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Factors Affecting on Greenhouse Workers' Attitude towards Pesticide Use, A Case Study in Hashtgerd City, Iran

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ABSTRACT

The inappropriate use of pesticides has created side effects such as resistance to pesticides, outbreak of new or secondary pests, environmental toxicity, and human health issues. The aim of this study was to investigate which factors influence green house workers' attitudes to pesticide use in a case study of 50 greenhouse workers in Hashtgerd city, Iran. Using Bayesian confirmatory factor analysis, variables influenced on farmers' attitude to pesticide use classified into five latent variables named Extension-Educational, Economic, Legal, Technical, and Social factors. The regression results indicated that two factors named Extension-Educational and Legal factors affected the Greenhouse Workers' attitude towards pesticide use. These factors could totally explained 36.2% of variance. So based on results, training programs can play a crucial role in pest control decisions, providing farmers with the technical knowledge that is necessary for the selection of appropriate pest management methods and also for safe and effective pesticide use.

Keywords: pesticide use; greenhouse; attitude; Hashtgerd City.

INTRODUCTION

With the world population predicted to rise from 6 billion to over 9 billion by 2050, population growth is a driver of increased demand for agricultural products [1]. This caused experts to increase performance per unit area. Baniameri [2] pointed out the plantation in a green house space as a suitable solution for this purpose. The green house space provides an appropriate environment to produce crops more than the natural environment. On the other hand, the green house is, also, a suitable environment for the growth of fungus and pest. Therefore, the green house farmers have to use different types of pesticides and fungicide in high concentration [3]. This observation interpreted the fact that, the green house's products have more chemical residuals. According to Baniameri [2] more than 64 types of chemical pesticides are being used in Iran's green houses industry. These different types of toxins not only remains on the crops' skin, but also penetrate in the tissue of fruits, vegetables and also grains. However, washing and peeling are important to decrease contamination. But, removing of their toxin effects is almost impossible [3].

Intensive usage of chemical pesticides has caused serious problems on both the human beings and the environment [4]. The negative effects on human health, agro ecosystems (e.g., killing beneficial insects), destruction of natural habitats for wildlife, insect and pest resistance against insecticides and pesticides, and polluting groundwater resources are some examples of unsustainable consequences of insecticide use [5-7]. These chemicals are known to remain for long periods in water, soil, air, and food. Their health hazards have been noticed after they began to be used widely in considerable amounts throughout the world [8].

It is estimated that pests damage 42 percent of agricultural products in Iran [9]. The estimated amount of different agrochemical pesticides (insecticides, nematicides, fungicides, and herbicides) used in Iran is 17-25 million liters a year, which is more than the optimum requirement [10]. The excessive, un-ecological and inappropriate use of them have created side effects such as resistance to pesticides, outbreak of new or secondary pests, toxicity, poisoning, causing cancers and genetics disorders [11-15].

There is consistent evidence in the literature indicating a relationship between farmers' attitudes toward environment and their farming practices [16]. Farmers' decisions to adopt a new agricultural technology depend on complex factors. One of the most important factors is farmers' perception [17]. Alonge and Martin [18] found that farmer's perceptions regarding the sustainable practices with their farming systems emerged as the best predictors of adoption of such practices. Therefore, the main objective of this study is to assess the attitudes of farmers with regards to pesticide use and the factors contributing to formation of these attitudes.

Based on previous studies, a questionnaire developed to study the variables influenced on greenhouse workers' attitude to pesticide use. The first section of questionnaire consisted some items to gather data about demographic characteristics, such as age, gender, greenhouse area and etc. The second section included 24 items to assess variables influencing on greenhouse workers' attitude to pesticide use. Those variables have five point Likert scale (1 completely undesirable to 5 completely desirable). The third section included nine items to assess dependent variable, i.e. greenhouse workers' attitude to pesticide use. Those variables have five point Likert scale (1 completely disagree to 5 completely agree). In the case of negative statements the scoring pattern was reversed.

One can categorize literature results into four factors as the following:
(1) Extension-Education factor including: Technical advice (extension and education) on: using exact dose of pesticide [19]; Principles of microbe control [20]; Chemical pesticide management in greenhouses [20]; Weed control methods [21]; Biologic control [21]; Identify pests and disease [22]; How to sterile seeds [22]; How to use green manure appropriately [22]; How to use animal manure appropriately [22]; Enhance consumer awareness about healthy food products [22].

(2) Technical factor including: Accessible: biologic pesticides [23]; appropriate technical constructs [23]; Infrastructures for healthy food production [23]; a laboratory for recognize chemical residue[23]; Hygiene control in all production stages [23].

(3) Legal factor including designing, implementing and enforcing national and regional standards for using pesticides [24]; Designing Regulations for healthy food production [24]; supportive government policies to reduce chemical pesticides [20]; supportive policies for greenhouse workers who use low chemicals [25].

(4) Socio-Economic factor including: Integrated and systematic approach in planning for export healthy production [24]; low price and easy availability to natural inputs [20]; loans and financial support for greenhouse workers who use low chemicals [26]; insurance in all stages of production, i.e. planting, treatment, and harvesting [19]; using pioneer greenhouse workers to encourage the others to use low chemicals [19].

And finally, attitude towards pesticide reduction use including the following variables: Protecting the environment [27]; Low cost of production because of reduction of pesticides costs [28]; Personal health [29]; family health [30]; consumer health [30]; Negative effects of agrochemicals on human and animal health [31]; Agricultural production can only be increased using agrochemicals (reversal statements)[31]; Farmers' main objective must be maximized profit (reversal statements) [31]; Long term negative effects of applying modern agricultural technologies on water, soil, and air[31].

The purpose of this research arrives in two steps. In the first step, observed variables are categorized into some latent variables. The latent variables are estimated for each observation using the average of observed variables which building up such latent variables. In the second step, using the well-known regression method to measure the independent latent variables (*Extension-Educational*, *Economic*, *legal*, *Technical*, and *Social* factors) on dependent variable (attitude towards pesticide reduction use).

MATERIALS AND METHODS

Questionnaire items were developed based on the previous literature. The questionnaire was revised with the help of experts to examine the validity of the research model. A five-point Likert scale ranging from 1 as strongly disagree or completely undesirable to 5 as strongly agree or completely desirable was used for the measurement. A pre-test for the reliability of the instrument was conducted with 15 farmers randomly chosen from the target population. The Computed Cronbach's alpha is 89%, which indicated the high reliability of the questionnaire.

The province of Tehran is the main greenhouse production area in Iran. Today, about 34% of greenhouse crops production in Iran is provided from this province. Hashtgerd is located in Tehran province (Figure 1). The research population included all the greenhouse workers in Hashtgerd city (N = 50). The initial and follow-up mailing generated 44 useable responses resulting in a response rate of 88%. Since sample size of the study is relatively small (n=44, for the usual CFA, we need about 200 observation) and all variables follow the Likert scale; Therefore, the Bayesian CFA is an appropriate statistical technique to analysis data [32]. To implement the Bayesian CFA to test the theoretical framework, the statistical package

WinBUGS version 14 was used. WinBUGS combines the prior information (which summarizes in a prior distribution) with observation and derives a distribution for factor loadings. This approach to factor loading provides more information about factor loading compare to other classical CFA approaches. More precisely, one can estimate mean, variance, and credible interval for mean of factor loadings.

As explained the above, all ordinal and observed variables in this research considered as normally distributed latent variables. Using such approach to ordinal and observed variables along with the Invert Gamma and the Invert Wishart priors, which commonly use with normal distribution (whenever no prior information is available), one can employ the WinBUGS software to test the theoretical framework given in introduction.

Analysis described below was run in WinBUGS for total of 100,000 iterations, which mostly, burn-in about 10,000 iterations. All model validation criteria, such as MC-error (it should be considerably lower than variance for each estimated parameters), Autocorrelation functions (it should be approached to zero exponentially for each estimated parameters), and kernel density (all estimated parameters have to be normally distributed) have been met by the final models. To consist on briefness such validity criteria removed from the article.

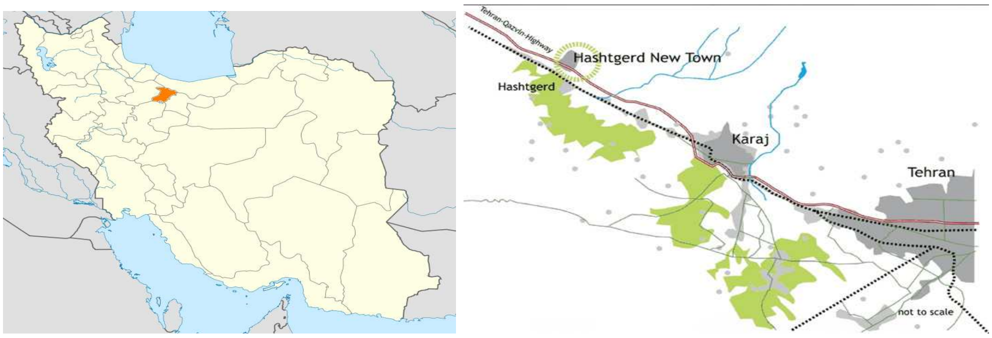

Figure 1. Location of the research case study, Hashtgerd City, Tehran Province, Iran.

RESULTS AND DISCUSSION

Descriptive statistics

Table 1 summarizes the demographic profile and descriptive statistics of greenhouse workers. As Table 1 represented: more than 88% of greenhouse works are male; average age of them is about 39 years; and more than 76% of them have Bachelor level of education. Therefore, we are dealing with an educated and young target population.

Table 1. Demographic profile and descriptive statistics of greenhouse workers

Work experience in greenhouses	Mean= 8	S.D=5.11
Gender	Female (11.9%)	Male (88.1%)
Age/year	Mean= 39.4	S.D=8.17
Greenhouse area (meter square)	Mean= 3702.4	S.D=1569.7
Level of education	Guidance (4.8%), Diploma (19%)	Bachelor (76.2%)

Bayesian confirmatory factor analysis (CFA)
Since sample size of the study is relatively small (n=44, for the usual CFA, we need about 200 observation) and all variables follow the Likert scale; Therefore, the Bayesian CFA is an appropriate statistical technique to analysis data [32].

The final conceptual framework arrived after: (i) removing "Integrated and systematic approach in planning for export healthy production" from Socio-Economic factor; (ii) adding a new factor, named "social", which obtained two variables “Enhance consumer awareness about healthy food products” and ” using pioneer greenhouse workers to encourage the others to use low chemicals” from Extension-Education and Socio-Economic factors. Figure 2 represents conceptual framework of the study.

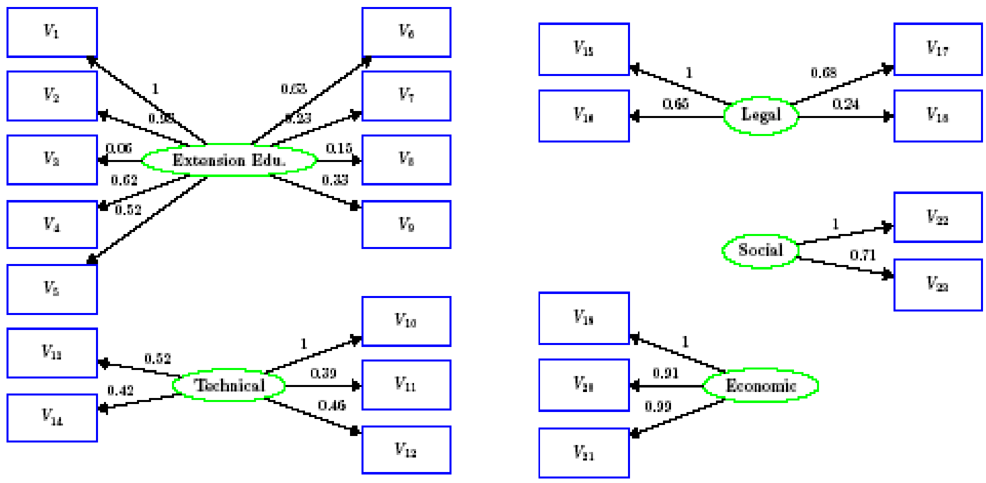

Figure 2: Conceptual framework of factors affecting pesticide use.

Variables V1,…,V2 in Figure 2, respectively, represent: Principles of microbe control (V1); using exact dose of pesticide (V2); Chemical pesticide management in greenhouses (V3); Weed control methods (V4); Biologic control (V5); Identify pests and disease (V6); How to sterile seeds (V7); How to use green manure appropriately (V8); How to use animal manure appropriately (V9); biologic pesticides (V10); appropriate technical constructs (V11); Infrastructures for healthy food production (V12); a laboratory for recognize chemical residue (V13); Hygiene control in all production stages (V14); Designing, implementing and enforcing national and regional standards for using pesticides (V15); Designing Regulations for healthy food production (V16); supportive government policies to reduce chemical pesticides (V17); supportive policies for greenhouse workers who use low chemicals (V18); Low price and easy availability to natural inputs (V19); loans and financial support for greenhouse workers who use low chemicals (V20); insurance in all stages of production, i.e. planting, treatment, and harvesting (V21); Enhance consumer awareness about healthy food products (V22); using pioneer greenhouse workers to encourage the others to use low chemicals (V23).

From factor loadings of the above conceptual framework, one may observe that: (i) using exact dose of pesticide provide more impact on the Extension-Educational factor; (ii) a laboratory for recognize chemical residue provide more impact on the technical factor; (iii) supportive government policies to reduce chemical pesticides provide more impact on the legal factor (iv) insurance in all stages of production, i.e. planting, treatment, and harvesting provides more impact on the economic factor(v) using pioneer greenhouse workers to encourage the others to use low chemicals provide more impact on the social factor. Table 2 represents the common variance which explained by each factor. From Table 2, one can order the factors based upon their impact as: Extension-Educational; Economic; Legal; Technical and Social. These factors, in total, explain 72.01% of total variance.

Table 2. The common variance which explained by each factors

Factor	Explained common variance by factor
Extension-Educational	20.33 %
Economic	18.43%
Legal	12.72%
Technical	10.69%
Social	9.84%
Total	72.01%

Multiple regression analysis

In the previous section, observed variables are categorized into some latent variables. The latent variables are estimated for each observation using the average of observed variables which building up such latent variables. In this section, using Multiple Regression Analysis to measure the independent latent variables (*Extension-Educational*, *Economic, legal, Technical,* and *Social* factors) on dependent variable (attitude towards pesticide reduction use).

Table 3 shows the result of stepwise regression model. The result indicates that 36.2% variance of the *attitude towards pesticide use* could be explained by two factors. In the first step, the Extension-Educational factor (which explained 25.1% of total variance) was entered to the model. In the second step, the legal factor (which explained 11.1% of total variance) was entered to the model. Findings in Table 3 can be summarized in the following equation: $Y = 2.711+0.303(X1) +0.675(X2) +error$. The equation shows that two *Extension-Educational* (X1) and *Legal* (X2) factors impact, directly, on *attitude towards pesticide use* (Y).

Table3. Multivariate regression analysis, with "attitude towards pesticide use" as a dependent variable

Variables	B	Beta	t	Sig.
Constant	2.711	…	5.929	< 0.0001
Extension-Educational factor (X1)	0.303	0.494	5.878	< 0.0001
Legal factor (X2)	0.675	0.257	3.633	0.001

CONCLUSION

The Bayesian CFA suggested that Extension-Educational factor (included: using exact dose of pesticide; Principles of microbe control; Chemical pesticide management in greenhouses; Weed control methods; Biologic control; Identify pests and disease; How to sterile seeds; How to use green manure appropriately; How to use animal manure appropriately; Enhance consumer awareness about healthy food products) as the most important factor. Moreover, the regression result also indicated that Extension-Educational is the most important factor among others.

A major issue for pesticide contamination in developing countries is the unsafe use of pesticides. Elements of unsafe use of pesticides that have been identified by past research include erroneous beliefs of farmers about pesticide toxicity, lack of attention to safety precautions, environmental hazards, and information about first aid and antidotes given by the label, the use of faulty spraying equipment or lack of proper maintenance of spraying equipment, and lack of using protective gear and appropriate clothing during handling of pesticides [33-36].

Fortunately, many greenhouse workers have expressed the need for information and training programs on pesticide safety, and therefore are likely to be responsive to such programs. Research has often emphasized the need to increase the awareness of farmers about the consequences of unsafe pesticide use and the importance of communication and education programs aiming to reduction of risk [37].

Agricultural extension is a major channel of communication between farmers and research experts which can improve crop production from many points of view as it provides a good link between farmers and research institutes where several agricultural technologies, including pesticides and the relative technology, are developed, tested, and modified accordingly. Training programs can play a crucial role in pest control decisions, providing farmers with the technical knowledge that is necessary for the selection of appropriate pest management methods and also for safe and effective pesticide use [38].

Baral *et al.* [39] also indicated that greater awareness about IPM technologies as well as awareness about technological failures of chemical pesticides also reduces the level of pesticide misuse. As expected, IPM training and membership with a farmer organizations reduces the level of pesticide misuse.

The above findings have been verified [40-42].

The Bayesian CFA suggested that economic factor (included: Low price and easy availability to natural inputs; loans and financial support for greenhouse workers who use low chemicals; insurance in all stages of production, i.e. planting, treatment, and harvesting) as the second important factor. Baral *et al.* [39] also indicated that all farmers adopting IPM technology agreed that the high cost of pesticide was a reason for adopting IPM and pesticide use.

Moreover, the regression result indicated that legal factor is the second most important factor among others. Hernandez- Rivera [43] also implied to legal factor as an explanatory factor for the different pesticide use patterns. The implementation of good agricultural practices is certified by means of private schemes or standards (e.g. Global GAP, the most widespread standard in Europe). Tests of pesticide residues in fruits are carried out by regional authorities (officially in charge of monitoring plans), fruit retailers (i.e. supermarkets), food industry companies, marketing organisations, and growers' associations. The participation of several actors in the control of pesticide residues indicates the importance of guaranteeing safety for fruit consumers.
Based upon the research findings, one may suggest:

• Using some motivational constructs, such as loans with low interest, to owners of green houses who use a lower level of pesticides compares to others.

- Designing a Bonus-Malus crop insurance system which provides some sort of reward (Bonus) for farmer who use a lower level of pesticides and some sort of penalty (Malus) for others. See Denuit *et al.* [44] for more detail.
- Legislation some rules which determine upper level of chemical residuals in each green house productions.
- Holding some mandatory training course for who owning or planning to own a green house to learn disadvantage of using pesticides in higher dose.

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