



Impact of Dust Storm on Agricultural Production in Iran

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Abstract

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One of the environmental concerns during the past decade is dust pollutant. This phenomenon is extensively known around the globe. In Iran, this destructive phenomenon has created serious problems among environmental policy-makers in general and agricultural producers in specific. Kermanshah Province is located near Iraq, a neighboring country in west part of Iran. It is believed that Iraq is mostly blamed for developing dust into different parts of Iran. The impact of dust on agriculture is not known. Specifically, it is not known how agricultural producers in Sarpol-e-Zahab Township in Kermanshah Province are affected by dust phenomenon. Thus, the purpose of this qualitative study was to determine the impact of dust on agricultural production. Using purposeful sampling, farmers and agricultural specialist as well as natural resources experts participated in this study. Deep interview as well as observation and audio recording were used to collect data. Grounded theory approach was used to analyze the data. Results revealed that dust has impacted orchard farmers, bee farmers, rose and grape growers differently. Results also revealed that orchard farmers and bee farmers were affected most by dust storm in the region. Overall, dust is a phenomenon that can only be mitigated if farmers are to adapt effective strategies.

1. Introduction

Dust phenomenon is one of the different types of climate change which has attracted the attention of the international community, especially in the Middle East, because of its increasing trend in recent years. This phenomenon is regarded as one of the most serious environmental problems in today's world (Griffin et al., 2001; Prospero et al., 2002; Garrison et al., 2003; Yang et al., 2007) as far as to be named one of the most important climate and natural disasters (Stefanski and Sivakumar, 2006).

Dust storms often occurring in the semi-arid regions of the world (Prospero et al., 2002) and their occurrence history going back to 70 million years ago (Nadafi, 2010), are capable of carrying massive amounts of particulate matters with a concentration of particles between 100- 100000 $\mu\text{g}/\text{m}^3$ (Tainsh and Strong, 2007). Atmospheric dust which can be

created at the time of occurrence of a wind with a speed of over 8 meters (Xuan et al., 2004; Engelstaedter et al., 2006), in addition to reducing air quality (Meng and Zhang, 2007), prevents the penetration of sunlight (Yang et al., 2003) and can reduce the sun's ultraviolet rays. It also leads to climate change at global and local scales, changing biological, geological, chemical and environmental cycles of human beings. Mineral particles in the dust influence cloud formation, cloud properties and precipitation (Krueger et al., 2004; Wang et al., 2005; Engelstaedter et al., 2006). Studies indicate that dust storm would increase death toll by %7.1 (Hua et al., 2007).

Particles carried by the storm, damages skin by sitting on them, as well as respiratory tracts by entering them (Goudie & Middleton, 2006), causing a range of respiratory diseases, lung inflammation and

asthma in individuals in infected areas (Kwaasi et al., 1998; O'Hara et al., 2000; Liu et al., 2006). Dust may also make organisms to catch bacterial and fungal infections (Kellogg et al., 2004). In addition to create health damages for individuals, it also causes various inconveniences for community, such as closure of offices, schools and various organizations, damages to the air transport and eventually results in heavy economic damages followed by different social problems, such as increased mental stress and traffic accidents (Khosravi, 2010).

The severity of the damage to agriculture and its related occupations is of considerable importance, these storms have different effects on agriculture (Sivakumar, 2005); among them reducing the performance of agriculture, garden (Shi-gong et al., 1995) and livestock products (Shi et al., 2005), spreading plant pests and diseases (Stefanski & Sivakumar, 2006) and consequently, reduction of agricultural production up to 5-30% (Yang et al., 2003) can be noted. Soil erosion and loss of its organic matter, the low level of productivity in agriculture and imposing damage to animal products could cause loss of the rural economy (Engelstaedter et al., 2006). This confirms the fact that rural areas are more likely to have more difficulties in terms of facing dust storms than urban areas.

It seems like there are limited researches into the effect of dust on livestock conditions, but there are a large number of cases of livestock dying as a result of breathing dust in (Meng & Zhang, 2007). In addition to the indirect effects of dust particles in reducing plants' defense ability, the results indicate that these particles have a direct effect on plant pathogenesis (Griffin, 2007) and the spread of plant diseases across continents (Chen et al., 2004). Actually, by falling dust on the leaves of trees, they are not able to breathe and leads to their withering and gradual dying. Dust particles are the transferring factor of a variety of diseases and animals eating polluted plants and trees' leaves, would catch numerous diseases. Dust has caused lots of direct and indirect damages to rural beekeepers' economy, such as decrease in honey production, decline in pollen due to decrease in bees' detection and vision power. Moreover, lack of nectar, pollen shortages, and disruption of mating by the queen and pollination problems can be noted as the indirect effects on honeybees. More to the point, due to air pollution, the level of forming bee colonies has decreased in proportion to years without any air pollutions (Tahmasbi, 2011). Furthermore, the existence of the phenomenon of dust along with the wind is the largest hazard to bees (Zainalzadeh, 2011). Because dust storms mainly exist in spring (Chun et al., 2002; Shao & Dong, 2006) and summer

(Goudie & Middleton, 2000; Middleton, 1986) when the honeybee colonies are active (Zainalzadeh, 2011).

The aforementioned injuries are only a small part of the intensity of damages to the agricultural sector. Hence, given the fact that the impact of the agricultural sector in achieving sustainable development in countries having a talent to develop in this field is undeniable, these countries must pay the required attention to this sensitive sector when such phenomena occur. One of the areas in recent years has faced serious risks in this field is Iran. Though not having that much of role in dust emission in the region, it has suffered many damages of dust storms, due to its proximity to countries such as Iraq, Saudi Arabia, Kuwait and Jordan as the origins of dust storms in the region.

Although dust phenomenon has influenced Iran in a variety of forms in the past, it has been quite different from what the country has experienced in terms of its intensity, the size of the floating particles and also the continuation of the time span in the last few years.

In other words, dust storms in the South, South West and West of Iran is a new issue over the past few years which has hardly influenced five provinces of Kermanshah, Khuzestan, Ilam, Kurdistan and Lorestan directly. In the meantime, because of the proximity of Kermanshah Province to Iraq, it has suffered from the adverse effects of such phenomenon. Though the dust phenomenon comes from drought, malicious human intervention in nature and habitat destruction, land use changes, drying wetlands, decrease in water share of important rivers located in Iraq and etc., up to now, no practical plans or suggestions to fix this problem have been offered (Kermanshah Post News Agency, 2011).

Sarpol-e-zahab located in Kermanshah Province adversely affected by dust phenomenon during recent years. The number of polluted days in this city has increased from 18 to 149 days during the years of 1992 to 2009 (Etelaat Newspapers, 2012), and the average of polluted days between the years of 2010 to 2011 has been 105 and 155 days, respectively (Kermanshah city hall portal, 2012).

The horizontal visibility which is considered as one of the most important outcomes of dust has reached less than 100 meters on some days of the year 2011 in this area and on some days it has reached less than 50 meters (ISNA, 2012). Facing with this phenomenon for more than half of a year, all animals, plants, forests, pastures, orchards and farms of the city have been damaged very seriously. This phenomenon reduces the productivity of crops, for instance, the level of damage of these contaminants to paddy field, corn and wheat farms has been estimated to be 20-30 percent

Also, due to the decrease of rainfall and dust particles' continuation; fields, meadows and pastures get polluted and livestock grazing dependent on pastures has turned into a serious threat to the spread of respiratory diseases and mortality of livestock. Dust phenomenon has also created many problems for the inhabitants of this region. Catching and intensification of respiratory diseases, heart diseases, asthma, allergy, mental and emotional diseases and depression are some examples. In the meantime, the most serious damages are aimed at those capable of such diseases (ISNA, 2012).

Another factor of note is that this region covers over a hundred thousand population and with about 33 thousand hectares of agricultural lands under multi-culture farming pattern, has a great deal of significance among the whole Province. Hence, due to the severity of dust impacts on the habitants, people living in dust-polluted areas will be forced to leave the place and migrate to the other regions in the future. Thus, in the near future, this region and other regions involved in dust phenomenon in Kermanshah will become empty (Rahmatian, 2012). Despite chronic damages of dust in the whole region, little has been done to understand and address the impacts associated with dust on different sectors, especially on agriculture.

Meeting these challenges, hence, this research tries to study the bad effects of dust phenomenon on agriculture from the viewpoint of agricultural experts as well as farmers who are perhaps the most defenseless soldiers of this unfair battle and as a result the most important injured people of the damaging effects of this plague.

2. Materials and methods

The nature of this study required a different approach of research from what is done as usual, namely surveys methods. Since, in order to gain a deep insight and collect rich primary data source, a qualitative method deemed appropriate for this study. A grounded theory approach as proposed by Strauss and Corbin was used to collect and analyze data. Grounded theory as a qualitative research method for understanding a phenomenon is based on the inductive approach (Goudie & Middleton, 2000). The unit of our analysis included farmers in Sarpol-e-Zahab township in Kermanshah province and the experts of related organizations including Jihad-e-Keshavarzi, Natural Resources, Environmental Organization and also Agricultural Researches Center who supposed to be rich sources of information about the impacts of dust particles on agriculture. Data was collected by using several focus groups and in-depth interviews. Theoretical saturation was achieved through 40 interviews. Various data gathering

techniques were used by the study team such as observation, photo taking and looking for the data bases to get valuable information which increases the research validity through a triangulation manner. A three steps process as recommended by Strauss and Corbin was followed to analyze data in grounded theory approach: open, axial, and selective coding. By open coding the manuscript/text is split and emerging ideas and events are tagged with conceptual names. Categories emerging from open coding are related to each other in the course of axial coding which targets the compilation of a phenomenon (Riefer and Hamm, 2008). Therefore, through an open coding process, 57 concepts emerged from the data. These concepts were then summarized and reduced into 8 categories demonstrated different core categories in the course of axial coding. Finally, by selective coding the conceptual model was formed.

3. Results and discussion

Corresponding to the main purpose of study discussed before, the main effects of dust phenomenon were classified in the form of eight categories, each of them being elaborated on below:

- The effects of dust phenomenon on gardens and sapling farms

After a group interview with experts, gardeners and sapling farmers of the region under study, it was found out that phenomenon of dust has caused a lot of economic damages for them. They expressed that the level of this damage has exacerbated in the recent years. The damages caused to gardens and sapling farms are stated below:

- Morphological damages to garden products and a decreased demand for them in the market,
- Morphological and physiological damages to gardens and sapling farms,
- A decrease in trees' resistance to pests and diseases and also an extension of the weeds.

- The effects of dust phenomenon on honeybee farms

Many of the honeybee growers of Sarpol-e-Zahab town report that dust phenomenon has caused them a lot of problems, among which the following can be named:

- Reducing the population of honeybees
- Reducing the activities of bees and the staying inside the apiary when there is dust outside
- Reducing the quantity and quality of honey production
- Breaking out of illnesses like diarrhea among bees.

- The effects of dust phenomenon on rose gardens

Farm owners expressed that they have not offered their flowers to rosewater makers in recent years because of serious impacts of dust storms on rose gardens. The findings of a thorough interview with farm owners are expressed as following:

- lack of pluck of roses with severe pollution,
- Losing the pleasant aroma of rose water extracted from polluted flowers,
- Sensitization of rose bushes to infection by plant pathogens.

- The effects of dust phenomenon on vineyards

The damages of dust on the vineyards in the area being studied are as following :

- morphological damages to vineyards,
- physiological damages to vineyards,
- decrease in the level of grape production

- The effects of the phenomenon of dust on vegetables

Farmers expressed that their vegetable fields also have suffered a lot of damages due to phenomenon of dust, among them the following can be mentioned:

- morphological damages to vegetable fields,
- physiological damages to vegetable fields,
- spreading of parasitic and fungal diseases among cucumbers, especially on bushes.

- The effects of dust phenomenon on livestock and poultry

According to an interview carried out with a number of ranchers and experts at livestock and poultry research center, the following results were achieved:

- Pollution of pastures with particles of dust and decreased quality of dairy products due to feeding livestock of the polluted grasses,
- Pollution of livestock wool with pests such as: Quesnay, fleas, etc.,
- Sickness of v and sheep due to transferring disease factors.

- The effects of dust phenomenon on farms and products like corns and grains

From what farmers and experts expressed, the following were revealed as the effects of dust on farms and agricultural products:

- Formation a separator layer on the surface of leaves by settled dust which prevents pests to damage the plants,
- Morphological and physiological damages to plants,
- fertility reduction of soil as well as destroyed structure of farming soil and getting an acidic PH due to polluted rainfalls,
- quantitative and qualitative decline in the yields of corn and grains.

- The social effects of dust phenomenon in the region being studied

From The whole statements of farmers on this phenomenon, it has been concluded that dust phenomenon has caused the following social consequences:

- Immigration migration to less polluted regions,
- reduction in people's tendency to be outside when a dust storm occurs, and consequently leaving agriculture-related jobs in dusty days,
- reduction of the rural households' welfare as a result of the decrease in their income,
- increase of the health care costs due to dust for farmer households.

- Discussion:

One of the regions which is seriously facing the dust phenomenon in the recent years is Iran, despite lack of any obvious role in spreading so much dust in the region, which has experienced a lot of losses as a result of dust storms coming from neighboring countries such as Iraq, Saudi Arabia, Kuwait and Jordan. This phenomenon is in progress with a greater intensity in the west, south and southwest provinces of Iran. One of the western towns of the country is the town of Sarpol-e- Zahab located in Kermanshah province, which has suffered many losses due to less distance to Iraq. This city with about 33 thousand hectares of farmland along with desirable special climatic conditions is greatly important for agricultural products in whole of the province.

But, unfortunately, the evidence shows that dust storms have damaged the agricultural products and farmers' community of this town in recent years. This research, using a grounded theory manner, tried to describe the impact of dust on Kermanshah Province after a thorough interview and group discussions with farmers and agricultural experts. Respondents expressed that they are facing with the destructive effects of dust phenomenon more seriously in recent years. They also stated that the leaves of their garden trees have turned yellow for which experts claim it happens as a result of reduced

photosynthesis due to sitting dust particles on the plant leaves. Also after direct observation and a thorough interview with garden owners, it was clear that the size of fruits like peach and nectarine has become smaller and remain green for a longer time compared to the past years. As far as they are forced to sell their small, green and less quality fruits with a cheaper price. The sapling farmers believe that the dust phenomenon is to be blamed for their small and damaged young trees. From the whole statements of gardeners and sapling farmers, it is concluded that they have had many economic losses coming from the dust phenomenon and also they have no other choice to resist with this problem except washing trees after occurring dust storms.

Moreover, it was demonstrated that after garden owners, the most damages imposed from dust are aimed to honeybee owners. In such a way that at the time of the occurrence of this phenomenon, bees' activity level is decreased and many of the bees leaving the hive get lost and will not return and those which return will be prevented to entering the hive by guardian bees due to pollution and sickness; resulting in increase in mortality rate of the infected bees and a very noticeable decrease in bees' numbers. They also reported that there has been a decrease in both quality and quantity of honey production through the recent years, as well as causing honey products to have an unpleasant taste and smell.

Also, through an interview along with a direct observation of the disadvantages of dust phenomenon on honeybee farms, it has been found that the bees get diseases like diarrhea which in turn produces an unpleasant atmosphere for honeybee farmers. Honeybee farmers also use low resistant methods like: covering the hives with wet hand kerchiefs at the time of the occurrence dust storm, making bees fly to the less infected areas or giving nectar to the bees in order to prevent them from leaving the hives.

The other damaged group in the region under study was the rose farm owners. They believed that as a result of the occurrence of dust phenomenon, rose bushes were ill and in the last 2-3 years, its damaging effects were to the extent that if they picked the flowers to make rosewater from them, the resulting rosewater coming from polluted flowers would not have a pleasant odor and flavor.

Therefore, they have been forced to avoid picking flowers, and this has led to many economic losses to rose farm owners. Vineyard owners of Sarpol-e-Zahabhas also experienced a lot of damages due to the dust phenomenon. According to their statements, grapevines' leaves have turned yellow due to the occurrence of dust storm in these years and additionally to an obvious reduction in the level of

grape production. Therewith, the quality of grapes has severely declined because of remaining green bunches of grape and lack of forming grape clusters.

Dust in the region under study has also left undesirable effects on vegetables and cucurbits. In such a way that vegetable farmers participated in the study expressed that the cucumbers leaves get pale and reach premature old age as a result of the occurrence of dust storms and this issue has caused a noticeable decrease in their products' marketability. In addition, they believed that the rate of vegetables' and Cucurbits' production has demised considerably because of the illness of bushes and a decrease in such crops' lifespan.

After a thorough interview with livestock owners and Researches Center experts, it was manifested that ever since the occurrence of the dust phenomenon, poultries are more seriously exposed to different diseases because of the pollution to dust particles and livestock's wool is affected by parasites such as: Quesnay, fleas and etc. Also because of grazing the livestock on infected farms, their milk quality has reduced and this leads to decreased quality of all dairy products in turn. Ranchers also stated that the only way to withstand dust phenomenon is to feed livestock by fodder inside instead of grazing and entering the pastures on the polluted days.. Agricultural lands and fields of grain and crops are also affected by damaging effects of this phenomenon and have led to an abundance of economic and environmental losses. Farm owners believed that after dust storms the corn and wheat leaves have turned yellow which experts state that it is due to the closure of holes and pores of farming plants as a result of the sedimentation of micro dust particles on them. Also according to experts' opinions, dust forms a layer on the surface of leaves which prevents pesticides to have a direct touch with leaves and this issue leads to the invasion of pests and diseases to plants and also the creation of some diseases such as barley and wheat rust. Dust will decrease the fertility of agricultural soils and making them acidic resulting from polluted rainfalls. In addition, farm owners expressed that ever since the occurrence of this phenomenon, bunches of wheat and barley and sheath in some crops like corn have weakened and don't completely fill as in the past. Agricultural experts believe that it is due to the lack of complete fertilization and sowing deficient seeds. In total, from what farm owners said, it is inferred that the amount of the crops produced in these years has been reduced dramatically. Their only remedy is to use sprinkler irrigation.

Totally speaking, it was manifested that dust has caused a lot of damages to the Sarpol-e-Zahab region, many of them are so sheer bad that

farmers can not bear economically which leads to a decrease in farming households' income and as a result a decrease in rural households' welfare. It has also other consequences such as leaving farming in the whole region. The intensity of the negative impacts of the dust phenomenon is to the extent that in some of the villages of this study area, farmers and their families were forced to migrate to less polluted regions.

4. Conclusion and recommendations

The findings of this research which was based on a grounded theory method showed that the dust has had many economic damages to the community of farmers and the collection of agricultural products of Sarpol-e-Zahab town and among them the most noticeable loss is targeted to garden owners and sapling farmers.

Shi-gong et al. (1995) also pointed out in their study that the occurrence of dust storms would decrease the performance of garden products. Also, according to Stefanski and Sivakumar (2006), the dust phenomenon would lead to a decrease photosynthesis activity disorder in fruit production process and as a result, a decrease in the rate of production of garden products. In accordance with these studies, the findings of the present study revealed that ever since the occurrence of dust storms, the quantity and quality of honey production in the region under study have decreased drastically. Moreover, it was determined that honeybee farmers were the second vulnerable group to experience the injurious disadvantages of this phenomenon. In this regards, Tahmasbi (2011) stated that because of the air pollution and occurrence of such storms, the rate of honeybee colonies' productions has decreased drastically. Also, Zaiynalzadeh (2011) considered this phenomenon accompanying by wind as the biggest pest for honeybees.

In continuation of the process of carrying out the research, it was recognized that the dust phenomenon has had a great deal of damaging effects on the fields, which is the same as the findings of Stefanski and Sivakumar's Study (2006). They declares that dust storms have negative effects on many agricultural products and also causes damages to plant tissues, decreasing photosynthesis, delaying and decreasing the growth of agricultural plants and as a result, decreasing the output of agricultural products and even at the time of the occurrence of storms, destroys plants.

Also the findings of this research are consistent with the findings of Xuan et al. (2004) in terms of the influence of the dust phenomenon on farms and agricultural fields. In accordance with the findings of the present research, dust results into

social consequences such as: avoiding farming occupy and a decrease in the income of farmers' households, which has led to a decrease in their economic power and as a result, damaging the rural economy. This result is consistent with Steider's (2006) findings. He believes that damages of dust storms to agricultural products and farmers are to the extent which can result in the loss of rural economy.

Now, since the main source of income among rural people in Iran is based on agriculture and products of this section, it is suggested that governmental officials pay more attention to harmful effects of dust phenomenon on agriculture sector and especially on the west of the country. In this relation, they should do their best to control dust impacts in these regions which play an important role for agricultural productions. It also can be recommended to negotiate with neighboring countries which are the main origin of this phenomenon, to take the necessary cares like petrol mulching in the desert areas as well as do the necessary measures to control it. Government can help to provide vegetation covers like planting trees and create Forest Green belts which could noticeably reduce dust phenomenon.

It is also proposed that other studies should be carried out about the methods of making resistant-variety of crops and the necessary genetic modifications to increase the resistance of saplings and agricultural plants by researchers of agricultural research centers of the province. The farmers and their families should not be forgotten and all measures should be carried out to reduce the economic and social pressures imposed on them resulting from this phenomenon. These measures can include providing free medical cares and establishing the mobile medical urgency units across the province at the time of the occurrence of the dust phenomenon in the regions being involved. It is also suggested that the conditions of insurance policies and compensation payments related to dust storms should be facilitated for the farmers in the regions involved in this phenomenon. Finally, rural development practitioners should plan for mitigation strategies rather than adaptation strategies because of the long-term nature of mitigation strategies. Also, agricultural extension educators at local level need to launch awareness programs in order to increase farmer's household resilience in front of dust storm.

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