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Application of Structural Equation Modeling to Scrutinize the Causes of Grape Losses in Production Chain

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ABSTRACT

Grape is the key product of Qazvin Province and a vast amount of it is annually lost during supply chain due to various causes. This study, therefore, aimed at examining the effective and significant causes of grape losses in supply chain in Qazvin. First, to identify the main causes of the grape losses and to develop the research framework, data was gathered through some qualitative methods. Twenty-three grape growers, researchers, and experts were interviewed by research team as the key informants. Meanwhile, grounded theory techniques were employed for data analysis simultaneous with data collection processes to develop the final theory and model. In second part, the study's hypotheses and research model were formed based upon the developed theory. Then, to examine the research model, Partial Least Square Structural Equation Modeling and Important-Performance Matrix Analysis techniques were used. The population involved/affected in this part was grape growers from five districts of Qazvin Province. The sample consisted of 380 grape growers who were selected through stratified random sampling. A questionnaire was utilized for data collection and data was analyzed with the Smart-PLS 3.0. Main findings show that "*management practices* and *resource and equipment*" had significant effect on the grape losses. In accordance with Important Performance Matrix Analysis (IPMA), "*extension and advisory services* and *management practices*" are of paramount prominence. Moreover, in indicators level, providing *on-farm participatory training, intelligible educational programs in local media*, and *financial resources*, had the utmost importance in mitigating grape losses.

Keywords: Extension and advisory services, Important-Performance Matrix Analysis (IPMA), Management practices, Partial Least Square Structural Equation Modeling (PLS-SEM).

INTRODUCTION

Losses of horticultural crops in general, and fresh fruits in particular, are quite crucial challenges within developing countries (Hailu and Derbew, 2015). Fruits sub-sector has the potential to contribute to improving smallholder's nutrition, and food security (Van den Broeck *et al*., 2018) consumed in either fresh or processed forms. Yet, both forms are lost or wasted each year throughout the whole supply chain by dint of numerous causes (Gustavsson *et al*., 2011). As stated by most researchers, loss of fruit in developing countries transpires primarily during the initial and middle stages of the supply chain encompassing agricultural production and postharvest processing (Kereth *et al*., 2013; Hailu and Derbew, 2015), and average of losses is between 20-50% (Mashau *et al*., 2012; Kereth *et al*., 2013).

In Iran, analogous to other developing countries, fruits suffer the highest rate of losses compared to other agriculture crops (Alikarimi, 2017). Moghaddasi *et al*. (2005) accentuated that roughly 7.6 million tons of the 25 million tons of fruit and vegetables

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are lost annually in Iran. Nonetheless, the rate of losses varies among fruits and the problem of losses becomes a more serious challenge when it comes to fruits such as grapes (Rajabi *et al.*, 2015). Among fruits, the most rates of the losses belong to grapes with 35-55 percent (Alikarimi, 2017). Losses during the supply chain may be aggravated due to grapes' delicateness and extreme perishability compared to other fruits. According to Moghaddasi *et al*. (2005), approximately 3 million tons of grapes are annually produced and nearly 640000 tons are processed in Iran, of which 30-38% are lost and thrown away at various stages of the postharvest chain. Rajabi *et al*. (2015) examined the amount of grape losses and waste throughout supply chain among small-scale grape growers in Qazvin Province. They revealed that about 53% of the grapes produced were lost in various stages of supply chain, which, major part of it (about 46%) took place in processing stage (19%), agricultural production (17.6%), and postharvest (9%) while only about 7% of the grapes were wasted during distribution and consumption stages. It is clear that losses represent a waste of land, water, energy, inputs, and other resources, while these resources could be used to increase fruit production and affect smallholders' food security (Tielens and Candel, 2014). Given all this, the ensuing questions were posed in this study:

RQ_1: What are the main causes of grape losses in processing, agricultural production, and postharvest stages of grape supply chain in Qazvin Province?

RQ_2: What are the most effective and the most important causes of the rising amount of grape losses in Qazvin Province?

In the present study, we aimed to answer the aforementioned questions.

MATERIALS AND METHODS

In order to identify the main causes of the grape losses and then to determine the effective and crucial causes, this study was conducted in two parts. First, a qualitative process and a review of literature was performed to identify the main causes of the grape losses and to reach a research framework. Then, to determine effective causes and important causes pivoting on the results of the first section, Square Structural Equation Modeling (SEM) was employed.

Research Framework and Hypothesis Development

To identify the main causes of the grape losses and to develop the research framework, first, data was gathered through the utilization of some qualitative methods including in-depth interview, observation, field notes, and document review (for comparison and conformity with previous literature). Snowball sampling as a type of purposive sampling was used for respondents selecting sequentially based on theoretical sampling. We achieved theoretical saturation when the number of respondents reached 23 participants, including 12 smallholder farmers (grape growers) from various areas of Qazvin, five researchers from Qazvin Agricultural Research and Education Organization (QAREO), and Takestan Grape Research Institute (TGRI), and six experts from Qazvin Agriculture-Jahad Organization (QAJO). Meanwhile, grounded theory techniques were employed (open coding and selective coding) for data analysis simultaneous with data collection processes to develop the theory. The constant comparative process form concepts outlined as Figure 1.

"Model of Main Causes of Grape Losses" (MMCGL) consisted of five categories and several subcategories of causes of grape losses in stages of pre-harvest, postharvest, and primary processing by farmers, as described in the following sections.

According to the "MMCGL", low level of knowledge, poor attitudes, and insufficient skills in all three stages of pre-harvest, postharvest, and primary processing could

Figure1. Model of the main causes of grape losses.

derive from the absence of innovative instructional approaches, providing educational programs for farmers without requiring assessment, lack of intelligible educational programs in local media, and lack of participatory trainings on-farm. Nevertheless, researchers emphasized that extension and advisory service providers are responsible to meet needs of each group and training is vital in the process of reducing losses (Abass *et al*., 2014; Hailu and Derbew, 2015; Midega *et al*., 2016; Epeju, 2016). In addition, increasing farmers' technical know-how and training (Abass *et al*., 2014), fitting technical training (Hailu and Derbew, 2015), educational innovation (Epeju, 2016), understanding local farmers' situations and needs (Midega *et al*., 2016), providing information through local media (McNamara and Tata, 2015) could be aggravating factors.

According to the model, weakness of agricultural management practices, technical management, farm health and safety management, environmental management, storage management, and processing management may raise grape losses in all three stages. In other words, good and timely agricultural practices, adaptive capacity to cope with climate changes, careful attention to the farm health, and good technical skills could be responsible for reducing grape losses. Some researchers revealed that improper practices (such as improper harvesting periods, mechanical injury, poor sanitation and improper packaging) result in crops losses (Hartikainen *et al*., 2018; Agarwal, 2017; Kereth *et al*., 2013); while improving post-harvest management systems (harvesting and handling techniques, packaging, storage and transportation facility, disease and pests, climate and weather condition) is apriority for farmers (Hartikainen *et al*., 2018; Kasso and Bekele, 2018; Arzani *et al*., 2009).

Based on the model, farmers are faced with limited financial resources; mechanization and equipment limitation; water resources restriction; limited skilled human resources during grape production process; and inappropriate handling and carrying tools. In other words, inadequate funds to provide input and equipment (Mandal, 2014); poor access to mechanization (Kasso and Bekele, 2018); water scarcity; inability to control pests and diseases (Abass *et al*., 2014; Mandal, 2014); lack of skilled manpower and labors (Kasso and Bekele, 2018); unsuitable packaging materials and transporting tools (Kasso and Bekele, 2018; Abass *et al*., 2014) may lead to higher grape losses.

According to the model, poor infrastructures could be divided into agricultural, postharvest, and processing infrastructures, every type of which has several subcategories (Figure 1). For example, lack of appropriate trellis systems, irrigation systems, harvesting equipment, and suitable local agro-meteorology center are some of the agricultural infrastructure limitations. In this way, Agarwal (2017) emphasized that losses are highest for the horticultural crops due to mechanical injury, improper packaging, inadequate storage, high temperature, transportation infrastructure, and processing units. Similarly, Beausang *et al*. (2017) referred to lack of processing facilities and Kasso and Bekele (2018) believed that harvesting and handling, storage, transportation and marketing facilities are major causes of post-harvest loss. Also, according to Gardas *et al.* (2019), high costs of marketing and limited marketing infrastructures could influence the efficiency of crops supply chain process.

Based on the model, numerous types of support services affect farmer's practices regarding high rate of grape losses. In other words, lack of financial, agricultural, advisory and legal support services might increase losses. In this regard, Ghiasi *et al*. (2017) indicated that smallholders in developing countries have limited access to consulting and extension services. Also, Mandal (2014) referred to inadequate government support for applied research and extension. Government financial assistance is the other factor that has been emphasized by researchers (Briones, 2013 and Li *et al*., 2018) through which Briones (2013) and Ghazanfari *et al.* (2019) avowed input subsidies, credit, investment plans as the government assistance to the farmers. Meanwhile, Rahimi-Soureh (2001) referred to assured prices and subsidy; He referred to subsidy paid as a support policy in Iran.

According to the above, the study's hypotheses and research model were formed (see Figure 2).

Effective and Important Causes of Grape Losses in Supply Chain

After a comprehensive literature review on theoretical bases of the causes of grape

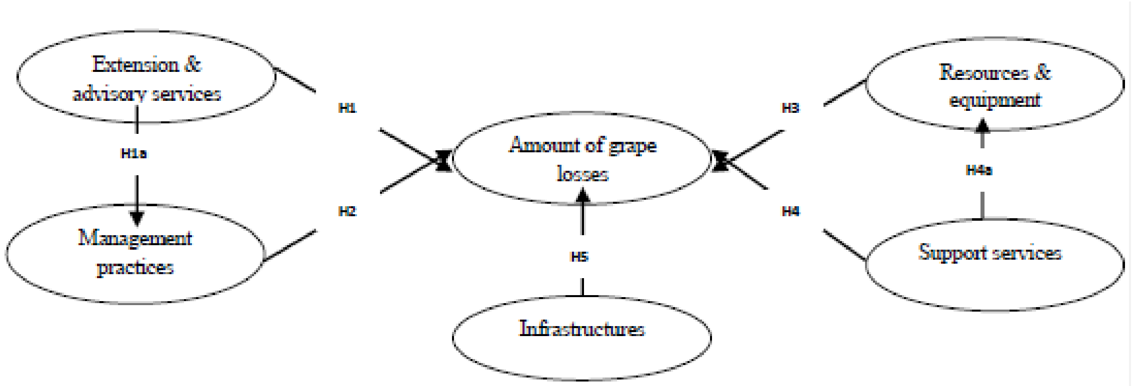

Figure 2. Research model: The main causes of grape losses.

losses and hypothesis development, the second main objective was to determine the effective and important causes of grape losses in supply chain including: agricultural production, postharvest, and primary processing by farmers in Qazvin Province.

Based upon the objectives, this paper has concentrated on determining effective causes and important causes of grape losses in Qazvin Province. As explained earlier, the research model includes six constructs: *extension and advisory services*, *management practices*, *infrastructures*, *resources and equipment*, and *support services* as independent constructs, and *amount of grape losses* as dependent construct.

The population of this study was smallholder farmers (grape growers) who were producing grapes at five regions (Khoramdasht, Ziaabad, Yahiaabad, Esfarvarin, and Takestan) in Qazvin Province (N= ۱۸,۰۳۹). The sample of the study consisted of ۳۸۰ farmers, based on Cochran, selected through stratified random sampling. From the total sample, 92% were male and 8% were female. As to age distribution, 12% of the respondents were below 25 years old, 39% aged 26-35 years, 38% were 36-45 years, and 11% were over 46 years. In terms of educational level, majority of the respondents (83%) had only high/elementary school level education, 9% were illiterate, and only 8% had academic degree.

In this research, a questionnaire was utilized for data collection. The questionnaire encompassed 26 questions pivoting on 7-point Likert scales. The questions derived from the MMCGL (Figure 1) (categories as constructs and subcategories as items) and were confirmed with previous studies and then modified to fit to the nature of this study. Validity and reliability were measured through pre-test, which was first distributed among 30 grape growers who were not in the sample of the study. The data was analyzed using Smart PLS 3.0 to ensure the measurement items were valid and reliable. To measure convergence validity of each constructs, factor loadings, Average Variance Extracted (AVE), and Composite Reliability (CR) were used. The results showed that the value of AVE of all constructs were greater than 0.50 (Barclay *et al*., 1995). In addition, CR for all construct was above the acceptable value of 0.70 in this study (Hair *et al*., 2010). Meanwhile, each square root of the value of AVE was more than correlation coefficient (Fornell and Larcker, 1981), thus discriminant validity was also supported. Additionally, Cronbach's alpha coefficient was used to assess the inter item consistency and the results suggested that the Cronbach's alpha of all the research variables had an acceptable reliability and it was more than 0.70. After verifying the validity and reliability, in total, 380 questionnaires were distributed among respondents, and 375 of them, that were fully and accurately completed, were used for data analysis purposes.

To test the research model, we used the Partial Least Squares (PLS) technique of structural equation modeling with Smart-PLS 3.0 (Ringle *et al*., 2015). The reason to use the PLS technique was its suitability with the exploratory nature of this study. A two-step process was applied: assessment of measurement model, to evaluate reliability and validity of the variables; and assessment of structural model, to evaluate the relations among the constructs and significance of the path coefficients by bootstrapping technique (Henseler *et al*., 2009).

In the last step, the Importance-Performance Matrix Analysis (IPMA) of path modeling was carried out extending the findings of the basic PLS-SEM in order to determine the areas that needed to be considered and improved. However, IPMA is a different way of presenting path information by assessing the impact of latent variables with a high importance (structural model total effect) and low performance (average values of the latent variable scores) on the endogenous latent variable (Hock *et al*., 2010). In this case, IPMA is useful to introduce the causes of grape losses, which should be focused in order to reduce the losses.

RESULTS

In order to achieve the objectives, first, the developed model based on research model (Figure 2) in Smart-PLS 3.0 was assessed with a two-step process as follows: (a) Measurement model evaluation, and (b) Structural model evaluation. Second, in order to further investigate the constructs and to highlight the important constructs for improving the management activities, IPMA was carried out.

Measurement Model

Initially, confirmatory factor analysis was executed to examine the reliability, convergent validity, and discriminant validity of the constructs for achieving the optimum values of parameters. As revealed in Figure 3 and Table 1, all factor loadings are higher than 0.5, and the AVE of all the reflective constructs are higher than the required value of 0.5. Besides, CR values of all the constructs are higher than the cut-off value of 0.7.

Meanwhile, to achieve adequate discriminant validity, each square root of the value of AVE was more than correlation coefficient. According to Table 2, the diagonal values of the correlation matrix were greater than the off diagonal values (Barclay *et al*., 1995; Hulland, 1999). Discriminant validity was also assessed using HeteroTrait-MonoTrait (HTMT) criterion (Henseler *et al*., 2015) and all the values were below the threshold of 0.85.

Structural Model

Structural model was assessed by evaluating the R^2 and path coefficient (β) values. The R^2 value of endogenous latent variable (amount of grape losses) was 0.703, which indicates that all the constructs significantly affect the endogenous latent variable. For the path coefficients, β values of each path were found to be 0.419 for management practices, 0.353 for resources and equipment, 0.133 for extension and advisory services, 0.082 for infrastructures, and 0.010 for support services (Figure 3).

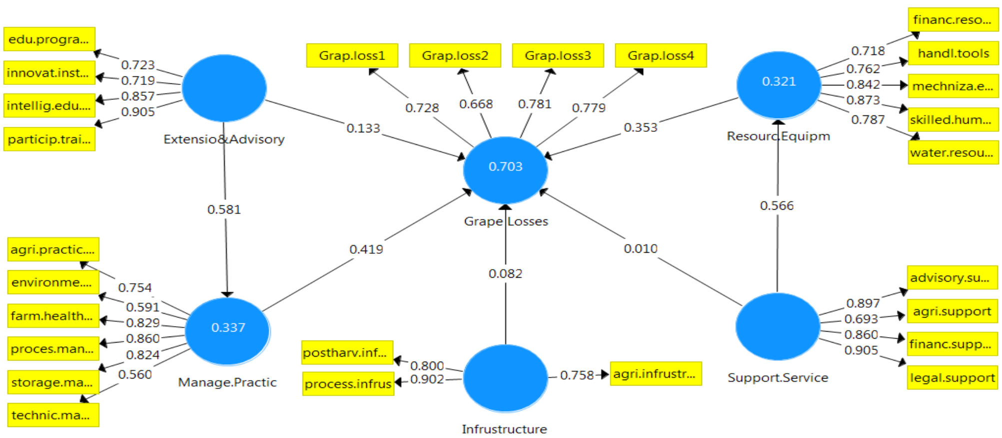

Figure 3. Measurement model: The main causes of grape losses.

Table 1. Results of measurement model based on confirmatory factor analysis.

Variables	Items	Loadings	AVE	CR
Extension and advisory services	Edu.program. need.assess	0.723	0.648	0.879
	Innovat.instruct	0.719		
	Intellig.edu.media	0.857		
	Particip.training	0.905		
Management practices	Agri.practic.manage	0.754	0.556	0.880
	Environme.manage	0.591		
	Farm.health.manage	0.829		
	Proces.manage	0.860		
	Storage.manage	0.824		
	Technic.manage	0.560		
Infrastructures	Postharv.infrustruc	0.800	0.676	0.862
	Process.infrustruc	0.902		
	Agri.infrustruc	0.758		
Resources and equipment	Financ.resource	0.718	0.637	0.897
	Handl.tools	0.762		
	Mechniza.equipment	0.842		
	Skilled.human.resource	0.873		
	Water.resource	0.787		
Support services	Advisory.support	0.897	0.711	0.907
	Agri.support	0.693		
	Financ.support	0.860		
	Legal.support	0.905		

Then, to assess the significance of all the paths, bootstrapping was performed. The path coefficient is significant if the t-value is larger than 1.96. The results showed that the relationships among extension and advisory services→grape losses, infrastructures→grape losses, and support services→grape losses, were not significant (Table 3). All other path coefficients were significant, specifically, management practices (t-value= 2.967; P= 0.000) and resource and equipment (t-value= 2.788; P= 0.005), each has significant and positive effects on the grape losses. Meanwhile, the extension and advisory services had a significant effect on management practices (t-value= 4.100; P= 0.000) and also support services had a significant effect on resource and equipment (t-value= 5.113; P= 0.000). Thus, “extension and advisory services” and “support services” had indirect effects on the grape losses. Therefore, H1a, H2, H3, and H4a are supported, whereas H1, H4, and H5 are not supported.

Importance-Performance Matrix Analysis

In the last step, IPMA was used in order to generate additional findings. We used IPMA for prioritizing both constructs and indicators separately and identifying the most important areas regarding the best grape-losses-management activities. The first step in using an IPMA is checking the requirements. Therefore, we reviewed the questionnaire and found that all the indicator data were on an interval scale from 1 to 7, a higher value represents a better outcome. Next, we checked the signs of the outer weights, all of which were positive. Then, Smart-PLS computed the performance and important values of the constructs and indicators.

As shown in Table 4, in constructs level, “extension and advisory services”, and “management practices”, had high

Table 2. Discriminant validity and correlation between constructs.[a]

Constructs	1	2	3	4	5	6
1. Extension and advisory services	0.805					
2. Grape losses	0.545	0.740				
3. Infrastructures	0.238	0.591	0.822			
4. Management practices	0.581	0.767	0.593	0.746		
5. Resources and equipment	0.414	0.722	0.627	0.611	0.798	
6. Support services	0.357	0.557	0.671	0.584	0.566	0.843

[a] Correlation is significant at the 0.05 level (2-tailed). Diagonal values are the square roots of the AVE, and below the diagonal values are the correlations between the construct values.

Table 3. Hypothesis testing, relationships between constructs.

Hypothesis		Sample mean	Standard deviation	t-value	P-value	Decision
H1	Extension and advisory services→Grape losses	0.151	0.161	0.826	0.409	Not supported
H1a	Extension and advisory services→ Management practices	0.583	0.142	4.100	0.000	Supported
H2	Management practices → Grape losses	0.400	0.141	2.967	0.000	Supported
H3	Resource and equipment →Grape losses	0.358	0.127	2.788	0.005	Supported
H4	Support services → Grape losses	0.016	0.198	0.049	0.961	Not supported
H4a	Support services →Resource and equipment	0.589	0.111	5.113	0.000	Supported
H5	Infrastructures → Grape losses	0.108	0.189	0.436	0.663	Not supported

Table 4. IPMA results in construct level.

Latent variables	Importance	Performance
Extension and advisory services	0.442	58.779
Management practices	0.411	65.575
Resources and equipment	0.349	65.962
Support services	0.200	75.945
Infrastructures	0.079	69.589

importance values. As indicated, the direct effect of the extension and advisory services on grape losses is not significant; meanwhile, it leaves significant indirect effect on grape losses through management practices. Therefore, the total effect (importance) of extension and advisory services is of the highest importance. In this regard, managerial actions should prioritize improving the performance of extension and advisory services. In other words, the best management for grape losses can be achieved by enhancing the extension and advisory services.

In the same way, as shown in Table 5, in indicators level, “participatory trainings on-farm”, “intelligible educational programs in local media”, and “financial resources”, were the top three areas enjoying high importance that could be focused in grape losses management activities compared with other indicators.

Furthermore, when we focus on each of the significant constructs and low performance, in extension and advisory

Table 5. IPMA results in indicators level.

No	Indicators		Importance	Performance
1	Particip.training	Participatory trainings on-farm	0.156	57.778
2	Intellig.edu.media	Intelligible educational programs in local media	0.121	53.333
3	Financ.resource	Financial resources	0.096	60.000
4	Edu.program. Need.assess	Educational programs for farmers with need assessment	0.086	66.667
5	Proces.manage	Processing management	0.080	71.667
6	Innovat.instruct	Innovative instructional approaches	0.079	60.556
7	Environme.manage	Environmental management	0.079	81.667
8	Mechniza.equipment	Mechanization and equipment	0.079	80.556
9	Financ.support	Financial supports	0.068	78.889
10	Storage.manage	Storage management	0.067	61.667
11	Skilled.human.resource	Skilled human resources	0.067	56.667
12	Agri.practic.manage	Agricultural practices management	0.066	56.667
13	Farm.health.manage	Farm health and safety management	0.061	62.778
14	Technic.manage	Technical management	0.060	53.333
15	Water.resource	Water resources	0.055	67.778
16	Handl.tools	Handling and carrying tools	0.051	65.000
17	Agri.support	Agricultural supports	0.046	82.778
18	Advisory.support	Advisory supports	0.043	69.444
19	Legal.support	Legal supports	0.043	70.556
20	Process.infrustruc	Processing infrastructure	0.031	69.444
21	Postharv.infrustruc	Postharvest infrastructure	0.027	67.222
22	Agri.infrustruc	Agricultural infrastructures	0.021	72.778

services, indicators such as on-farm participatory trainings and intelligible educational programs in local media need more attention from experts, researchers, and extension agents. Concerning management practices, processing management and environmental management need to improve, and about resources and equipment, reinforcement of financial resources and mechanization and equipment should be considered.

DISCUSSION

In Iran, in line with other developing countries, substantial amount of losses of fruits occur in initial and sometimes middle stages of supply chain, particularly for grapes, which are the most vital product of Qazvin Province; yet, great amount of it is lost annually. Therefore, the main objective of this study was determining major causes of grape losses in grape supply chain, including agricultural production, postharvest, and primary processing by farmers in Qazvin Province by using PLS-SEM and IPMA.

Key Findings

According to the results, "management practices" had a strong and positive effect on the amount of grape losses. This finding was consistent with Kasso and Bekele (2018) and Abass *et al*. (2014) who suggested that good and timely agricultural practices, and good technical skills and postharvest handling competencies could be responsible for reducing losses. This result also validated the findings of Beausang *et al*. (2017) and Hartikainen *et al*. (2018) who revealed that adaptive practices to cope with environmental changes.

Second, "extension and advisory services" has indirect effect on the grape losses through management practices. The results suggested that appropriate education and extension services and training programs reduce losses through raising farmers' knowledge, attitudes, and skills, which was in accordance with previous studies (Kereth *et al*., 2013; McNamara and Tata, 2015; Hailu and Derbew, 2015; Midega *et al*., 2016; Epeju, 2016).

Third, the result of IPMA in indicators level showed that "on-farm participatory trainings" have the highest importance in improving farmers' performance and reducing grape losses. This result validated the finding of McNamara and Tata (2015) and Gadzirayi and Mafuse (2015). Gadzirayi and Mafuse (2015) indicated that farmer field schools were more effective in terms of improvement in farmers' knowledge, skills empowerment, and change in crop practices. The IPMA results further revealed that "intelligible educational programs in local media" play a crucial role in improving farmers' performance, which was consistent with the result of the study of McNamara and Tata (2015), who believed that an education program could utilize demonstrations through radio messages, print media, and local newspaper articles. This finding was in accordance with previous studies (Rezaei *et al*., 2017; Nazari and Hassan, 2011). The findings of Rezaei *et al*. (2017) revealed a significant relationship identified among networks and media on farmers' perception and their activities toward better management. Nazari and Hassan (2011) indicated that mass media is an effective channel for communicating agricultural messages, which increases knowledge and influences behavior. In this regards, Kassem *et al.* (2019) revealed that the print media such as pamphlets are highly qualified for disseminating information. In addition, the IPMA results confirmed that "financial resources" was one of the areas enjoying great importance. This was consistent with the result of the study of Kiaya (2014) that indicated the investment was required to reduce losses. This result also validated the finding of Briones (2013) pointed out input subsidies, credit, and investment plans as the government assistance to the farmers. Meanwhile, Rahimi-Soureh (2001) referred to assured prices and subsidy and indicated that the total subsidy is paid for agriculture in line with support policies in Iran.

Implications for Research

This study has several implications to the existing literature. Firstly, it should be noted that we developed and introduced the "Model of Main Causes of Grape Losses" (MMCGL) as the new theory in this area. Secondly, we used this model as the conceptual framework to identify important causes of grape losses and the results revealed that good and adaptive management practices would reduce amount of grape losses, while these practices are strongly affected by appropriate extension and advisory services. However, researchers emphasized that extension and advisory service providers are responsible to meet the needs of different actors who are involved in supply chain (McNamara and Tata, 2015), while prior studies often neglected the indirect effects of extension and advisory services through managerial skills. Thirdly, we used IPMA for prioritizing and identifying the most important areas regarding the best grape losses management activities and found that "on-farm participatory trainings" and "intelligible educational programs in local media" were two effective educational approaches that extension and advisory service providers could adopt in Qazvin Province to reduce amount of grape losses. Generally, effective extension cannot be achieved without the active participation of the farmers themselves. In participatory approaches, farmers involve in decision-making processes, development of the programs, implementing programs, and evaluating programs (Cohen and Uphoff, 1980). Therefore, on-farm participatory trainings have the highest importance in improving farmers' performance. In addition, it seems that mass media is an effective channel for communicating agricultural messages that increase knowledge and influences behavior of audience (Nazari and Hassan, 2011; McNamara and Tata, 2015). This is the most important contribution in our research.

Implication for Practice

From a practical perspective, this study might help extension and advisory service providers to target their training strategies facing grape growers, especially the smallholders. According to the results, "on-farm participatory trainings" and "intelligible educational programs in local media" were two effective educational tools to improve knowledge, practices, and skills of grape growers. In this regard, educational programs for farmers could be offered in proper time and appropriate manner in local media such as radio, TV, newspaper, and pamphlet. In addition, considering the expansion of mobile applications and ICT even in the rural and among illiterate farmers, training and educational programs can be presented through popular communication apps. Therefore, communication apps have become common tools for transmitting voice, video, documents, and other services in the form of groups and channels. Therefore, researchers, extension agents, and specialists can use this capacity to improve their training and extension services for grape growers and their families and receive their comments and feedbacks.

Limitation and Future Research

All studies have limitations that affect the findings. We also had some major limitations in this study that should be interpreted. First, we developed and introduced the "Model of Main Causes of Grape Losses" as the new theory in this area and, then, we examined it as the conceptual framework in this study. To confirm the validity of this model, future study should examine this model as a conceptual framework in other Provinces and even other similar crops. Second, the size of the sample in this study is relatively small, which may affect the generalizability of the findings to all grape growers. Third, in this study we concentrated on smallholder grape growers in Qazvin Province. Therefore, we can't generalize the findings to other types of farmers in different areas. Finally, we suggest future studies investigate the role of "extension and advisory services" and "management practices", in general, and "on-farm participatory trainings", and "intelligible educational programs in local media", in more details, since they were found as the highly important areas in grape losses management in Qazvin Province.

CONCLUSIONS

In this study, the "Model of Main Causes of Grape Losses" was added to previous literature about crops losses and wastes, as a new theory in this area. In addition, this study showed how the "on-farm participatory trainings" and "intelligible educational programs in local media" could be two effective educational approaches that extension and advisory service providers could adopt in Qazvin Province to reduce amount of grape losses. However, this study suggested that amount of grape losses would be reduced significantly by offering educational programs to farmers. These trainings should include issues on modern cutting, grafting, soil and grapevine nutrition, irrigation, pruning, drying, juicing, and packaging methods of the grapes or about pest and diseases management, use of hormones and micronutrients, protection of seedlings and fruits against climate change and unforeseen rain, harvesting in proper time and in appropriate manner, and pre-cooling ways. Education can be done through local media such as radio, TV, newspaper and pamphlet and through mobile applications and channels. It is necessary for future research to examine other effective factors that could decrease the grape losses in Qazvin Province.

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کاربرد مدلسازی معادلات ساختاری جهت بررسی علل ایجاد ضایعات زنجیره تولید انگور

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چکیده

انگور یکی از محصولات کلیدی استان قزوین محسوب می گردد و سالیانه مقادیر زیادی از آن در طول زنجیره تولید به جمع ضایعات می پیوندد. لذا، هدف اصلی این مطالعه، بررسی و ارزیابی دلایل موثر و مهم ضایعات زنجیره تولید انگور در استان قزوین است. در این راستا، ابتدا جهت تعیین دلایل اصلی ایجاد ضایعات انگور و دستیابی به چارچوب مفهومی مطالعه بر اساس آن، داده های مورد نیاز با استفاده از برخی روش های کیفی مانند مصاحبه عمیق، یادداشت در عرصه، و مرور منابع،گردآوری شد. تعداد ۲۵ انگورکار، محقق و کارشناس باغبانی، توسط تیم تحقیق مورد مصاحبه قرار گرفتند. در همین حین، تکنیک گراندد تئوری جهت تجزیه و تحلیل داده های جمع آوری شده و در طول فرآیند گردآوری داده ها، جهت دستیابی به تئوری و مدل، به کار گرفته شد. در گام دوم، فرضیه های تحقیق و مدل تحقیق بر اساس تئوری ایجاد شده از بخش اول، شکل گرفتند. سپس، برای ارزیابی و سنجش مدل تحقیق، مدلسازی معادلات ساختاری با رهیافت حداقل مربعات جزیی، و ماتریس تحلیل اهمیت–عملکرد، مورد استفاده قرار گرفت. جامعه آماری این بخش از مطالعه انگورکاران پنج ناحیه از استان قزوین بودند. نمونه آماری شامل ۳۸۰ انگورکار بود که به روش نمونه گیری تصادفی طبقه ای برگزیده شده بودند. پرسشنامه ای محقق ساخته برای گردآوری داده ها در این بخش استفاده شد و داده های حاصل با استفاده از نرم افزار Smart-PLS 3.0 مورد تجزیه و تحلیل قرار گرفت. یافته های مهم حاصل از این بخش نشان داد، دو عامل اقدامات مدیریتی، و منابع و تجهیزات تاثیر مثبت و معنی داری بر ایجاد ضایعات انگور دارند. بر اساس یافته های حاصل از ماتریس تحلیل اهمیت–عملکرد، دو حوزه ی خدمات ترویجی و مشاوره ای و اقدامات مدیریتی، به ترتیب بیشترین اهمیت را داشته که می تواند مدنظر مدیران جهت بهبود وضعیت تولید انگور قرار گیرد. ضمن اینکه، ریزفاکتورهایی چون فراهم نمودن آموزش های مشارکتی در سطح مزارع، ارائه برنامه های آموزشی قابل فهم برای انگورکاران در رسانه های محلی، فراهم نمودن منابع مالی مورد نیاز، مهم ترین عواملی بودند که در صورت مورد توجه قرار گرفتن توسط مسئولین امر، در نهایت منجر به کاهش ضایعات انگور می گردد.