

Integration of Communication Media For Horticultural Sustainability: The Application of Multiple Criteria Decision Making (MCDM)

¹Mehdi Nooripoor, ¹Mansoor Shahvali and ²Kiumars Zarafshani

¹Department of Agricultural Extension and Education, Shiraz University, Shiraz, Iran

²Department of Agricultural Extension and Education, Razi University, Kermanshah, Iran

Abstract Communication media play an important role in sustainable agricultural programs such as sustainable horticulture. These media include a broad range from Folk to New Media. In this study, literature review as well as field survey were used to determine sustainable horticulture criteria. The findings showed that these criteria could be considered in an expanded view including organizational sustainability (e.g., cost-sharing with customers and reducing corruption among staff); appropriate development programs (e.g., erosion control, integrated pests management and prevalence of permaculture); proper communication media (e.g., two-way interactive and attractive media); focus on real customers (e.g., rural poor) and suitable monitoring and evaluation system (e.g. participative monitoring and evaluation). Also, Analytic Hierarchy Process (AHP) a Multiple Criteria Decision Making (MCDM) technique was used to select the most appropriate combination of media in order to reach horticultural sustainability. Results indicated that Folk Media such as local festivals and new media especially inter/intranet and television are the most useful media in the process of sustainable horticulture. More detailed descriptions of findings are presented in the body of paper.

Key words: Sustainable horticulture . communication . multiple criteria decision making . analytic hierarchy process . Iran

INTRODUCTION

Agriculture is an important economic sector in developing countries such as Iran. Therefore, sustainable agriculture should be an integral part in national planning and policy/decision making for country's development. Sustainable development, specifically sustainable agricultural development is a communication process, because during this process development agents communicate innovations to specific clientele [1]. Thus, communication media play a crucial role in this process, because they facilitate communication between Development agents and farmers.

Two main approaches of using communication media for Sustainable Agricultural Development (SAD) have emerged recently. The first approach emphasizes new media for information and communication purposes because they facilitate distance communication/education and marketing, as well as reducing costs that are endured by intermediaries [2, 3]. The second approach emphasizes folk media for training rural communities on sustainability issues relate to agriculture. Based on this

approach, folk, local, traditional media such as local festivals, songs and drama are effective for creating awareness on sustainability issues because they have the advantage of integrating education with entertainment opportunities [4-6].

Each approach has its own distinctive characteristics. Therefore, a question that comes directly to our mind is that how can we integrate these two kinds of media to achieve sustainable agriculture. Communication researchers have suggested that both have the potential to achieve sustainable agriculture [7, 11]. However, the major question is that which combination of communication media is the best for sustainable agriculture? In other words, how do we decide on the optimum combinations of communication media in order to reach sustainable agriculture?

For agriculture to be considered sustainable, certain economic, environmental and social criteria need to be met. Moreover, a sound decision making tool is essential if we are to decide on the most appropriate communication media in order to reach agricultural sustainability. Without the knowledge of sustainable agriculture criteria, it would seem difficult to answer the above-mentioned question. Therefore, if we are to

decide for the best combination of communication media, we need to identify criteria for agricultural sustainability in general and use effective decision making tools in particular.

MCDM use mathematical calculations to choose the best alternative with regard to some criteria. For this purpose, the relative importance/weight of alternatives and criteria should be calculated. By using expert knowledge the relative importance of criteria or relative preference of alternatives are derived [12, 13].

The purpose of using MCDM in this study is to identify the priority and optimum combination of communication media. Such a prioritization would help decision makers and also development agents in the context of communication and sustainability to allocate time, money, labor force and other resources to select combination of media based on their priorities.

In the context of SAD, agricultural sector consists of three distinct sub-sectors: agronomy, horticulture and animal husbandry. The focus of this study is on the horticultural sub-sector. Therefore the purpose of this study is to find ways to integrate communication media to reach a sustainable horticulture. The objectives of the study are:

- Determination of sustainable horticulture criteria
- Determination of optimum combination of media for sustainable horticulture

This study was conducted in rural area of Koh-Gilooyeh and Boir-Ahmad (K&B) Province, Southwest Iran. A sample of orchard farmers was selected for this research. The term "folk media" (FM) in this paper is used to name all kinds of folk/local media either performing or singing. Also, the term "new media" (NM) is used to name all kinds of new information and communication media in electric, electronic or digital forms.

MATERIALS AND METHODS

Step 1: Selection of the MCDM technique: MCDM techniques are very diverse (e.g., Analytic Hierarchy Process/AHP; Simple Average Weighting/SAW;

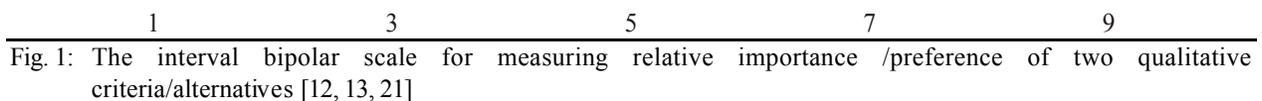
ELECTRE 3, ELECTRE 4, TOPSIS and CP) with a various range of applications (e.g., to select the best irrigation method: [13]; to choose the best strategy of water pricing: [14]; to develop a sustainable decision making model for municipal solid waste management: [15]; to determine the priority of cleaner production: [16]; to evaluate offshore technologies for produced water management: [17].

Although subject to some critics [18], the Analytic Hierarchy Process (AHP) technique was selected for this study because it is widely used in complex decision-making process [18]. The AHP, proposed by Thomas L. Saaty, is a powerful and comprehensive methodology designed to facilitate sound decision making by using both empirical data as well as subjective judgments of the decision maker. It combines tangible and intangible aspects in order to derive a ratio scale, the abstract scale of priorities, which is valid to make complex decisions [19]. The AHP was developed to solve a specific class of problems that involves prioritization of potential alternative solutions [20]. It is a well-known tool for decision-making in operational analysis [9].

The primary stage of AHP is "developing a decision tree" to show the relation between ultimate goal, level (s) of criteria and alternatives in a hierarchy framework [12, 13]. Decision maker(s) judge about relative importance of criteria with respect to goal and relative preference of alternatives with respect to each criterion in a pair-wise comparison structure (IBID).

All criteria and alternatives were qualitative measures in this study. The scale used for comparison of two qualitative measures was a bipolar scale (Fig. 1). There were two types of Pair-wise comparisons; first, a comparison of criteria with respect to goal; and second, some pair-wise comparisons of alternatives with respect to each criterion. These comparisons were shown in matrix structure named decision matrix. Therefore, the resulted decision matrixes included a decision matrix for criteria comparisons and some decision matrixes for alternatives comparisons.

The Consistency Ratio (CR) is measured for each decision matrix. CR shows the precision of judgments in comparing criteria and alternatives. In other words,



- 1: Equal importance/preference
- 3: Weak importance/preference of one over another
- 5: Essential or strong importance/preference
- 7: Demonstrated importance/preference
- 9: Absolute importance/preference
- 2, 4, 6, 8: Intermediate values between the two adjacent judgments

Folk songs Local festivals Printed media Radio Television Inter/intra net

Fig. 2: The selected media spectrum

the Inconsistency Ratio (IR) shows the possible error (s) in judgments. Inconsistency ratio for each matrix should be less than 0.1 otherwise; the decision maker(s) should re-evaluate the judgments for the related matrix until the ratio is finally less than 0.1 [13, 21].

There is a reciprocal relation between measures when they compare each other. i.e. if number 3 assigns to criteria/alternative 1 in comparison with criteria/alternative 2, then 1/3 should be assign to criteria/ alternative 2 in comparison to criteria/alternative 1 [12, 13, 21].

Step 2: Selection of alternatives (media): Each communication approach represents a range of media. For the purpose of this study, those media that were more popular in the region was selected for AHP analysis. For example, folk media was most preferred by local people and new media was the most preferred source for development agents. Therefore, media such as "folk songs" and "local festivals", "printed media", "radio", "TV" and "inter/intra-net" were found most popular in the study region. The selected media were arranged in a spectrum of FM to NM which is shown in Fig. 2. Of course, according to the local officials (Personal contact), some other media such as printed media has been the most widely used media in sustainable horticulture programs during past decades in the study region. Therefore, they should be also regarded in the supposed media spectrum. Because printed media are neither FM nor NM, they are placed in the middle of the selected media spectrum

Step 3: Determination of sustainable horticulture criteria: Sustainable horticulture criteria were determined in three stages:

- In stage 1, criteria were obtained from literature review and library research.
- In stage 2, a survey method was used in the K&B province to determine the most problematic criteria for study area. For this purpose, a questionnaire including criteria obtained from the first stage was designed with close-ended statements and Likert-type scale. The face validity of questionnaire was verified by five subject matter specialists. A pilot study with 30 samples out of research sample was conducted. The reliability coefficient between 0.72-0.86 was calculated using Cronbach's Alpha reliability coefficient. Using stratified random sampling, 90 contact farmers and 35 agricultural officers of Rural Agricultural Services Centers

were selected for this study. The respondents were asked to assess problematic sustainable horticulture criteria in the region. Based on the mean score and variance, problematic sustainable horticulture criteria were developed for the region.

- In stage 3, a survey research using Delphi technique with participation of 6 subject matter specialists was used to determine policies that are required to meet each criterion in stage two. This stage is very helpful to reach more objective criteria.

Step 4: Identifying the best combination of media for sustainable horticulture: Although it is suggested that a combination of folk and new media should be used to achieve sustainable horticulture [7-11], it is not clear as to what specific combination of media is appropriate sustainable activities such as sustainable horticulture. Therefore, it deemed necessary to define an optimum combination of media for sustainable horticulture in the study region. In doing so, AHP technique was used to determine the priority of the supposed media to meet each criterion or each category of criteria of sustainable horticulture. For this purpose, a sustainable horticulture model that consisted of different levels of criteria and alternatives were designed. The priority of each criteria and priority of alternatives to deal with each criterion was assessed using pair-wise comparisons of criteria and alternatives. Decision makers were three subject matter specialists in the context of "horticulture", "sustainable development" and "natural resources". They compared and weighed criteria and alternatives by using pair-wise comparisons in consultation to each other.

FINDINGS

Determination of sustainable horticulture criteria

By literature review: Although most studies view the context of sustainability, e.g., sustainable horticulture, in terms of "socio-cultural", "economic-technical" and "environmental" aspects [1, 11, 22-24], it would be more useful if sustainable horticulture considered in a broader and more comprehensive view. Because sustainable horticulture can be considered as a communication process, its sustainability aspects can be identified based on elements of communication process, i.e., "source", "message", "channel", "receiver" and "feed back" irrespective of considering the direction (one-way or two-way) [25]. This view considers sustainable horticulture in terms of:

- Development organizations as sources,
- Sustainable programs (socio-cultural, economic-technical and environmental) as messages,
- Communication media as channels,
- Customers (farmers) as receivers and
- Monitoring and evaluation (M&E) of development programs as feed back system.

Therefore, a sustainable horticulture as a communication process will be more sustainable if there is more:

- Organizational sustainability,
- Appropriate sustainable programs,
- Proper communication media,
- Focus on real costumers and
- Appropriate monitoring and evaluation (M&E) system.

Sustainable horticulture criteria for each one of the above five components were determined by literature review as shown in Table 1.

By survey research: Table 2 shows the most problematic sustainable horticulture criteria derived through survey research.

By Delphi technique: Table 3 illustrates policies to meet each sustainable horticulture criteria derived by Delphi technique.

AHP implementation

Development of decision tree: As it was described, decision tree shows the relation between ultimate goal, level (s) of criteria and alternatives in a hierarchy framework. For example, Fig. 3 shows a part of sustainable horticulture tree view that only includes “organizational sustainability” and “proper communication media”.

Determinations of criteria priorities by pair-wise comparisons:

The first level of criteria considered as main components of communication process/ sustainable horticulture was given equal weigh. The 2nd level of sustainable horticulture criteria in each category was compared using pair-wise techniques. The same comparison was made for the 3rd level of sustainable horticulture criteria. Table 4 shows the priorities of criteria in each category at every level.

Determinations of media priorities by pair-wise comparisons:

The third level criteria are too detailed. Therefore, it isn't either useful or efficient to present media prioritization with respect to such detailed criteria. Thus, the results of media prioritizations are presented considering only the first and second levels of criteria. Table 5 shows these results.

Sensitivity analysis: Figure 4 shows the results of sensitivity analysis for sustainable horticulture model. This figure shows how changes in one media will affect the effectiveness of other media priorities.

Table 1: Sustainable horticulture criteria derived from literature in the first stage

Organizational Sustainability	Decentralization and customers' participation; establishment of intermediate associations including: customers and officials; privatization; cost-sharing with customers; coordination/ cooperation among different development agents/organizations [26-31].
Appropriate development programs	
Socio-cultural	Rural-urban migration rate reduction; income generating; Health, nutrition, housing and employment improvement; Recreational opportunities and education provision; crimes and stress reduction; prevalence of perma-culture; social security availability; motivation for achievement [22, 32-34]
Economic-technical	Profitability of horticulture; quality & quantity of product improvement; modern irrigation methods; sustainability of pre-planting, maintenance and harvesting activities; post-harvest improvement, especially storage and processing; dealing with international demands; direct marketing; offering extension and education courses on sustainability [22, 31, 35].
Environ-mental	Diversity of planting; erosion control; water use efficiency; integrated pest management implementation, disease and herbs management; amplification of soil texture; chemical management (e.g., spraying time, amount of chemical fertilizers and pesticide use; biological control); waste management; rangeland degradation prevention [29, 35-37].
Proper communication media	Two-way, interactive and participative communication; attractive communication; using local and volunteer leaders [24, 30, 31, 38-40].
Focus on real costumers	More focus on rural poor, youth and women [1, 26, 41, 42].
Suitable M&E system	Participative and people-oriented M&E such as empowerment M&E [43].

Table 2: Sustainable horticulture criteria determined by survey research in the second stage

Organizational sustainability	cost-sharing with customers; coordination/cooperation among different development agents/organizations; reducing corruption among staff*
Appropriate development programs	
Socio-cultural	Provision of recreational opportunities; employment improvement t; prevalence of perma-culture
Economic-technical	Direct marketing; post-harvest improvement, especially storage and processing
Environmental	Rangeland degradation prevention; On-time application of pesticides; chemical management (e.g., spraying time); integrated pest management
Proper communication media	Two-way and interactive communication; attractive communication
Focus on real costumers	More focus on rural poor, youth and women
Suitable M&E system	Participative and people-oriented M&E

*In the survey some criteria such as "reducing corruption among staff" were referred by the respondents that didn't pre-exist in the questionnaire

Table 3: Sustainable horticulture sub-criteria derived through Delphi study

Cost-sharing with customers	Delegating responsibilities to customers or their representatives; Provide opportunities for customers to take part in cost-sharing
Coordination/ cooperation among different development agents/organizations	Shared digital terminals; central monitoring system development
Reducing corruption among staff	Increasing Customers' awareness about their rights through extension pamphlets; automation of administrative activities; establishment of feedback system
Provision of recreational opportunities	Performing local cultural-artistic programs; cultural-artistic programs exchange among regions
Employment improvement	Introducing job opportunities; development of non-agricultural jobs (e.g. rural industries); development of technical-vocational courses
Prevalence of perma-culture	Public awareness programs on environmental conservation; planning and implementing of conservative programs such as extension/ education courses
Direct marketing	Mutual communication between farmers and purchasers; local horticultural products exhibitions for major purchasers
Improvement of post-harvest activities	Mutual communication between farmers and food process industries in urban area; extension of small/ home scale food processing methods
Rangeland degradation prevention	Sustainable policy making and planning; introducing the consequences of rangeland degradation to farmers
On-time application of pesticides	Educating farmers on the necessity of proper timing in using pesticides; public announcement of the time of spraying
Integrated pest management (IPM)	Extension and implementation of IPM; introducing key IPM informants
Two-way and interactive communication	Using direct/ face to face communication methods; flexibility of communication; provide opportunities for negotiation
Attractive of communication	Entertain ability; provide opportunities for building mutual relationships; using local language and symbols in communication processes
More Focus on rural poor	Rural poor-oriented new technologies development; rural poor motivation for participation; organizing rural poor in vocational associations/ cooperatives
More focus on rural youth	Organizing rural youth in cultural-artistic groups/clubs; providing facilities for rural youth to exchange experience outside of village
More focus on rural women	Development of women-oriented extension/education courses; organizing rural women in vocational associations/ cooperatives
Participative and people-oriented M&E	Evaluation of development programs based on customers' opinions; developing evaluation criteria using customers' feedback

Table 4: AHP results of prioritization of 2nd and 3rd levels criteria

1 st level criteria	2 nd level criteria in order of their priority and assigned percent	IR	3 rd level criteria in order of their priority and assigned percent	IR
Organizational sustainability				
	Reducing corruption among staff (73)	0.03	Increasing Customers' awareness about their rights through extension pamphlets (49); automation of administrative activities (31); establishment of feedback system (20)	0.05
	Coordination/ cooperation among different development agents (17)		Central monitoring system development (67)	0.00
	Cost-sharing with customers (10)		Shared digital terminals (33)	
			Provide opportunities for customers to take part in cost-sharing (67)	0.00
			delegating responsibilities to customers or their representatives (33)	
Appropriate development programs				
	Employment improvement (21)	0.05	Development of technical-vocational courses (48); development of non-agricultural jobs (e.g. rural industries) (40); introducing job opportunities (12)	0.03
	IPM (16)		Extension and implementation of IPM (67); introducing key IPM informants (33)	0.00
	Prevalence of perma-culture (14)		Planning and implementing of conservative programs i.e. extension/education courses (67); Public awareness programs on environmental conservation (33)	0.00
	Improvement of post-harvest activities (13)		Extension of small/ home scale food processing methods (86); Mutual communication between farmers and food process industries in urban area (14)	0.00
	Rangeland degradation prevention (13)		Introducing the consequences of rangeland degradation to farmers (67); sustainable policy making and planning (33)	0.00
	On-time application of pesticides (12)		Educating farmers on the necessity of proper timing in using pesticides (67); public announcement of the time of spraying (33)	0.00
	Direct marketing (6)		Local horticultural products exhibitions for major purchasers (67); mutual communication between farmers and purchasers (33)	0.00
	Provision of recreational provision (5)		Performing local cultural-artistic programs (80); cultural-artistic programs exchange among regions (20)	0.00
Proper communication media				
	Two-way and interactive communication (67)	0.00	Provide opportunities for negotiation (54); flexibility of communication (30); using direct/ face to face communication methods (16)	0.01
	Attractive communication (33)		Provide opportunities for building mutual relationships (58); Entertain ability (24); using local language and symbols in communication processes (18)	0.05
Focus on real customers				
	More focus on rural youth (50)	0.03	Providing facilities for rural youth to exchange experience outside of village (67); Organizing rural youth in cultural-artistic groups/ clubs (33)	0.00
	More Focus on rural poor (25)		Rural poor-oriented new technologies development (41); organizing rural poor in vocational associations/cooperatives (33) rural poor motivation for participation (26)	0.05
	More focus on rural women (25)		Organizing rural women in vocational associations/cooperatives (67); Development of women-oriented extension/education courses (33)	0.00
Suitable M&E system				
	Participative and people-oriented M&E	0.00	Evaluation of development programs based on customers' opinions (67); developing evaluation criteria using customers' feedback (33)	0.00

Table 5: The priority of media* with respect to 1st and 2nd levels of criteria

1 st level criteria	2 nd level criteria in order of priority	Priority of media						
		1	2	3	4	5	6	IR
Organizational sustainability	Reducing corruption among staff	I	T	R	P	F	S	0.05
	Coordination/ cooperation among different development agents/organizations		P	T	R	S	F	0.04
	Cost-sharing with customers	T	R	I	P	F	S	0.05
Appropriate development programs	Employment improvement	T	I	P	F	R	S	0.06
	IPM	F	T	R	P	S	I	0.03
	Prevalence of perma-culture	T	F	R	P	S	I	0.07
	Improvement of post-harvest activities	F	T	R	P	I	S	0.04
	Rangeland degradation prevention	T	R	P	F	S	I	0.05
	On-time application of pesticides	R	T	F	P	I	S	0.04
	Direct marketing	I	T	R	P	F	S	0.07
Proper communication media	Provision of recreational provision	F	T	I	R	S	P	0.05
	Two-way and interactive communication	T	F	R	P	I	S	0.05
Focus on real customers	Attractive communication	F	S	T	I	R	P	0.04
	Two-way and interactive communication	F	S	T	I	R	P	0.04
	Attractive communication	F	S	T	I	R	P	0.04
Suitable M&E system	More focus on rural youth	I	R	T	P	F	S	0.04
	More Focus on rural poor	F	S	T	R	P	I	0.03
	More focus on rural women	F	P	R	T	S	I	0.05
	Participative and people-oriented M&E	I	F	T	R	P	S	0.03
		F	P	T	R	I	S	0.03

*Inter/intra net: I; Television: T; radio: R; Printed media: P; local festivals: F; folk songs: S



Fig. 3: The tree view of sustainable horticulture

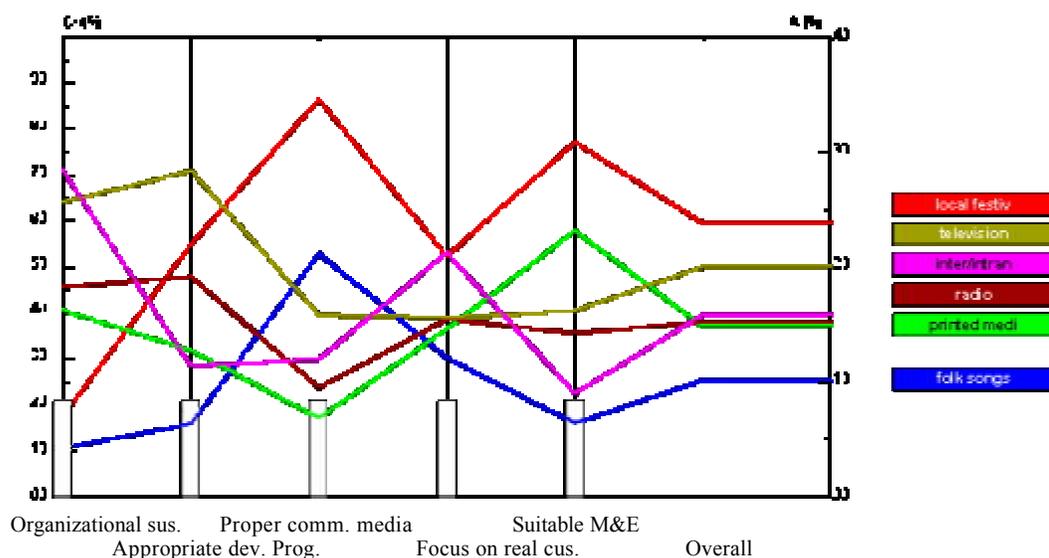


Fig. 4: Sensitivity analysis for sustainable horticulture model

CONCLUSION AND DISCUSSION

The results of this study clearly demonstrated that the combination of communication media for sustainable horticulture is imperative. This finding is in line with findings of Shahvali [11], Kaye and Johnson [8], Rawan [10], Althaus and Tewksbury [7] and Ozcan [9]. Moreover, the results of this study revealed the following applications of communication media:

Inter/intranet is a very useful media for issues related to sustainable development especially sustainable horticulture through:

- Development of Organizations via automation of administrative activities; maintaining proper system to gain customers' feedbacks; development of organizational monitoring system; and providing share digital terminal between different organizations.
- Development of marketing activities especially direct marketing via facilitating communication between farmers and processing industries in urban areas and inviting major purchasers to local horticultural products exhibition.
- Development of rural youth by: providing facilities for their interaction with the outsiders; and organizing them into cultural-artistic groups/ clubs.

The common theme derived from the above applications is "facilitating distance communications" for the purpose of "organizational development" and "teaching/ learning". These qualities of inter/intra net has been reported by many researchers. For example,

using inter/intra net for marketing facilities in England and Wales [3, 44], providing scientific information in African poor regions [38], facilitating inter/ intra city communication [45], online sales in USA [46], providing services for rural youth in Norway [47] and development of small and medium-sized enterprises across the world [48].

Local festivals are the most useful media for the following purposes:

- Development of extension-education programs directed towards integrated pest management; conservation of natural resources; and small home-scale processing methods.
- Performing local cultural-artistic programs; and accessing local cultural-artistic programs across the country.
- Development and maintaining interactive communication process between development agents and farmers in a flexible, negotiable and face-to-face and yet entertaining way using local jargons and symbols.
- Organizing target groups such as rural poor and women in order to motivate them for participating in development programs.
- Providing a share atmosphere between development agents', officers and local people so that participatory programs in M&E are enforced.

Similar qualities of folk media have been reported by researchers. For example, folk media have been used to organize local people for voluntary activities such as disease control in India [40], preserve wild life in

Cameron [49], prepare cultural-artistic programs for family planning in Iran and a few South Eastern Asian countries [50] and establishing a share basement between formal agricultural institutions and rural people [31].

TV is found to be an appropriate media for:

- Organizational development via: acquainting customers (farmers) about their rights as well as administrative procedures of organizations; motivation of farmers to cover some costs of sustainable horticulture programs; and delegating part of administrative responsibilities to farmers or their representatives.
- Providing facilities for different developmental programs such as: disposal of educational courses especially technical-vocational courses; extension of non-agricultural rural jobs; introducing job opportunities; social publicity for building up new cultural habits such as permaculture; sustainable policy-making and planning; and public announcement in areas such as right time of spraying.

Based on the above discussion, some recommendations are presented for further researches:

- Findings of this study proved the necessity for media combination. However, this study was limited to a specific region. It is therefore, recommended that similar study be conducted in other countries to test the applicability of media in different sustainability topics.
- Sustainable development programs such as sustainable horticulture are usually faced with limited resources. Therefore, it is necessary to find a way to prioritize different programs and goals and then allocate resources towards those goals. The best media combination that proved effective from this study can aid development agents to break down different resources and allocate them to media based on their priorities and related goals. Therefore, it is recommended that development agents and decision makers utilize these strategies in their decision/ policy making processes.
- Interestingly, printed media was not the first priority in anyone of the sustainable topics. However, these media have been widely used for sustainable horticulture programs during past decades in Iran. It seems appropriate to shift from printed to other media such as internet and TV.
- With regards to the holistic perspective, a phenomenon such as sustainability has several dimensions. However, in this study we tried to

expand our perspective and consider sustainable horticulture criteria in a broader view, but we also can use some alternative techniques of AHP like Analytic Network Process (ANP) to study and evaluate criteria especially in more complex situations of sustainable development.

- Although FM such as local festivals showed to have a remarkable role in sustainable horticulture programs, it has been given limited attention in the past research. Therefore it is strongly recommended that development agents be more cautious in preserving folk heritage and utilize them for developmental purposes such as sustainable horticulture.

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