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Preferred Extension System for Sustainable Horticulture in Sari, Iran

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Abstract

Lack of understanding of the extension, education, and development practitioners' role and their contribution to sustainable agriculture is the main challenge of sustainability projects in Iran. Accordingly, the aim of this study was to identify the extension system that has been more successful in sustainable horticulture. The population consisted of 22 pioneer farmers that had used or are using the services and/or consultations of both public and private extension experts in different ways. Based on census data, 20 farmers were studied. A questionnaire was used to collect the data. To determine the face and content validity, a panel of experts and to assess the reliability, inconsistency ratio was used (IR=0.03). Based on the five sustainability criteria, public extension system was identified as the superior system in the improvement of the sustainability of horticulture activities. Analytical hierarchy process based on the pair-wise comparison and the combination of the relative weights of sub-criteria and options showed that the public system is preferred over the private system, especially in ecological, cultural, and social dimensions. Given the relative superiority of the public extension system over the private extension system, it is recommended to use private extension system along with the public system as a supplementary system so as to gradually pave the way for assigning the authorities and activities to the private sector. Then, we can hope for the full privatization of agricultural education and extension system.

Keywords:
sustainable horticulture, public extension, private extension

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INTRODUCTION

Most economic activities in most countries are concentrated on the agriculture sector. Therefore, the economics of these countries are heavily dependent on this sector and thus, the export and import of the agricultural commodities can be a major source of foreign currency for their economics (Emadzadeh et al., 2009). On the other hand, the concept of sustainable development that meets the requirements of the present and future generations in its broadest sense has always taken land conservation (Moharamnejad & Mafi, 2010) in general and the conservation of agricultural lands in particular as the main production resource and driver of the industry into account.

In the age of globalization, sustainability and community development are intimately connected and ultimately challenged (Sumner, 2009), and for this reason, the sustainable development of agriculture is presently the top priority in the developing countries' national development plans.

Sustainable agriculture encompasses a wide area. It is a means for the improvement of human and environmental well-being, not for making ever-increasing private profits, regardless of the social, environmental, and even economic costs. A truly sustainable horticulture would not only be organic, but also produces social, environmental and economic justice, thus contributing to local community development on a global scale and becoming part of what has been referred to as sustainable globalization (Sumner, 2009).

Despite the attempts made in this respect, the economic growth-driven policies, industrial renovation, technology transmission, and the emphasis on more production have entailed negative economic, social, and environmental consequences, and overall, have resulted in unsustainability in most countries (Ertiaei, 2006). Iran has the second highest rate of erosion and deterioration of fertile soils and natural resource following Australia so that it is 33 t ha^{-1} soil. One major reason is the excessive use of chemical fertilizers and herbicides in the agriculture sector (Malek Saeidi et al., 2009). Also, statistics show remarkable growth of the application of chemical fertilizers and herbicides. In other words, since the introduction of the concept of sustainable agriculture in Iran in 1993 (Ghanbari & Barghi, 2008) and extensive research on the achievement of the sustainable agriculture, it has not had optimum, practical results. A major relevant challenge is that no supporting institution has been assigned to implement sustainable agriculture policies yet. In this respect, the public extension system has been traditionally responsible for the fulfillment of all extension plans, albeit the records of the extension activities in recent years show that the government has encountered some obstacles in realizing the goals of agricultural extension and has been unsuccessful in delivering extension educational services as the driver of agricultural education and extension (Bahrami et al., 2010). Elias et al. (2016) argue that the development of demand-driven extension service development is a key issue and that private education and extension system should be considered as one of the solutions because it is believed that the private sector can play a critical role in the effectiveness improvement of the education and extension service by the transmission of technical knowledge and modern skills to farmers (Rivera &Alex, 2004).

The privately owned extension sector was established in Iran in the early 2000s with a combination of experienced and young experts to improve the technical and consulting services in farming. As the private sector started its activities by the establishment of consulting services and technical engineering firms as the most eminent, privately owned institutions in the agriculture sector, they started to serve such activities as surveying and mapping of gardens and extension activities. In addition to the responsibilities defined for them by the Iranian government in the recent policies, the private sector was assigned a major role in caring for sustainability of agriculture along with the public sector. Now that some years have passed since the launching of the privately owned extension firms along with the public sector, it is time to appraise which one has been more successful. Numerous studies have been conducted on sustainable agriculture (its aspects, indices, and significance) and the use of Analytic Hierarchy Process (AHP), some of which are reviewed in

the next paragraphs.

Omani and Chizari (2006) analyzed the sustainability of wheat growers' farming system and found that literacy level, technical knowledge, knowledge of sustainable agriculture, crop income, social status, social participation, the extent of using communication channels, and participation in education and extension courses accounted for 92.5% of the variance of farming system sustainability. Rezaei-Moghaddam and Karami (2008) argued that the ecological criterion, that is, reasonable use of resources, environment protection, and crop quality, was the most critical criterion for sustainable agriculture in Iran. In a structural analysis of factors affecting agricultural sustainability in Qazvin Province, Iran, Poursaeed (2010) employed multivariate decision-making models to examine the partnership models in the development of sustainable agriculture in Ilam Province using the experts' evaluations and AHP and reported that environmental, technical, and social aspects were more important than culture, political, institutional, and economic criteria. Poursaeed et al. (2010) investigated the partnership models of sustainable development of agriculture based on Multiple Criteria Decision-Making (MCDM) in Iran and reported that reduced amount of immigration of farmers, the hiring of agriculture engineers, land integration, higher farmers' awareness, crop rotation, lower fertilization rates, lower rates of herbicide application, fertilizer recommendations, and optimum allocation were the main criteria of sustainable agriculture in Iran. In a study using AHP to assess farmers' priorities and their main objectives in the planning of their activities, Kallas et al. (2012) found that the main objective in economic sector was to maximize total farm income along with the improvement of crop quality and that the farmers expressed their willingness to use the minimum chemical fertilizers to reduce the costs and conserve the environment. Asadi et al. (2013) found that ecological, social, and economic sustainability positively affected the agricultural sustainability; however, ecological sustainability had a greater impact on agricultural sustainability than economic and social sustainability. In a study entitled "A multiple criteria evaluation of sustainable agricultural development models using APH", Moumeni-Helali et al. (2013) prioritized the criteria of ecological sustainability which resulted in this list: the application of lower rates of chemical herbicides per ha, lower fertilization rates per ha, greater use of bio-control, greater use of bio-fertilizers, saving in water consumption, and lower frequency of the use of plough.

There have been studies that investigate and examine the various fields of extension systems. In a study to compare the efficiency of extension by private sector vs. public sector in the Punjab State of Pakistan, Davidson et al. (2001) showed that the systems had some duplication in their programs, competed to each other in some programs, and had conflicts in some activities. Saadi et al. (2008) compared the efficiency, private extension system, and governmental extension system with respect to preventing desertification in an attempt to determine the preferred extension system with a relative theoretical preference using 13 education-extension criteria. They found that governmental extension system had a relative preference in most issues of preventing desertification, but in most cases, the public extension system could play a role along with the governmental system in desertification. In a study on farmers' perspectives on the quality of agricultural information delivery with an emphasis on the comparison between the public and private sources, Ali (2013) analyzed farmers' responses to the question about the quality of the agricultural information delivery and found that the private resources delivered information with significantly higher quality to the farming community than the public resources. Directorate of Agricultural Extension Services conducted a study on the agricultural extension approaches implemented in Ghana and reported that the commodity-based approach had the highest efficiency in enhancing the awareness of activities, the awareness of activity programs, and the delivery of support services. Training and visiting approach was the most efficient with respect to research and extension, continuous or availability, and productivity. In addition, cooperative approach showed the highest efficiency in the

mutual relationship. Omar et al. (2013) worked on alternative approaches of agricultural extension to promote sustainable agriculture in Eastern Libya and reported that public-private extension approach had the highest impact on the development of sustainable agriculture. Most respondents mentioned the following items as the important factors to realize sustainable agriculture: transferring research results to farmers and extension agents, participating in the reform of agricultural markets to stabilize farmers' income, and supporting microcredit institutions, especially by interacting with commercial banks. Elias et al. (2016) worked on farmers' satisfaction with agricultural extension services and the influencing factors in North West Ethiopia and recognized a need for demand-driven extension service development rather than supply-driven service. The services should be aimed to increase the rewards to farmers to keep their cooperation and satisfaction which would result in the sustainability of extension program.

Mazandaran province is one of the agricultural poles in Iran, which was ranked first place in the country's rice and citrus production. The county of Sari, as the center of Mazandaran, has a special role in the field of agriculture and horticulture. Based on available statistics, the total area of the gardens of Sari is about 30114 hectares, which has increased by more than 2600 hectares over the past three years. The main garden product in Sari is citrus, which has a cultivated area of 21 thousand hectares (Jihad-e Agriculture Organization of Sari County, 2017).

A review of the documents in the early past decade shows a lack of attention to sustainable agriculture, as in the ecological dimension, statistics shows the uncontrolled and unskilled use of pesticides and fertilizers by farmers. With the disclosure of the importance of sustainable agriculture and the approval of government policies in support of sustainable issue, the extension centers have made extensive efforts in this regard. The extension centers in Sari including, seven public and 11 private extension centers (operate in the form of consulting and technical engineering services companies) are providing educational and extension services to the farmers. These centers conduct their educational and extension programs in various forms, including courses, classes, workshops and etc. These programs directly or indirectly consider various aspects of sustainability, including ecological, economic and social, which are referred to below.

Conducting and implementing collaborative projects is one of the important actions of extension centers. The most important collaborative project is farmer field school. This project, with the general aim of increasing the level of scientific knowledge and technical skills of gardeners, while improving the level of participation and social and collective actions in agricultural activities, pursue important goals in the ecological dimension. Among these goals, special and continuous emphasis is placed on the optimum and limited use of fertilizers and chemical pesticides and the use of organic inputs to produce healthy, optimal and economical. The project to promote entrepreneurship and the development of sustainable business is one of the projects that specifically focuses on economic dimension of sustainability. The main objective is to generate revenue and improve the economic situation of the beneficiaries. In addition, one of the most important features of this project is special attention to rural women. This project consider social aspects and gender equality as one of the goals of sustainability. Another important plan of extension centers in the ecological and environmental field is the holding and follow up of a special plan for healthy crop production. This plan involves a process and a set of actions and activities that will lead to the production of healthy and organic products, for example; the reduction and limitation of the use of fertilizers and chemical pesticides and the use of inputs and organic methods for combating pests and diseases.

In order to assess the results of these efforts, the amount of chemical pesticides used in gardens has been compared in recent years. The result showed that the amount of chemical pesticides has decreased over the last three years, as the amount of insecticides and fungicides used in 2014, decreased from 221275 and 183952 to 135355 and 39405 liter-kilo, respectively, in

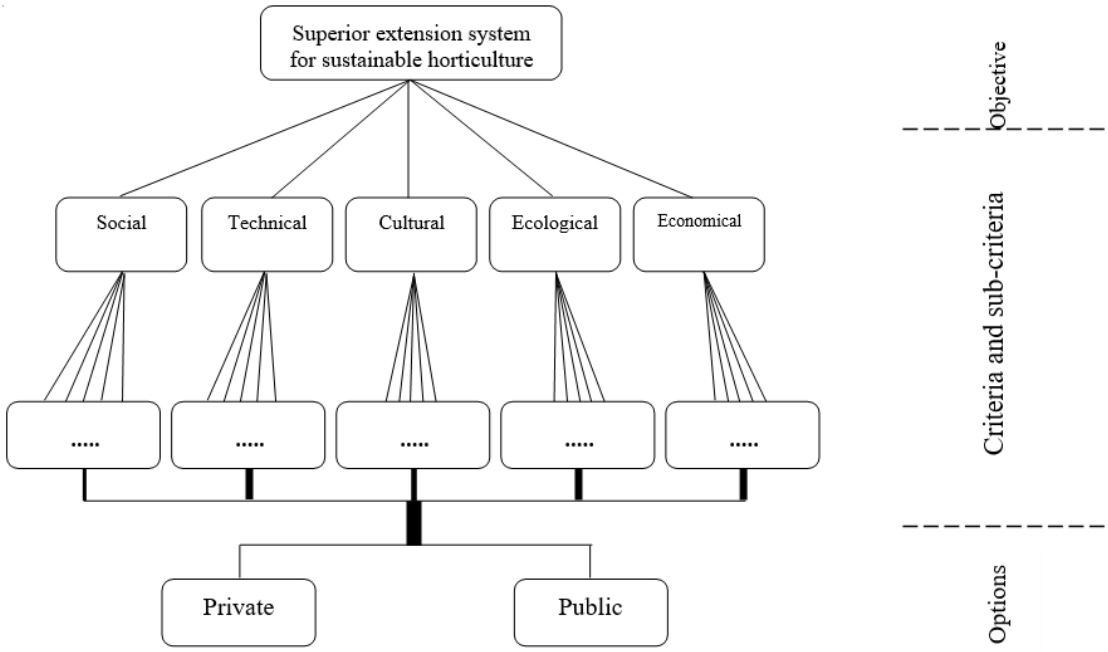

Figure 1. The research conceptual framework based on hierarchical structure to determine the preferred extension system of sustainable horticulture

Table 1
Pairwise Comparisons Scale

Preferences (oral judgment)	Importance degree
Equal importance/preference	1
A little preferred/more important/more optimum	3
Strongly preferred/important/optimum	5
Very strongly preferred/important/optimum	7
Completely preferred/more important/more optimum	9
The intermediate values between these judgments	2, 4, 6, 8

2017 (Jihad-e Agriculture Organization of Sari County, 2017).

Reviewing the previous studies and research shows that there is no research about importance and place of extensions systems in field of sustainable agriculture especially in sustainable horticulture. In this respect, the general objective of the research was to introduce a preferred extension system that was more successful for sustainable horticulture in rural regions in Sari. In addition to the main objective of the study, its specific objective was to prioritize the criteria and sub-criteria of sustainable horticulture. Based on reviewing the above-mentioned studies, the relevant variables (criteria and sub-criteria) extracted and then, the research conceptual framework designed (Figure 1). The detailed of sub-criteria is shown in Table 2.

MATERIALS AND METHODS

The work was a descriptive study and an applied research in terms of objective, since it sought to examine the criteria of sustainability and introduce the superior active extension system in the field of sustainable horticulture by appealing to the principles and assumptions of sustainable agriculture indices. It was carried out spatially in Sari County, Iran and temporarily in 2016. The statistical population was composed of all pioneer horticulturists who had consulted or are consulting with extension agents of both public and private sectors either formally or informally and either directly or indirectly. To identify these people, first, a list of pioneering farmers was prepared by talking to services and extension service of Jahad-e Agriculture Organization. Final pool containing 34 horticul-

Table 2
Prioritization of Criteria and Sub-Criteria of Sustainable Horticultural Activities

Priority	Criteria	Percentage	Sub-criteria	Percentage	Priority	Inconsistency rate
1	Economical sustainability	31.8	Recommendation, consultation and help with the creation of employment atmosphere in rural areas	24.5	1	0.04
			Recommendation to improve the crop quality	22.9	2	
			Attempts to reform agricultural markets to stabilize the horticulturists' income	18.7	3	
			Help with the reduction of costs	17.8	4	
			Financial and credit support of horticulturists	16.1	5	
2	Technical sustainability	21.9	Management of horticulture production process	23.0	1	0.03
			Supply of inputs	22.9	2	
			Supply of horticulture machinery services	20.4	3	
			Management of post-harvest crop wastage	20.3	4	
			Storage and warehousing of horticultural crop	13.5	5	
3	Ecological sustainability	21.4	Recommendation to decrease the use of chemical herbicides	32.5	1	0.02
			Recommendation to decrease chemical fertilization rates	20.8	2	
			Recommendation to use more organic fertilizers	16.4	3	
			Recommendation to develop the application of biological pest control	15.4	4	
			Recommendation to develop modern irrigation systems	14.9	5	
4	Social sustainability	12.8	The communication of practical findings to horticulturists	26.1	1	0.08
			the help with the improvement of social awareness among horticulturists	24.4	2	
			the educational coverage of horticulturists	21.6	3	
			Horticulturists' cooperation in horticultural plans	17.5	4	
			Encouragement for commitment in activities	10.3	5	
5	Cultural sustainability	12.1	Attention to local knowledge	27.8	1	0.03
			recommendation and attempts for sound use and conservation of resources	25.3	2	
			participation in rural people's problem-solving process	18.0	3	
			Application of religious instructions about horticulture	14.8	4	
			Attention to local culture, customs and traditions	14.1	5	

turists. Next, the pioneering horticulturists who had used the extension services of both public and private sectors were identified to be 22 people. Given the size of the statistical population, data were collected by the consensus method. Eventually, the data collected from 20 horticulturists were included in the analysis. The public and private extension systems were prioritized with the analytic hierarchy process (AHP) technique. The research tool was a questionnaire composed of three sections in accordance with the research objective. The first section contained questions pertaining to the pairwise comparison of the agricultural extension systems in terms of the individual sub-criteria of sustainability. The second section was made up of questions asking the pairwise comparison of sustainability criteria and sub-criteria in terms of the sustainability of the horticulture activity. The final section collected the participants' demographic data. The questionnaire was first delivered to a panel of experts including the experts from public and private agriculture sector to voice their opinions about the face and content of the questionnaire. After the final adjustments, its validity was confirmed. The reliability of the questionnaire was estimated by the rate of inconsistency. The inconsistency rate of judgments up to 0.1 is regarded as acceptable. The inconsistency rate of all pairwise comparisons was estimated 0.02 to 0.08 in the present study (see Table 2). Research variables included social, technical, cultural, ecological, and economic criteria, each with public and private extension systems. Given the nature of the study, the data were analyzed by Expert Choice 11 Software Package as it is commonly used in AHP technique.

Analytic hierarchy process (AHP)

AHP is a multiple criteria decision- making method that is based on pairwise comparison and allows managers to examine different decision-making scenarios. It attempts to focus on the experts' technical opinions rather than using decision-makers' quantity (Ghodsipur, 2012). It is a rigorous technique recommended for problem-solving and decision-making in agriculture (Khosravi et al., 2011) and the analysis of sustainable agricultural systems (López & Requena, 2006). According to Saadi et al. (2008), the main advantages of AHP process include flexibility, adaptability, and the feasibility in solving the simple and complex problems. The steps of AHP are as follows:

Step 1. Drawing hierarchical structure. After the literature review, the criteria were identified for sustainable horticultural activities in accordance with education and extension models. Next, they were formatted in a structured process as a hierarchy depicted in Figure 1.

Step 2. Weighting. In AHP, the individual elements at each level are compared to the corresponding element at the higher level on a pairwise basis and then, their weights known as the relative weight are estimated. Next, the relative weights are combined to give the final weight (final priority) of each option that came to be known as the absolute weight. The present study specified the relative weights of the individual criteria, sub-criteria, and options by making a pairwise comparison of sustainability criteria on the basis of sustainable horticulture, pairwise comparison of sub-criteria on the basis of the individual criteria of horticulture sustainability, and the pairwise comparison of the extension systems (options) on the basis of the sub-criteria, respectively. The pairwise comparisons were adjusted according to Table 1, and they were replicated according to Equation (1). Finally, the relative weights were integrated to give the absolute weights for the options and subsequently, to introduce the superior agricultural extension system for the sustainable horticulture activities.

$$PC=X(X-1)/2 \quad (1)$$

where PC = pairwise comparison, and
X = the number of criteria or options.

Step 3. System consistency. In AHP, the decision consistency can be estimated and its goodness/badness or acceptability/unacceptability can be judged. As was mentioned earlier, the inconsistency rate up to 0.1 is regarded to be acceptable. The inconsistency rates calculated for all pairwise comparisons were smaller than

0.1 in the present study. Accordingly, the decisions were all consistent and acceptable.

RESULTS

Respondents' demographic and professional characteristics

The respondents' age was in the range of 27-64 years with the mean of 48.74 years. All respondents were male. They mostly had a bachelor's degree or higher (65%). Their mean experience in horticulture was 17.53 years and their mean annual income was about 220 million IRR.

Prioritization of criteria and sub-criteria of sustainable horticulture

To prioritize the criteria and sub-criteria of horticulture sustainability, the criteria were first compared pairwisely according to the sustainability goal and then, the sub-criteria were compared pairwisely according to the individual sustainability criteria. From among the aspects studied, the economic, technical, and ecological aspects were ranked first to third. As is shown in Table 2, these aspects were prioritized for sustainable horticulture activities in the order of economic aspect (31.8%), technical aspect (21.9%), ecological aspect (21.4%), social aspect (21.8%), and cultural aspect (12.1%). The prioritized sub-criteria in economic aspect included "recommendation, consultation and help with the creation of employment atmosphere in rural areas" (24.5%), "recommendation to improve the crop quality" (22.9%), and "attempts to reform agricultural markets to stabilize the horticulturists' income" (18.7%). In the technical aspect, they included "the management of horticulture production process" (23.0%), "the supply of inputs" (22.9%), and "the supply of horticulture machinery services" (20.4%). In the ecological aspect, they were "recommendation to decrease the use of chemical herbicides" (32.5%), "recommendation to decrease chemical fertilization rates" (20.8%), and "recommendation to use more organic fertilizers" (16.4%). Within social aspect, the preferred sub-criteria included "the communication of practical findings and results to horticulturists" (26.1%), "the help with the improvement of social awareness among horticulturists" (24.4%), and "the educational coverage of horticulturists" (21.6%). In cultural aspects, the prioritized sub-criteria included "attention to local knowledge" (27.8%), "recommendation and attempts for sound use and conservation of resources" (25.3%), and "participation in rural people's problem-solving process" (18.0%).

Superior agriculture extension system in terms of sustainability aspects

To identify the superior extension system in terms of the individual sustainability aspects, they were first compared in a pairwise manner with respect to the individual sub-criteria, and their relative weights were calculated. Next, the sub-criteria pertaining to each criterion were compared in a pairwise manner and their relative weights were determined. Next, the relative weights of the sub-criteria and options were combined to find out the optimum extension

Table 3
Preferred agricultural extension system with respect to the criteria of sustainability

Sustainability aspects (in order of importance)	Extension systems (In order of importance and the relevant percentage)		Inconsistency rate
	1	2	
Economical	Public 69.6	Private 30.4	0.04
Technical	Public 55.8	Private 44.2	0.03
Ecological	Public 76.6	Private 23.4	0.02
Social	Public 72.9	Private 27.1	0.08
Cultural	Public 73.8	Private 26.2	0.03

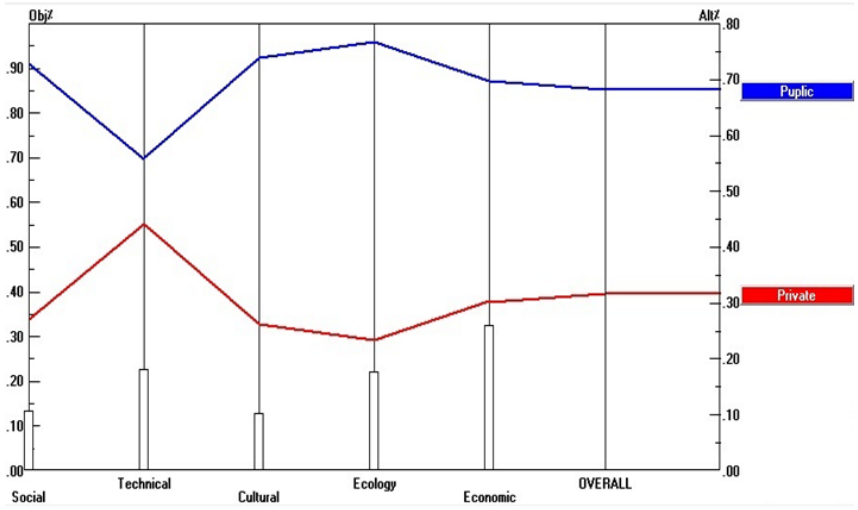

Figure 2. Sensitivity analysis of the extension systems in terms of sustainable horticulture criteria

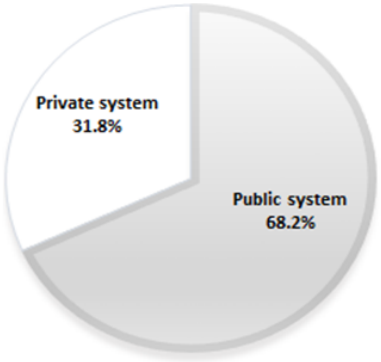

Figure 3. Preferred agricultural extension system for sustainable horticulture

system for the sustainability in each aspect. As shown in Table 3 and given the percentages of economic, technical, ecological, social, and cultural criteria, the public extension system were recognized as the preferred extension system

The functions of extension systems (sensitivity analysis) are depicted in Figure 2 with an emphasis on sustainability criteria. The sensitivity analysis shows the extent of variation of the options priority as the individual criteria are changed. Figure 2 indicates the change in the priority of extension systems with the importance of sustainability criteria. The sensitivity analysis model displayed that the role of the public system diminished to a greater extent in the technical aspect than in other aspects of sustainability, whilst the other aspects did not change remarkably as compared to each other. It implies that the public system was less successful in technical sustainability than the private extension system among all aspects of sustainability.

Agriculture extension system preferred for sustainable horticulture

As was stated, the relative weights of the options were specified on the basis of the individual sub-criteria and the relative weights of the sub-criteria were specified on the basis of their respective criteria. Next, the relative weights of the criteria were determined after their pairwise comparison on the basis of the objective, that is, the sustainability of the horticultural activities. Next, the relative weights of the criteria, sub-criteria, and options were integrated according to which the public extension system was selected as the preferred extension system for sustainable horticulture with 68.2% and optimum inconsistency rate of 0.03. The end result is shown in Figure 3.

DISCUSSION AND CONCLUTIONS

The present study employed AHP to identify the agricultural extension system preferred for the sustainability of horticultural activities in Sari County, Iran. The prioritization of the criteria on the basis of the respondents' assessments and using AHP technique showed that the economic, technical, and ecological aspects are more important than the social and cultural aspects. The significance of these criteria has been emphasized by Asadi et al. (2013), Omar et al. (2013) and Poursaeed (2010), likewise, underscored the importance of these standards. Consequently, it can be inferred that the aspects important for the sustainable horticultural activities are the economic issues that seem to be the foundation of the sustainability of any activity including horticulture, the technical issues that address the garden maintenance, and the ecological criteria whose key aspects are lower consumption rates of herbicides and fertilizers.

The sensitivity analysis showed that the public system was less successful in technical sustainability. In other words, the private system could keep the pace with public system with respect to technical sustainability. It emphasizes the optimum performance of privately owned extension system in the technical aspect in recent years. Following the integration of the relative weights of the criteria and sub-criteria of sustainable horticultural activities as well as the agricultural extension systems (options), the public system (68.2%) was finally selected as the preferred extension system for the sustainable horticultural activities with 0.03 inconsistency rate. Consistent with our findings, Saadi et al. (2008) reported that the public extension system was in relative preference, but in most cases, the private extension system could play a key role along with the public system. In addition, Omar et al. (2013) stated that public-private extension approach was deeply effective in the development of the sustainable agriculture.

The fact is that the private extension services are more welcomed among high-income farmers than are among low-income farmers (Khatoonabadi, 2005). In this respect, it is generally believed in Iran that the horticulturists are more prosperous than farmers, and on the other hand, they have more information requirements that cannot be met by the public extension system. Thus, the horticulturists were expected to use the services of the private sector more extensively. Yet, the results showed the opposite which may be related to the duplication or the provision of essentially similar services by the public and private sectors as has been mentioned in Davidson et al. (2001), too. Another reason for the less extensive use of private extension services is the lack of the supply of surplus services by private sector (the services that would help the sustainability enhancement), that is, by itself, related to the fact that most horticulturists in Northern Iran are smallholders, and it is not economical for them to pay for such services. Likewise, we should not overlook the likely lower quality of the private sector services in sustainable agriculture (e.g., recommendations to decrease the use of herbicides, chemical fertilizers, etc.) as compared to the public sector, which discourages the horticulturists from using the services of the private sector in Iran. However, Ali (2013), in a study in India, showed that the private sources provided information to farming communities with significantly higher quality as compared to public systems.

Given the results of the present study showing the relative superiority of the public extension system in sustainability of horticultural activities, on the one hand, and the emphasis placed on privatization in Article 44 of the Constitution of the Islamic Republic of Iran, on the other hand, the government is required to cautiously move toward the privatization of agricultural extension and develop its scope of activity in its attempt to fulfil privatization policies in the field of rural agriculture, especially horticultural activities. In this respect, it is very critical to consider that most local farmers are smallholders. Moreover, given the relative superiority of public extension system over the private system, it is recommended to use private extension system along with the public system as a supplementary system so as to gradually pave the way to assign the authorities and activities to the private sector with the maturity of the private system over

time. Considering these recommendations, one can hope for the full privatization of agricultural extension system.

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