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How farmers perceive the impact of dust phenomenon on agricultural production activities: A Q-methodology study

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ABSTRACT

Dust as one of the environmental concerns during the past decade has attracted the attention of the international community around the world, particularly among West Asian countries. Recently, Iran has been extremely affected by the serious impacts of this destructive phenomenon, especially in its agricultural sector. Management of dust phenomenon increasingly calls for initiatives to understand the perceptions of farmers regarding this phenomenon. Farmers' views about dust phenomenon can affect their attitude and their mitigating behavior. This can also make a valuable frame for decision and policy-makers to develop appropriate strategies for mitigating dust phenomenon impacts on the agricultural sector. In line with this, a Q methodology study was undertaken to identify the perception of farmers toward dust phenomenon, in Khuzestan province, Iran. Sixty participants completed the Q sort procedure. Data analysis revealed three types of perceptions toward dust phenomenon: health adherents who seek support, government blamers who seek support, and planning adherents who seek information. Awareness of these perspectives is expected to promote the exchange of thought and knowledge among policy and decision-makers, and to support the development of a shared vision on dust phenomenon management.

1. Introduction

Dust phenomenon is a kind of severe natural disaster that often occurs in arid and semiarid regions (Prospero et al., 2002). Dust storms, one type of dust event, are in most cases the result of turbulent winds, including convective haboobs (Goudie, 2009), which raise large quantities of dust from desert surfaces and reduce visibility to less than 1 km (Song et al., 2007). This dust not only occurs in dust storm source areas but is also transported over thousands of kilometers (Goudie, 2009; Zuo et al., 2017). Dust storms mainly occur during the spring season with the highest frequency in April. They cause serious environmental, economic, and social problems and have negative effects on human society (Ebadat, 2010). Much of the current interest in dust storms relates to their possible role in the Earth System (Goudie and Middleton, 2006). Dust loadings may affect air temperature through the absorption and scattering of solar radiation, may affect cloud formation and convectional activity (Wong and Dessler, 2005; Zhang et al., 2019). Dust storm also influence Sulphur dioxide levels in the atmosphere, either by physical absorption or by heterogeneous reactions (Adams et al., 2005), and influence marine primary productivity and thus atmospheric carbon dioxide levels (Goudie, 2009). Yang et al. (2007) in their study on climate change in Northern China showed that in the semiarid region, the temperature and precipitation series were negatively correlated with the dust storm frequency on a decadal timescale (Yang et al., 2007). Dust storms impact humans in different ways. One of these is human health. Dust storms can cause transport accidents for both civilians and the military. More importantly, dust emissions from dried lake basins (e.g., the Aral) introduce fine particles, salts, and chemicals (including herbicides) into the atmosphere, with a suite of health impacts, including not only respiratory complaints but also other serious illnesses (Small et al., 2001). Dust storms can lead to particulate levels that exceed internationally recommended levels and transport allergens, including bacteria and fungi (Kellogg and Griffin, 2006). The annual meningococcal meningitis outbreak in the Sahel of Africa (Sultan et al. 2005) and Coccidioidomycosis outbreaks in the southwest USA have been related to the dust storm activity. On the other hand, a recent study of asthma incidences in children living in the Aral Sea region appeared to be unrelated to dust exposure (Goudie, 2009). Therefore, dust storms are important environmental problems and receive increasing attention by the government and by the public.

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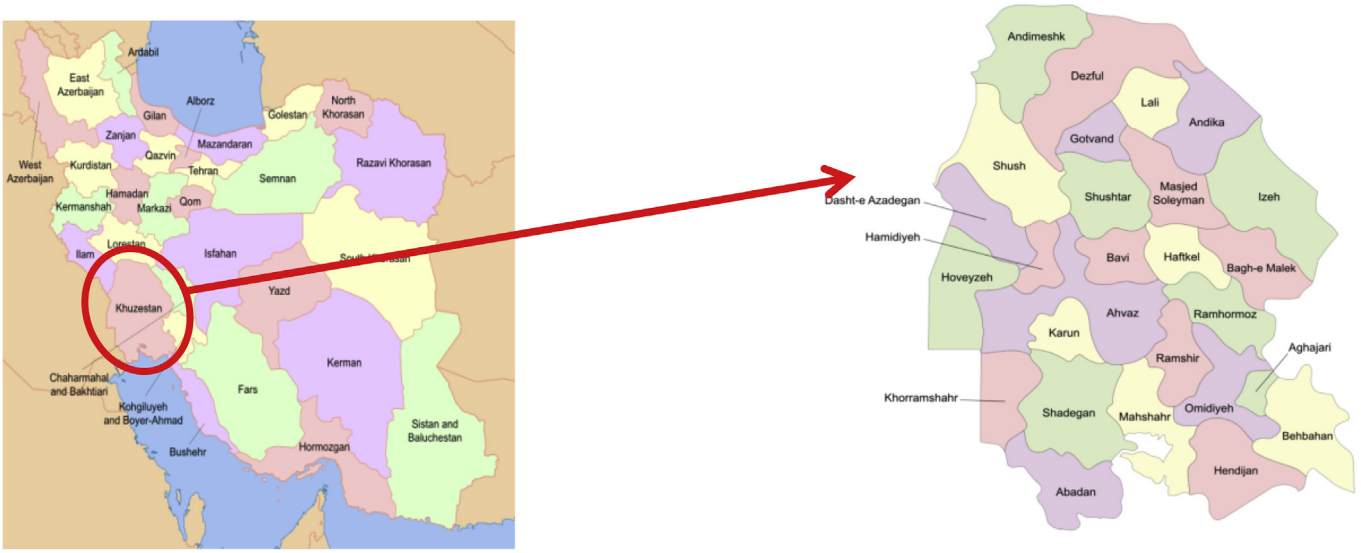

Fig. 1. Geographical position of the study area.

This article focuses on the impacts of dust phenomenon on agricultural production activities which are extremely affected by dust (Wang et al., 2006; Sivakumar 2005). Reduction of agricultural products (Shi et al. 2005), decrease in livestock products (Zongbo et al. 2005) and spread of pests and plant diseases (Sivakumar 2005) are some of the severe damages of dust to the agricultural sector. Dust storms, therefore, may endanger achieving sustainability in the countries heavily dependent on the agricultural sector. Under these conditions, agriculture can only survive when farmers identify useful and adaptive strategies and apply them to the face of dust particles (Ghambar Ali et al., 2013). There are different ideas about how rural communities adapt to their economic and environmental conditions. Farmers have valuable local strategies, including identifying and responding to climate change parameters (Nyong et al., 2007). Therefore, farmers employ different measures and strategies to plan and reduce the risk of dust phenomenon.

This paper focuses on a vital issue in dust phenomenon policy, that is, identifying how farmers think about dust phenomenon. This is of central importance, because if we are not aware of farmers' discourses regarding the dust phenomenon, it will be very hard to judge which policies will be socially accepted, and therefore, capable of being implemented by farmers. A stakeholder perspective is the cognitive representation that a stakeholder makes of the external reality and his or her position toward this reality (Raadgever et al., 2008). Developing an overview of different stakeholders' perspectives can increase the awareness of other perspectives (Pahl-Wostl and Hare, 2004; Ridder et al., 2005). In turn, awareness of the stakeholders' views can unfold their attitude and behavior which in turn facilitates the urgency to address and mitigate the issue. Indeed, finding out how people understand an issue is essential to the whole process of problem identification, both normatively and politically (Barry and Proops, 1998).

Therefore, identifying farmers' perceptions and attitudes is necessary for proper management and planning in the agricultural sector (Lobell et al., 2008Zobeidi et al., 2016). Iran is one of the countries which has been extremely affected by the serious impacts of dust phenomenon in recent years. Iran, despite its inactive role in spreading dust, is located near dust storm source areas like Iraq, Saudi Arabia, and Kuwait and has suffered from huge damages of dust storms (Gerivani et al., 2011). Hence, the main purpose of this paper is to present different perspectives on dust phenomenon in Khuzestan Province, Iran. Understanding farmers' perceptions toward dust phenomenon is important in dust management practices. Different perspectives suggest that various individuals think differently about the nature, causes, impacts, and ways of responding and mitigating dust phenomenon. It is expected that the result of this study could be utilized as a basis for the development of more appropriate strategies to mitigate the impacts of dust in the agricultural sector. Indeed, every plan to mitigate the impact of dust on agriculture should consider the findings of this study. The main hypotheses of the study are as follows:

H1. Farmers have different perceptions toward the dust phenomenon.

H2. The farmers believe that farming has no influence on creating dust storms.

H3. The farmers are worried about the destructive impacts of dust on human health.

H4. The farmers believe that they can plan and reduce the risk of dust phenomenon.

2. Methodology

2.1. Study area

To provide an insight into how farmers experience dust phenomenon, an area was selected in which dust has become an increasingly important and problematic issue for them, especially during dry seasons. Therefore, Khuzestan Province in the southwest of Iran, with an area of 64236 square kilometers and 3740 villages, was selected (Fig. 1). Its rural population is mainly involved in agriculture, animal farming, and fishery activities. While dust is a major problem for rural life, this province is known as one of the major producers of agricultural crops in the whole country (Jihad-e-Keshavarzi Organization of Khuzestan Province 2014). Unfortunately, in recent years, the occurrence of dust storms in this province has caused serious damages to agriculture. The statistical estimation data have indicated that dust phenomenon led to a loss of about 7–17 million tons of farmers' products in 2009, and more than 4 million tons during 2010–2011, in both grain and horticultural production. In addition, in terms of monetary damages, dust phenomenon has led to more than 1882 billion rials damages to agricultural products including irrigated and rainfed wheat, barley, and canola (Khoman, 2013). Furthermore, this phenomenon has significantly reduced the quality of date crops. Nevertheless, unfortunately, dust damages are not compensated by insurance law.

2.2. Material and methods

This study was based on Q-method in which farmers' perceptions toward dust phenomenon were explored. Q-methodology was pioneered by the British psychologist and physicist Stephenson (1953) and was elaborated by his followers (Davis and Hodge, 2007; Barker, 2008; Zagata, 2010). It proved to be a good, but time-intensive, method for eliciting and analyzing human perceptions, attitudes, and interpersonal relationships in a structured and unbiased way (Raadgever et al., 2008). This method, by combining the strengths of both qualitative and quantitative research traditions (Barker, 2008; Forouzani et al., 2013), is increasingly applied across the social sciences to identify and describe unique viewpoints as well as commonly shared views (Akhtar-Danesh et al., 2009). It is also developed to examine the patterns of individual subjectivity about a specific issue and to reflect the broader discourses that exist within the public sphere in relation to that issue (Doody et al., 2009; Salazar, 2009; Forouzani et al., 2013). Therefore, Q methodology provides a foundation for the systematic study of subjectivity, a person's viewpoint, opinion, belief, attitude, and the like (Brown, 1993). Accordingly, it is used to construct typologies of different perspectives by identifying patterns across individuals, not variables (Brown, 1993). In line with this, it is aimed to test the typology's proportional distribution within the small population and, therefore, uses small sample sizes to identify a typology. Typically, Q analysis focuses on the relationships among participants who rank order specified variables in similar ways (Borthwick et al., 2003), and each category of similar ranked variables is then conceptualized by the researcher using the statements of participants. Although the researcher offers an interpretation on recognized points of view, this follows on from the participant's activity rather than imposing a framework within which there is an implicit right or wrong response (Barker, 2008).

Generally, in a Q methodological study, people are presented with a sample of statements about some topics, called the Q-set. Respondents, called the P-set, are asked to rank-order, called Q sorting, the statements from their individual points of view, according to some preference, judgment, or feelings about them, mostly using a quasi-normal distribution. By factor analyzing the Q sorts, people's subjective viewpoints or personal profiles are revealed (Brouwer, 1999; cited in: Van Exel and de Graaf, 2005, p.1). Hence, for performing a Q methodological study, as utilized in several studies, five principal steps must be followed: (1) definition of the concourse (Q-population), (2) development of the Q sample, (3) selection of the P set, (4) Q sorting (Q-sort), and (5) analysis and interpretation.

Following the aforementioned steps to do a Q research, the study was carried out to explore farmers' perceptions regarding the nature, causes of dust, as well as solutions to get rid of its unfavorable impacts.

2.2.1. Definition of the concourse (Q population of statements)

Before any progress can be made in selecting the statements for ranking by participants, we need a population of discourses which exist about the topic in question. Thus, the first stage is to establish a 'concourse' of statements in relation to a chosen subject (Ockwell, 2008), in this case, the dust phenomenon. A concourse is the volume of discussion on any topic (Brown, 1986). Q-methodology is based on the premise that there are limited numbers of concourses on any subject (Doody et al., 2009). The contents of the concourse include conversations, commentaries, photos, videos, texts, and generally anything that is related to the subject (Brouwer et al., 2007).

Semi-structured interviews were conducted to extract statements toward dust phenomenon from four individual agricultural specialists and four individual farmers who were not included in the study participants. These eight key informant individuals were selected among agricultural experts and farmers through purposive sampling in Khuzestan Province. Table 1 indicates the characteristics of farmers and specialists involved in the semi-structured interviews. The obtained statements covered broad areas such as nature, origin, causes, impacts, experiences, and coping strategies about the topic. Along with this process, a review of related existing literature was carried out by bringing together the published evidence on the topic in question. A structured method was used to generate the Q population. According to the components of a framework suggested by Leeuwis and van den Ban (2004) that presents the basic variables for identifying the behavior of farmers in dealing with a phenomenon, the statements were formulated in such a way that cover all aspects of the framework. This leaves us free to consider a wide range of statements about the concept, causes, impacts, origins, and experiences of dust as well as coping strategies applied by farmers to their farms and policies applied by the central government to the country and/or its neighbors at the regional scale. These aspects are as follow:

- Concept: the nature of dust phenomenon
- Source: factors that contribute to the origins of dust
- Causes: factors that may produce and exacerbate dust
- Improvement strategies
- Reward and punishment systems from the government to motivate conservative activities
- Perceived ability to mobilize resources
- Perceived availability of skills and abilities
- Farmers' confidence in the knowledge taken from informant sources
- Perceived ability to control or adapt to dust
- Perceived technical, social, and economic impacts

The generated Q-population was examined for relevance, intelligibility, and similarity to other statements. Then, duplications were removed. After correcting redundant and unclear statements, total statements were collected as the Q population (180 statements about dust phenomenon).

2.2.2. Development of the Q sample

The second stage in conducting a Q study is to select a representative subset of statements drawn from the concourse to administer to participants (Forouzani et al., 2013). Toward this end, a structured manner was used to choose the Q sample. According to Brown (1980), such a structure may emerge from further examination of the statements in the concourse or may be imposed on the concourse based on some theories. Whatever structure is used, it forces the investigator to select statements widely different from one another in order to make the Q set broadly representative. In line with this manner, 180 statements were primarily classified into 10 domains which are a combination of the main issues emphasized in the primitive interviews of stakeholders and those factors presented in the suggested framework by Leeuwis and van den Ban (2004). Then, a ranking scale was adopted by experts and specialists for choosing the Q sample. Thus, a group of experts, including the authors, independently examined the statements of each domain to prioritize them and rank the most representative and distinctive statements with regard to dust phenomenon. The final set included 48 statements that represented key ideas from each domain about dust.

According to Van Exel and de Graaf (2005), a number was randomly assigned to each statement, and then, statements and their corresponding numbers are printed on separate cards for Q sorting.

After that, the Q sample was pilot tested in an interview with one volunteer farmer, and then, immediate changes were made to the wording of statements in order to improve their clarity and conciseness.

2.2.3. Selection of the P-set

As noted by Brown (1980), the P set is a structured and non-random sample of respondents who have a clear and distinct viewpoint regarding the problem under consideration. Indeed, choosing a statistically representative sample of people from a larger population is not the point in a Q study. The point, instead, is that the patterns revealed by a Q study can be considered to reflect the discourses that exist in wider

Table 1
The characteristics of the individual farmers and specialists participated in the interviews.

Features	participants							
	Farmer no. 1	Farmer no. 2	Farmer no. 3	Farmer no. 4	specialists no. 1	specialists no. 2	specialists no. 3	specialists no. 4
Age (year)	32	45	52	32	48	46	34	58
Sex	Male	Male	Male	Male	Male	Male	Male	Male
Agricultural experience (year)	10	30	40	15	32	22	10	22
Education (year)	12	9	5	5	18	18	18	18
Crops (mainly)	Wheat	Vegetables	Wheat	Wheat	–	–	–	–
Major	–	–	–	–	Extension	General Agri.	Environment	medical plant

society (Ockwell, 2008). One of the most salient characteristics of Q-methodology, as discussed by Yeun (2005), is the use of a small sample to extract intra-individual differences rather than inter-individual ones. At this stage of the study, key informant farmers who may have a divergent understanding of dust were invited to participate and capture as much variation as possible. Hence, a purposive sample including 60 key informant farmers was selected in the study area by following the steps below:

First, researchers sought to capture statistical data on dust during the last seven years. Thus, all dust measuring stations of Khuzestan Meteorological Bureau were examined according to the accessibility of correct and complete data for the time range of interest. In addition, they tried to consider a uniform distribution of stations throughout the whole province. Only 12 stations were recognized as appropriate for the purpose of this study. They were placed in different counties of the study area including Abadan, Omidieh, Ahvaz, Izeh, Mahshahr, Behbahan, Dezful, Ramhormoz, Masjed Soleyman, Bostan, Lali, and Hendijan. At the second step, these counties were ranked according to two criteria: frequency of dusty days during the year and the concentration of dust in each day (Table 2). The ranking stage resulted in selection of Abadan (ranked first in both criteria), Omidieh (ranked second in both criteria), Izeh (ranked third in both criteria), and Dezful (ranked conversely based on two criteria) counties which demonstrated maximum variation in dust occurrence. Among them, at the third step, 18 villages were randomly and proportionately selected which encompassed 15, 10, 15, and 20 farmers from Abadan, Omidieh, Izeh, and Dezful, respectively.

After that, according to the local people and extension agents' recommendations, key informant farmers in each selected village were identified and asked to take part in Q sorting. Surprisingly, all of them were male.

2.2.4. Q-sorting

The statements of Q sample were sorted according to a rating pattern to demonstrate perceptions, opinions, or feeling models of the participants on dust phenomenon. Therefore, each participant was asked to evaluate statements by cross-comparing and then sorting them along a continuum from −2 (strongly disagree) to +2 (strongly agree). To avoid leaving blank cells by participants, a ranking grid with a quasi-normal distribution was presented to them, and they were conducted to a forced sort approach or fixed pattern in which they had to place all statements in the columns until all blanks on the grid are completed (Fig. 2). Participants, for example, were required to identify the 8 statements they most agreed with and place them in the +2 column.

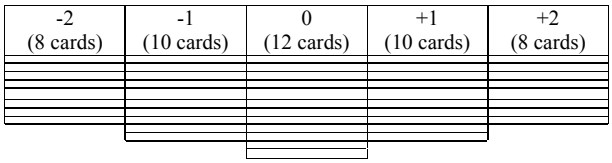

Fig. 2. Sorting distribution for statements in a Q Sorts (Quasi-normal distribution).

Each individual response is called a Q-sort. After each Q sort, participants were interviewed about the items they placed in the extreme columns, i.e., strongly disagree (−2) and strongly agree (+2). This information was used for the interpretation of factors later on. Participants were also asked to complete a short survey including questions pertaining to demographics and their experiences in agriculture.

2.2.5. Analysis and interpretation

After Q sorting, the results of the Q sorts are correlated and then factor analyzed. By correlating people, Q factor analysis gives information about similarities and differences in viewpoints on a particular subject (Van Exel and de Graaf, 2005). Therefore, Q sorts were intercorrelated, resulting in a 60 * 60 correlation matrix in which coefficients indicated the degree of (dis)similarity between each individual Q sorters (farmers) and the others. This correlation matrix serves to prepare the data for factor analysis (Brown, 1993). Accordingly, a centroid method was undertaken on this matrix of statement responses. Factors were then rotated using varimax rotation. To select the final factors representing the particular viewpoints of farmers on the topic, two criteria were considered: 1) a factor which had eigenvalues of greater than 1.0 and 2) a minimum 5% of Q sort (three Q sorts in this study) loaded significantly on that factor alone. Final factors were therefore interpreted as reflecting the key viewpoints that the farmers were assumed to subscribe to. Indeed, farmers with similar views on the topic share the same factor. The loading factor of a farmer on a certain factor gives the extent to which he agrees or disagrees with it. Therefore, a loading factor was determined for each Q sort, expressing the extent to which each Q sort is associated with each factor. An 'ideal Q sort' was then computed for each factor based on how a 100% individual loading on that factor would rank each statement (Ockwell, 2008). All analyses of the Q-sorts were carried out using PQMethod software, version 2.11. Then, the factors embracing a group of farmers were interpreted by examining three elements: 1) the words that were distinctive among other factors, i.e., distinguishing statements which statistically distinguish the discourse from other factors at $P < .01$ or

Table 2
Ranking of different counties according to maximum frequency of dusty days and daily concentration of dust during 2006–2012.

Ranking criteria	County											
	Abadan	Omidieh	Ahvaz	Izeh	Mahshahr	Behbahan	Dezful	Ramhormoz	Masjed Soleyman	Bostan	Lali	Hendijan
based on frequency of dusty days during a year	1	2	1	3	2	3	1	2	1	2	2	3
based on daily concentration of dust	1	2	2	3	1	2	3	3	3	1	3	1

Table 3
Farmers' factor loadings after rotation.

Person sample	Factors		
	Factor 1	Factor 2	Factor 3
1	0.5659[X]	0.4406	0.1054
2	0.5448	0.6217[X]	0.0508
3	0.6832[X]	0.3216	0.1744
4	0.3617	0.3340	0.6328[X]
5	0.3460	0.5616[X]	0.4171
6	0.4669	0.4565	0.4590
7	0.6915[X]	0.1958	0.2579
8	0.3748	0.5829[X]	0.4315
9	0.7186[X]	0.0913	0.4284
10	0.6726[X]	0.1001	0.3477
11	0.6418[X]	0.3978	0.3281
12	0.2701	0.4251	0.0944
13	0.6145[X]	0.5077	0.1692
14	0.5710[X]	0.4315	0.1028
15	0.6742[X]	0.3946	0.2927
16	0.6038[X]	0.5201[X]	0.2513
17	0.2584	0.5791[X]	0.3292
18	0.2234	0.3793	0.4562[X]
19	0.6219[X]	0.2524	0.3172
20	0.2707	0.4202	0.5739[X]
21	0.3738	0.6651[X]	0.1943
22	0.0333	0.3910	0.5827[X]
23	0.5005[X]	0.2685	−0.0515
24	0.5867[X]	0.3735	−0.0115
25	0.6693[X]	0.2058	0.2243
26	0.3739	0.5902[X]	0.2339
27	0.3761	0.4419[X]	0.1392
28	0.0899	0.4883[X]	0.2568
29	0.6860[X]	0.4150	0.0798
30	0.4415	0.5162	0.4459
31	0.5335[X]	0.3422	0.3500
32	0.4031	0.4519	0.5036
33	0.5499[X]	0.4661	0.2028
34	0.4743	0.2398	0.5862[X]
35	0.5376	0.5213	0.2637
36	0.4787[X]	0.4321	0.1937
37	0.6028[X]	0.3210	0.3441
38	0.5504	0.4818	0.2700
39	0.4587	0.6127[X]	0.2528
40	0.3052	0.3572	0.3878[X]
41	0.4087	0.2569	0.5078[X]
42	0.5023[X]	0.0782	0.4212
43	0.5678[X]	0.5359	0.1804
44	0.2384	0.6889[X]	0.3310
45	0.3431	0.3167	0.5359[X]
46	0.2066	0.6265[X]	0.3048
47	0.2983	0.1652	0.5129[X]
48	0.2229	0.4865[X]	0.3840
49	0.4837[X]	0.1124	0.2069
50	0.3204	0.4689[X]	0.3066
51	0.5916[X]	0.2041	0.3899
52	0.4598	0.2258	0.4444
53	0.5063[X]	0.2653	0.4239
54	0.1694	0.0384	0.7093[X]
55	0.5696[X]	0.2711	0.3315
56	0.5707[X]	0.3253	0.2335
57	0.3261	0.5442[X]	0.0387
58	0.6736[X]	0.3043	0.3292
59	0.5249[X]	0.4418	0.2389
60	0.5098	0.6056[X]	0.2821
Variance explained (%)	24	18	12
Number of defining sorts	28	16	10

[a] Factor loadings marked by superscript star were flagged by PQMethod software. Those indicating the value over 0.282 or 0.372 are significant at $p < .05$ or $p < .01$, respectively. For more information see Forouzani et al. (2013).

$P < .05$ significance level, 2) the words that were similar among factors, i.e., consensus statements, and 3) the comments made by the participants during post sort interviews on the most extreme rated statements within the ideal type Q sort for that factor (i.e., those rated either +2 or −2). The ideal Q sort represents how a 100% individual loading on that factor would rank each statement (Ockwell, 2008). The focus of interpretation is the factor score, a weighted average score for each factor on each statement (Salazar, 2009).

Table 4
Farmers' basic characteristics by factors.

characteristic		Total	Factor 1	Factor 2	Factor 3
county	Abadan	15	6	4	2
	Omidieh	10	4	2	3
	Izeh	15	7	5	2
	dezful	20	11	5	3
Major crops	Wheat	29	11	9	6
	Corn	5	4	0	1
	Alfalfa	2	2	0	0
	Rice	4	2	2	0
	Citrus	2	1	1	0
	Vegetable	5	4	0	1
	Date	13	4	4	2
Mean of personal characteristic	Land amount (ha)	9.51	10.18	10.91	9.10
	Age (year)	40.68	38.28	42.31	46.00
	Agricultural experience (year)	19.90	19.67	21.12	22.40
	Education (year)	11.96	11.92	11.68	11.20

3. Results and discussion

The resulting factors represented common patterns across individuals, not variables. Therefore, three distinct factors, or common patterns (discourses), were extracted from the analysis (Table 3). Table 3 demonstrates Q sort loadings of each factor, level of variance explained by each factor, and the number of defining sorts. Among the 60 participants, Q sort of 54 farmers significantly loaded on the factors, and a total of 6 Q sorts did not load on any factors. This means that they are not represented by these major viewpoints. Table 4 represents the distribution of the participants on factors according to their main basic characteristics. According to Table 4, all farmers were literate (n = 60; 100%), and on average, they had over 19 years of experience in farming. They were male farmers whose age ranged between 23 and 58 years.

All authors spent several hours to reach consensus over the interpretation and nomination of the factors. A description of each factor is presented below with a summary of demographic details about the participants who loaded significantly on that factor. Rankings of relevant statements are indicated by the numbers in parenthesis within the description of each factor. For example, in the description of factor 1, (11: +2) indicates that statement 11 is ranked in the +2 position (strongly agree).

3.1. Factor I: health adherents who seek support

The first viewpoint included 28 farmers who loaded significantly on the factor. Farmers grouped in this factor believed that health is more important than agricultural production and income (11: +2). They stated that if a farmer does not feel healthy, he cannot work. Therefore, for persuading farmers to protect themselves against dust storms, the government must distribute free masks, goggles, and gloves among them, especially when dust occurs (20: +2). In their point of view, some poor farmers may have not financial ability to afford protecting devices. In addition, they are not equal on access to these devices because all villages are not homogenous in term of access to pharmacy, drug store, and/or health centers where the sanitary facilities can be provided. Accordingly, the government should provide them with these facilities. They also added that, since masking is not a usual health caring practice among farmers, if the government provides and distributes free masks among them, it will become an accepted and normal

behavior among farmers. Hence, farmers will learn to use masks when dust is occurring and will be motivated to provide masks in similar situations in the future. In relation to the perceived consequences of dust phenomenon, this group believed that dust has massive negative impacts on the products' marketing in such a way that they have trouble to sell their crops, particularly dates (15: +1). Accordingly, the government is expected to pay compensation to farmers whose products have been damaged by dust (42: +1). This group also believe that agricultural support networks are not effective enough. They stated that, for example, the natural resources office had been unable to plan adequate programs for mulching or planting trees in order to control or reduce dust storm (5: 1). In addition, farmers are not served properly by experts and change agents in terms of providing necessary educational and training programs on how to protect themselves and their crops against dust (39: 2). Nonetheless, they opposed that farmers should avoid doing agricultural practices when dust occurs (26: −1). They insisted that farming is the only source of income for farmers, and they have no other choices to gain income; therefore, they cannot leave their farms even at the time of dust formation. Farming, by its very nature, has required farmers to be present on their farms in all situations even if the weather is not favorable. They stated that wearing a mask ensures farmers to be healthy and protected against dust; therefore, they can freely undertake farming practices. This group also disagreed that farming practices are responsible for dust phenomenon; hence, they were very opposed to the idea that farmers should avoid plowing lands in order to protect agricultural soil against more powdering and erosions (31: −2). They insisted that without plowing, cultivation is impossible. Although some of these farmers raised no-tillage cultivation, they believed that no-tillage can make cultivation possible only for one season, and farmers cannot follow this method for all of the cultivation year. There was a strong belief among farmers that plowing has nothing to do with dust phenomenon. The soil particles fragmented due to plowing are heavy and are not light enough to be moved by the wind; therefore, they instantly sit on the ground and just influence a limited small area.

3.2. Factor II: government blamers who seek support

This factor was loaded by 16 farmers. Farmers who belong to this factor believe that farms are damaged when dust occurs, especially due to the invasion of pests and plant diseases (22: +2). They explained that dust generally provides a favorable environment for pests and plant pathogens' attacks. Dust also act as a litter to carry and transfer pests and pathogens from one place to another. They added that, in time of dust storms, the pores on the surface of the plant leaves are closed as a physiological reaction which withers and weakens the plants, and consequently, the condition is appropriate for the pathogenesis diseases. Therefore, they insisted that the government must support farmers financially and pay compensation to those whose crops are damaged by dust (42: +1). Otherwise, social dissatisfaction and forced migration as the outcomes of dust storms will be expected (19: +1). Although this group believed that the recent dust storms have arisen from external sources and neighboring countries such as Iraq and Saudi Arabia (34: +1), they blamed the government as the main agent for their damaged crops. They believed that the government does not provide any help to control and restrain this destroying phenomenon. In fact, according to this group, farmers are not financially capable to remedy dust induced damages to their crops.

Regarding farmers' trust in the reliability of knowledge they acquired from different sources, this group stated that agricultural experts and extension agents were not successful in providing their educational needs on coping with dust (39: 1). In addition, they strongly emphasized that the national mass media, particularly TV, do not play any useful programs in the field of dust (30: 2), or if so, they are not played at a proper time which farmers could freely watch. Moreover, most of the time, information is given to farmers when the dust has occurred and affected the situation; hence, nothing has been done regarding early warnings. Nonetheless, this group of farmers introduced farmers as the active participants who can involve in dust mitigating programs and opposed the idea that farmers cannot do anything to reduce or cope with dust (24: 1). They can help to reduce the negative impacts of dust by refusing to use chemical inputs and pesticides (18: +1). Dust storms will be decreased by better water management on farms or less waste of water by farmers (34: +2). In their view, water management prevents soil drying out; hence, keeping soil moisture will inhibit the creation of dust storms. However, they disagreed with this statement that farmers must refuse plowing farmlands in order to protect agricultural soil (31: −1).

3.3. Factor III: planning adherents who seek more information

In all, 10 farmers loaded on this factor. This group, like the first one, emphasized the impact of dust on human health and believed that dust reduces visibility and increases respiratory problems in humans (21: +2). They added that farmers are more exposed to dust and consequently envisage more damage because of penetrating more dust particles into their lungs. In addition, like the second group, they believed that when dust occurs, damages caused by pests and plant diseases increase (22: +1). However, they stated that dust has a negligible effect on animal production, and subsequently, loss of animal production is low (45: −1). They did not believe that dust will lead to migration and dissatisfaction (19: −2). In their point of view, a farmer's decision to migrate means that he/she wants to be totally detached from farming; hence, he/she tries to sell his/her farmland. In contrast, the purchaser will definitely be a farmer who has to involve in agricultural practices. Therefore, the cycle of farming will be started again.

The main difference between this group and other groups is that despite confirming the serious negative impacts of dust on health and farm economy, this category of farmers believed that the government's attempts to control dust had been partly helpful. In this regard, the department of natural resources has achieved some successes in reducing dust storms by mulching and tree planting (5: +1). Moreover, the scant educational training on protecting against dust, provided for farmers, has been very effective (8: +1) so that using mask has become an ordinary behavior among them. In fact, they disagreed with the idea that despite the free distribution of masks among rural people, masking is not a common and accepted manner in their living area (40: −1). Nonetheless, in their point of view, the rural health centers are not successful in providing good educational training for rural people on self-protecting against dust (32: −1). Therefore, the national state must immediately provide more information and education for the public, especially farmers, regarding how to keep themselves healthy during a dust storm (2: +2). The meteorological department should also issue early warnings and inform public before dust happens (29: +2). They explained that if they know when dust is to occur, they can plan for accomplishing their essential daily tasks and postponing unnecessary activities until the dust passes. In addition, they are able to plan more accurately for farming practices such as irrigation or spraying herb/pesticides and postpone them to other unpolluted days or hours. Therefore, they do not have to avoid farming or leave agriculture and animal husbandry in coping with dust (26: −2).

On the other hand, these farmers and the second group of farmers shared the same view on opposing the idea that farmers cannot do anything to reduce or cope with the dust (24: −2). Instead, they believed that farmers can help to avoid local dust storms by planting trees and reduce health damages by using masks. In addition, they asserted that farmers can reduce the negative impacts of dust on the safety of human beings by rejecting using chemical inputs and pesticides which penetrate the human body along with the dust (18: +1). Nonetheless, they believed that farmers are not willing to financially support the government to implement dust control programs (35: −2) since they feel that they are not wealthy enough to pay such monetary costs.

4. Conclusion

In this study, a Q-method was used to uncover various farmers' perceptions about dust phenomenon. According to the findings, three different perceptions were identified: health adherents who seek support, government blamers who seek support, and planning adherents who seek information. Accordingly, the first hypothesis of the study is accepted since there are different perceptions of farmers toward dust phenomenon. Although there are similarities between these perceptions, each one holds a distinct view on the nature, causes, impacts, the effectiveness of supportive networks, and the ways to respond and mitigate dust phenomenon. Regarding the causes of dust, although only government blamers apparently pointed out the external sources for dust, all groups tacitly believed that farming has no influence on creating dust storms. This result is supported by second hypothesis of the study. With regard to the impacts of dust, our study showed that the majority of farmers shared their views with the health adherents who showed their concerns about the destructive impacts of dust on human health. Accordingly, the third hypothesis of the study is also accepted since farmers concerned about the destructive impacts of dust on human health. In the context of the ways to respond and mitigate dust phenomenon, despite the inactive role of farmers in raising dust, the majority of farmers believe that they cannot do anything to reduce or cope with the dust. Accordingly, the fourth hypothesis is rejected as only planning adherents were enthusiastic to take part in preventive activities like tree planting for reducing the occurrence of dust phenomenon. Understanding these multiple meaning systems on a challenging issue like dust will be critical for decision and policy makers, as they may provide a basis for developing more appropriate mitigating strategies (Forouzani et al., 2013). By exploring different subjective shared views among actors in a particular context, policy and decision-makers could plan well for satisfying diverse needs as well as taking advantage of various supportive beliefs in the context of a rapidly changing condition. Hence, many projects and programs can be launched. For instance, it can be suggested that based on a quantitative method like survey, distribution of various perceptions could be identified. Then, due to limited resources and compulsion to make sound decisions for mitigating dust, planning can be done in accordance with the dominant perception. The conclusion to be drawn from our analysis, insofar as a risk management policy is concerned, is that the most effective means is to create and implement policies and programs that will lead to the integration of the different farmers with the governmental body.

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