factors, economic factors, educational factors, and technological factors could predict IPM adoption, significantly.

Although research findings revealed that pistachio growers IPM technical knowledge and their environmental attitude scores are at the average level, they need to enhance their knowledge as well as their attitude towards using IPM appropriately. Davis et al. (2012) have also found that farmers’ IPM technical knowledge and their environmental attitude are at average level, particularly at the beginning years of adoption process.

Among individual factors, age and farming experience had negative correlation with IPM knowledge, environmental attitude, and IPM adoption. Consequently, elder pistachio growers with great farming experience had more unwillingness towards IPM technologies adoption compared to younger ones. This finding confirms Veisi (2012) study but there is also evidence that shows age is positively correlated with IPM technical knowledge (Mancini et al., 2007).

Although IPM is a knowledge-based technology, education could facilitate IPM knowledge among farmers (Veisi, 2012; Davis et al., 2012). It was approved by this study because education positively affected IPM adoption through increasing IPM technical knowledge. Similarly, another study has also shown the positive relationship between education and IPM technical knowledge (Heong and Escalada, 1997). Therefore, those pistachio growers who had higher education were more capable in adopting IPM.

Albeit participation and innovative sprit had significant positive correlation with IPM technical knowledge, environmental attitude, and IPM adoption, innovative spirit could predict the respondents’ environmental attitude ($\beta = 0.29$), IPM technical knowledge ($\beta = 0.09$) directly, and IPM adoption ($\beta = 0.088$), indirectly (Figure 3). Benjamin and Wesseler (2016) confirm that farmers’ participation is one of the positive factors engaging farmers to adopt IPM technologies. Therefore, those pistachio growers with adequate innovation spirit and participation were in suitable condition of IPM technical knowledge. It also has been confirmed (Heong and Escalada, 1997) that farmers who actively participate in rural activities and have more tendency to use innovations are at higher level of IPM technical knowledge. Moreover, similar to Veisi’s (2012) results, findings revealed that pistachio growers who had larger farm size had more IPM technical knowledge and environmental attitude.

Those pistachio growers who felt more challenge in IPM application process had less IPM technical knowledge. In addition, those pistachio growers who used more educational services than others had more IPM technical knowledge. Davis et al. (2012) believe that educational services.
positively increase IPM technical knowledge.

Amount of educational services benefit has direct causal effect on IPM technical knowledge ($\beta = 0.31$) and IPM adoption ($\beta = 0.21$). Other studies (Van den Berg and Jiggins, 2007) reflect the positive role of educational factors on IPM adoption procedure.

Life and welfare motivations positively affect IPM technical knowledge. Indeed, they increase knowledge at first and indirectly improve environmental attitude, which means higher rate of IPM adoption. Consequently, motivations could be one of the main reasons for conducting IPM.

Regarding Structural Equation Modeling (SEM) results, the various range of variables including individual factors, economic factors, educational factors, productivity factors, technical factors in conjunction with IPM technical knowledge and environmental attitude can significantly predict IPM adoption, simultaneously. The SEM results (see Figure 4) reveal that knowledge has remarkable positive role in IPM adoption. Some other studies also implied that increasing farmers’ knowledge could enhance their ability to apply IPM (Mancini et al., 2007; Veisi, 2012). In other words, IPM technical knowledge is the most important factor in IPM adoption. Environmental attitude could also positively predict IPM adoption among pistachio growers. There are some evidences that approve positive relationship between knowledge and attitude in IPM adoption process (Lamichhane et al., 2015; Kalmar et al., 2014; Mancini et al., 2007). Sanyal et al. (2008), Davis et al. (2012), and Mancini et al. (2007) believe that IPM technical knowledge is essential for adopting IPM. Regarding this finding, those pistachio growers who have high IPM technical knowledge and environmental attitude, would have greater IPM adoption level. Those pistachio growers with higher environmental attitude have adopted IPM more than others. Van den Berg and Jiggins (2007) also found positive relationship between environmental attitude and IPM adoption.

Educational services related to IPM are the second important factor towards enhancing IPM adoption among pistachio growers. Davis et al. (2012) believe educational services could provide adequate information to improve farmers’ knowledge about IPM. It is expected that providing educational services by focusing on low literacy of pistachio growers along with motivating them could be effective in their IPM adoption. Therefore, preparing educational services and supporting educational programs concerning IPM should be the main part of IPM diffusion programs. We found that environmental attitude was also an important factor for improving IPM adoption. Therefore, increasing environmental attitude could enhance IPM adoption. Knowledge could also make positive change towards environmental attitude among pistachio growers. Subsequently, diffusing IPM among pistachio growers is entirely dependent on knowledge and attitude based on some individual, economic, educational, and technical factors. Findings show that pistachio growers’ income could positively affect their IPM technical knowledge and environmental attitude. As a result, IPM is favorable for pistachio growers who have higher income. As Eneh (2011) mentions, farmers with proper income have more tendency to receive knowledge about IPM. There is also some evidence that implies that income is not related to IPM technical knowledge (Sanyal et al., 2008; Timprasert et al., 2014). In contrast, IPM technical costs negatively affect IPM adoption. Sometimes, farmers with high IPM knowledge have paid more for IPM technologies (Veisi, 2012).

Individual factors such as motivations, education, and innovative spirit positively affect IPM adoption process. As a result, localizing IPM technologies based on pistachio growers’ individual factors could positively improve their adoption for a long period. It is also necessary to motivate them by some advices by extension specialists.
The SEM model not only shows IPM adoption is a simple procedure but also it could be affected by the various range of factors. Moreover, concentration on economic, educational, technical, and individual factors is crucial for agricultural researchers and extension services towards diffusion of IPM.

CONCLUSIONS

This is the first time that IPM adoption procedure among pistachio growers has been investigated using SEM analysis to show the predictive power of all variables in different factors to understand their direct and indirect effect on IPM adoption. Since pistachio is one of the most important agricultural export products, understanding the procedure of IPM adoption is crucial for policy makers. One of the strength points of this study is investigation of the role of different factors among pistachio growers who are adopting IPM in Kerman Province as the main area of pistachio cultivation in Iran. Notably, because of vast geographical distribution of pistachio gardens and farmers’ sensitivity to participate in data gathering process, accessibility to pistachio growers were the limitations and difficulties of this study. Based on the research results, it can be concluded that IPM adoption rate is mainly dependent on pistachio growers’ technical knowledge and their environmental attitude. In fact, pistachio growers who had higher IPM technical knowledge and stronger environmental attitude had adopted IPM more than others. Considering that technical knowledge toward IPM could lead to stronger environmental attitude, it is recommended that extension programs be concentrated on enhancing pistachio growers’ IPM technical knowledge. Such programs should take their clients’ conditions into consideration. It is recommended that the growers be classified based on their income, education level, life and welfare motivations, and innovative spirit.

REFERENCES

Field School Outcomes Using the Sustainable Livelihoods Approach in India. 
Bt Maize and Integrated Pest Management: 
A European Perspective. Pest Manag. Sci., 
67(9): 1049-58.
Economic Performance of Conventional, 
Coefficient: Its Values Range between +1/-1, 
or Do They? J. Targeting Meas. Anal. 
Mark., 17(2): 139-142.
Innovations. 4th Edition. Simon and 
Schuster, New York. USA.
and Shrestha, A. 2008. Revisiting the 
Perspective and Progress of Integrated Weed 
Production and Marketing of Iran’s 
Pistachio and the Policies Concerned: An 
Application of the Garret Ranking 
17. Sheng, Y., Zhao, S., Nossal, K., and Zhang, 
D. 2015. Productivity and Farm Size in 
Australian Agriculture: Reinvestigating the 
Returns to Scale. Aust J Agric Resour Econ. 
59:16–38
18. Timprasert, S., Datta, A. and 
Ranamukhaarachchi, S. L. 2014. Factors 
Determining Adoption of Integrated Pest 
Management by Vegetable Growers in 
Nakhon Ratchasima Province, Thailand. 
19. Toleubayev, K., Jansen, K. and Van Huis, 
A. 2011. From Integrated Pest Management 
to Indiscriminate Pesticide Use in 
Kazakhstan. J. Sustain. Agric., 35(4): 350- 
75.
2018. Farmers’ Active Participation in 
Water Conservation: Insights from a Survey 
among Farmers in Southern Regions of 
Tech. (JAST), 20(5). In press.
Investing in Farmers the Impacts of Farmer 
Field Schools in Relation to Integrated Pest 
of Adoption Behavior of Clean 
Technologies in Agriculture: A Case of 
Integrated Pest Management. Asian J. 
23. Villano, R., and Mehrabi Boshrabadi, H. 
2010. When Is Met Frontier Analysis 
Appropriate? An Example of Varietal 
Differences in Pistachio Production in 
Iran. J. Agr. Sci. Tech. (JAST), (12): 379- 
389.

ترکیب چندگانه پذیرش مدیریت تلقیف آفات: شواهدی از تولیدکنندگان پسته در 
استان کرمان، ایران

م. محمدرضایی, و. د. حیاتی

چیکیده
مدیریت تلقیف آفات به عنوان یکی از عوامل حیات بالعمری بر روی 
سازوکار های بیشتر این عوامل برای محصولات کشاورزی تاثیر پرداخته است. هدف اصلی این 
مطالعه، تحلیل نشانه عوامل تأثیرگذار بر بیشتر مدیریت تلقیف آفات در میان پسته کاران استان کرمان 
است. پیامد با استفاده از پرسشنامه محقق ساخت مورد ارزیابی قرار گرفت. در نهایت، ۲۴۵ پسته کار 
به عنوان جامعه نمونه بر اساس روش نمونه برداری خوشه ای دو مرحله ای تصادفی انتخاب شدند. روانی
پرسشنامه توسط پانل متخصصان تایید شد. آگاهی کروناخ برای تایید پایایی پرسشنامه استفاده شد. نتایج نشان داد عوامل فردی نظیر سن، تحصیلات، تجربه و انتخاب‌های مربوط به طراحی عوامل اقتصادی نظیر درآمد و هزینه‌های فردی بر روی پذیرش مدل‌های تلفیقی اثرات نسبی می‌گذارد. به علاوه، خدمات آموزشی به همراه دانش فنی مدل‌های تلفیقی آفات و نگرش زیست محیطی نقش می‌پردازند در پذیرش مدل‌های تلفیقی آفات دارد. مدل معادلات ساختاری نشان داد تحصیلات، روحیه توانمندی، انگیزه ها و هزینه‌های فنی تأثیرات مستقلی به عنوان پیش‌بینی‌کننده در طراحی فنی مدل‌های تلفیقی آفات را از طریق اثرات مستقل به‌پایه‌ی فنی توانمندی دانش‌های فنی تفاوت‌هایی را می‌آورند. درواقع، دانش فنی مدل‌های تلفیقی آفات منجر به توسعه نگرش زیست محیطی شده و پذیرش مدل‌های تلفیقی آفات را به طور مستقیم افزایش می‌دهد. برخی پیشنهادات عملیاتی بر

منابع یافته‌های مطالعه در‌پایان مقاله ارائه شده است.