

Climate change perceptions and adaptations for dairy cattle farmers in Jordan: Case study in North East Region - Al-Dhulel Area

MYSAA ATA*, MOHAMMAD ALTARAWNEH**, MOTASEM AL-MASAD*

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Abstract

This study was designed to investigate how dairy farmers of Al-Dhulel Cooperative Dairy Society (ACDS) perceive climate change, the adaptation strategies adopted by farmers to cope with the impact of climate change and the barriers to the adoption of these strategies. A 92 dairy farmers responded to a designed questionnaire that was developed to collect the data and covered farmers perception, adaptation strategies, and the barriers facing them towards adopting the strategies. The personal interviews with the farmers were performed during early January, 2020. The data was analyzed using the Statistical Package for Social Sciences (SPSS). The main result obtained from the study that most of dairy farmers were aware of the climate change impact on dairy cattle performance and health. Furthermore, the adaptation strategies that were suggested have limiting factors according to farmers as a result of governmental and agricultural institutions restriction policies. Therefore, recommendations regarding new policies were suggested to facilitate the way of getting benefit from grants and financial support for improving dairy farms and to mitigate the effect of climate change on dairy cattle.

Keywords: Climate change, Dairy farms, Perception, Adaptation strategies, Barriers.

1. Introduction

Climate change recently showed an impact on various set of biological and physical ecosystems and its effect made an extensive change in many sectors mainly in the agriculture sector, which is the primary source of livelihood for many country side residents (Ado *et al.*, 2019).

The negative effect of climate change appears in water shortage which leads to drought land in many countries and that will increase the death of animals, weight loss and increase the incidence of disease occurrence to livestock and ac-

cordingly the income of farmers will be reduced and the economy will be affected (Thornton and Herrero, 2008; IISD, 2009; Alrusheidat *et al.*, 2016; Koç and Uzmay, 2018).

Climate change had an impact on dairy and meat production which arising from its effect on range and grasslands (FAO, 2019). Highly sensitivity of dairy cattle towards increasing temperature, humidity, and feed shortage can be reflected on their feed intake which causes an impact on milk production during their production season (Allen *et al.*, 2013).

* Animal Production and Protection Department, Faculty of Agriculture, Jerash University, Jerash, Jordan.

** Agricultural Economics and Extension Department, Faculty of Agriculture, Jerash University, Jerash, Jordan.

Corresponding author: mysataa@jpu.edu.jo

The importance of the animal husbandry and dairy farming sector to human life revealed from centuries. Dairy farming contributes in maintaining the ecological system by providing an important product to the human wellbeing (Variakshapanicker *et al.*, 2019). This sector plays a significant role in creating employment opportunities in rural sector, besides providing low-priced and nutritious food to numerous numbers of people (Al-Sharafat, 2013).

Jordan is considered as a small country which has a total surface area of 89.2 km², mostly about 90% of this area is a semi-arid area (Bourn, 2003; Abdallah, 2015). Three geographical areas with different climates were determinant in the country which are the Jordan Valley, the highlands, and the eastern desert (Abu Jaber, 2011). About 90% of the country represented by the eastern desert and more than 50% of the milk production by dairy farms comes from the semi-arid region which Al-Dhulel is located (MOA, 2018). According to reports provided by the Department of Statistics (DOS, 2018) and other studies which includes various maps showing the fluctuation in temperature and precipitation in Jordan and in our study area regarding climate changes (Freiwan and Kadioglu 2008; Matouq *et al.*, 2013; MoFA, 2018), Al-Dhulel region has a hot weather with a temperature of 40 °C during summer and an average rainfall of less than 200 mm annually.

Dairy farming in the eastern desert seems to be promising despite of the higher temperature and the hard climate conditions (Zytoon and Numan, 2015). The government is encouraging the dairy farming sector in this area by providing intensive production system which support the farmers and the dairy farming system (Alqaisi *et al.*, 2009). The total number of dairy cows in Jordan is 92600 distributed in the dairy farms all over the country governorates and producing around 488000 metric tons of fresh milk which represents more than 60% of the country consumption and almost 75% of the total milk production (MOA, 2018).

Climate change is considered as a serious challenge faced by dairy farmers, as a result it is important to identify dairy farmers' knowledge towards climate variability and its effect

on livestock population and production (Rojas *et al.*, 2017). Limited researches had been found on the measuring knowledge of dairy farmers to climate change and their adaptation programs towards it worldwide and especially in Jordan. Therefore, in this present study, a knowledge assessment was developed and made to evaluate dairy farmers' perceptions toward climate changes among the dairy farmers of Al-Dhuele Cooperative Dairy Society (ACDS) and to identify new adaptation policies towards reducing climate change effects on dairy farming in the area.

This study was designed to evaluate how dairy cattle farmers in Al-Dhulel at Jordan perceive climate change and the adaptations methods they have adopted to deal with the adverse consequences of climate change. Specifically, the study was designed to: i) Assess the existing knowledge of dairy cattle farmers have on climate change. ii) Explore the adaptation methods farmers have adopted to cope with the adverse consequences of climate change. iii) Identify the perceived barriers to the adopted adaptation methods.

2. Materials and methods

2.1. Study area and population

This study was conducted in Al-Dhulel area which is located in the eastern region (Zarga Governorate) of Jordan. Al-Dhulel is considered as one of the most important milk producing area in Jordan with several dairy farms. Its climate is mostly an arid type that is characterized by a wide variety of daily and seasonal temperature.

The population of this study was the dairy farmers of Al-Dhulel Cooperative Dairy Society (ACDS). All farmers in this population were secured from the administration of the dairy society in Al-Dhulel region. According to governmental records of dairy farmers in the area, it was indicated that the number of dairy farmers was estimated to be about 100. Therefore, this study was based on a comprehensive scale survey directed to all dairy farmers in this region.

A designed questionnaire was distributed to the 100 farmers and 95 questionnaires were retrieved. An exclusion of three questionnaires

was done due to their inability to be analyzed, thus bringing the number of farmers who responded and were applicable to this study to be 92 dairy farmers.

2.2. Study design, data collection and analysis

The data and information utilized in this study were based on the secondary data sources drawn from as the Ministry of Agriculture and the Department of Statistics reports (MOA, 2018; DOS, 2018) and their related agricultural directorates in the country. Furthermore, the source of the primary data gained from well-designed survey questionnaire. The information in the questionnaire was used to extract the basic perceptions and adaptations for dairy cattle farmers to climate change impact of their farms.

The main data collection tool was a structured questionnaire which was performed by the authors considering suggestions provided by the animal production experts of the Faculty of Agriculture at Jerash University to evaluate dairy farmers' perceptions and adaptation policies toward climate changes among dairy farmers of Al-Dhulel area. It contained some demographic variables and themes related to the study as following:

1. Demographic variables: age, gender, educational qualification, farmers' cattle-raising experience, and milk production amount.
2. Study topics: The questionnaire included the following topics:
 - The source of obtaining agricultural information related to the effects of climate change.
 - Dairy farmers' perceptions of the effects of climate change.
 - Strategies to adapt to the effects of climate change.
 - The barriers and obstacles to adopting adaptation strategies.

Personal interviews with the farmers were conducted during January, 2020. Information obtained from this questionnaire was analyzed using Statistical Package for Social Science (SPSS, version 20.0). The analysis covered pro-

cedure yielded percentages, means and standard deviations that provided in the various tables presented in this study.

3. Result and discussion

3.1. General characteristics of dairy farmers and their farms in Al-Dhulel

As indicated earlier, 92 dairy farmers were interviewed on their perception about climate change and the adaptation policies they adopt to cope with its effect. As provided in Table 1, the average age of farmers is 45.7 years old and the farmers responded to the study (according to gender) were males which implies that the majority of dairy farmers in Al-Dhulel who are engaged in large animals farming activities were males.

It was reported that 10.8% of the respondents were illiterate, around 9.8% had primary school certificates, and 17.4% had secondary school certificates. Moreover, 21.7% had post-secondary school certificates, and 40% have acquired university degrees from recognized institutions in the country. This results positively reflects on farmers' perceptions about and adaptations to climate change, which will be discussed in the

Table 1 - Basic information about dairy cattle farmers in Al-Dhulel Area, Jordan.

Characteristics	Average	%
Farmers age	45.7 years	
Gender (males vs. females)		100% males
Educational level of farmers		
Illiterate		10.8
Primary		9.8
Secondary		17.4
Post-secondary		21.7
Higher education		40.2
Dairy farming experience	17.06 years	
Farm size (km)	6 acers	
Milk production/ cow/day	27 liters	

Source: Authors' computations.

Table 2 - Source of knowledge of dairy farmers about the climate change.

Source	Yes %	No %
Personal experience	97.8	2.2
Agricultural sales representatives	35.9	64.1
Agricultural extension / public sector	21.7	78.3
Agricultural extension / private sector	27.2	72.8
Television agricultural programs	39.1	60.9
Agricultural cooperative association	40.2	59.8
Agricultural research centers	20.7	79.3
Agricultural sites on the Internet	57.6	42.4

Source: Authors' computations.

coming sections. The results also showed that farmers experience in dairy farming is around 17 years and the average farm size those farmers possess is around 6 acers as each cow average milk production per day is around 27 liters.

The source of knowledge about climate change for dairy farmers in Al-Dhulel area is presented in Table 2.

As shown in the results, about 97.8% of the farmers had gained knowledge about the effect of climate change on dairy farming from their personal experience which was accumulation as shown in Table 2 through the information provided by the audio and video news bulletins, in addition to social media. It was noticed that agricultural extension sector did not increase farmers awareness about the climate change effect since that 75.6% of farmers did not had information of climate change from agricultural extension representatives. Moreover, only 40.2% of farmers had knowledge about climate change from agricultural associations, and only 20.7% had information about the effect of climate change from the different agricultural research centers. These results implies that the agricultural associations and centers located in the study area do not provide enough workshops or programs for farmers to increase their awareness about the impact of climate change on dairy farming.

3.2. Farmers' perceptions and adaptations to climate change

The perceptions about climate change and the adaptation strategies used to cope with climate change consequences on dairy farming at Al-Dhulel area is presented in Table 3 and Table 4. Dairy farmers' perception and awareness about the impact of climate change is shown in Table 3.

Out of the 92 farmers interviewed, almost 50% of them noticed a reduction of ration and increase in water consumption by cows regarding the climate changes, while around 70% of the farmers observed feed loss by cattle, and about 70% responded that feed and water consumption increased during hot weather. 50% of the farmers agreed that global warming has an effect on dairy cattle production, meanwhile, more than 80% of the farmers noticed an increase of disease occurrence in dairy cows and referred that to climate change effect. On the other hand, farmers agreed that cow age overlapped with climate change and increase the impact on performance; about 80% of the farmers noticed an effect of climate change in performance for younger animals (heifers), while around 50% of farmers agreed that older animals (cows aged more than two years) are more affected by climate changes during the different seasons. Mortality rates in infant calves noticed to be increased as 68% of farmers responded, moreover, 63% of farmers noticed an increase in respiratory and digestive system diseases and referred that to the impact of climate change. These findings are in consistent with that reported by Juana *et al.* (2016) that studied farmers' perception and awareness about the climate change effect on livestock. Moreover, Kant *et al.* (2015) reported dairy farmers at the study area were at medium level of knowledge towards climate variability which reflected in the necessity of further awareness and providing more information to farmers to be able to develop coping strategies to overcome the impacts of climate variability. Maddison (2007) noticed that educated farmers were more likely to perceive changes in climate and might adapt mitigating procedures easily, consequently improving farmers' education and offering free extension advices will play an important role in

Table 3 - Perceptions of the impact of climate change on dairy farms in the Al-Dhuleh Area.

Criterion	Dairy Farmers Perception (%)			mean	sd
	low	medium	high		
Reduction in consumption of rations by dairy cows	29.7	24.2	46.2	3.29	1.09
Increase in water consumption by dairy cows	26.1	27.2	46.7	3.43	1.17
Increased feed loss	11.0	18.7	70.3	3.96	1.00
Low response for medications by dairy cows	27.2	30.4	42.4	3.28	1.01
Global warming effect on dairy cow production	15.4	33.0	51.6	3.51	0.92
Rain precipitation distribution in the Region	7.8	34.4	57.8	3.64	0.83
Climate diversity affects temperature variation	5.4	34.8	59.8	3.66	0.76
Climate changes effects on feed and rations quality	13.2	23.1	63.7	3.70	1.04
Climate change affects dairy cows health and increases occurrence of diseases	7.6	9.8	82.6	4.27	0.93
Heifers performance affected by climate changes	2.2	17.4	80.4	4.26	0.82
Cows aged more than two years more affected by climate changes	25.0	23.9	51.1	3.43	1.17
Feed price increases according to the season.	14.1	19.6	66.3	3.77	0.98
Climate change affects the milk yield during milking season	20.7	21.8	57.5	3.70	1.14
High temperature affects the cows' feed and water consumption	3.3	19.6	77.2	4.17	0.86
Reduction in cow weights due to low feed consumption	4.3	10.9	84.8	4.14	0.78
Increase in mortality rates of infant calves	16.3	15.2	68.5	3.95	1.17
Increasing the incidence of respiratory and digestive diseases in cows	23.9	13.0	63.0	3.78	1.28

Source: Authors' computations.

increasing their response to climate change and encouraging adaptation.

The adaptation strategies suggested to mitigate the effect of climate change in Al-Dhuleh area is presented in Table 4.

Dairy farmers at this study were asked about the strategies that they might find suitable to mitigate the effect of climate change on their dairy farms. The results showed that 87% of the farmers agreed about adopting new technologies related to farm systems and 84% agreed to use new water supply systems to reduce the effect of climate change on dairy cattle. Meanwhile, around 81.5% of farmers approved to adopt the strategy of using appropriate rations to cattle in their different production stages to minimize the feed losses, while 53.8% of farmers decided to make the best use of existed farm resources to cope with the effect of climate change. On

the other hand, more than 60% of the farmers did not agreed on different strategies regarding improving dairy cattle breeds that used in their farms to cope with climate change effect. Moreover, more than 50% of the farmers decided to adopt the strategy dealing with reducing cattle gaseous pollution by using a proper procedure of disposing cattle litter. Similar to these results, Amamou *et al.* (2018) found that almost all dairy cattle farmers perceived that the extreme impact of climate change reflected on cow performance, therefore, farmers' attitudes towards climate change adaptation were associated with farm typology by focusing mainly on increasing water capacity for livestock and improving livestock housing conditions. Claessens *et al.* (2012) provided new methods for evaluation climate change adaptation strategies and reported that a combination between semi-subsistence

Table 4 - Adaptation strategies to mitigate the effect of climate change on dairy farms in Al-Dhulel Area.

<i>Adaptation Strategy</i>	<i>Farmers response to strategy Adoption</i>	
	<i>Accept %</i>	<i>Not-Accept %</i>
Adopting new and technology related farm systems	87.0	13.0
Using appropriate rations for cows' different productive stages	81.5	18.5
Adequate new water supply systems	84.8	15.2
Diversification of animal production activities	48.3	51.7
Apply periodic vaccinations	85.9	10.9
Preserving disease resistant dairy species	19.6	77.2
Cross-bred of disease resistant species	15.4	81.3
Use dairy cattle strains which resist climate changes	41.6	58.4
Making the best use of farm resources	53.8	46.2
Minimizing the impact of gaseous pollution produced by cattle	58.2	41.8
Disposing of cattle litter in an appropriate manner	59.8	40.2

Source: Authors' computations.

systems and developing new socio-economic scenarios will improve the adaptation strategies for climate change by focusing on improving agricultural systems including land use, cost of production, and farm and household size.

3.3. Barriers to climate change adaptations

Most of the interviewed dairy farmers in Al-Dhulel area had experienced certain barriers to climate change adaptation strategies, this is presented in Table 5 which shows the results of farmers' responses.

The main barriers to climate change adaptation strategies in Al-Dhulel area, as farmers responded, were "Policy restrictions on land

use", "Shortage of financial support and capital investment", and "Limited land space for livestock performance" as farmers responses to the mentioned barriers were 91.1%, 89.8%, and 74.4%, respectively. Other barriers like "Insufficient or inaccessible counseling services", "Insufficient or no information on climate change", and "Insufficient or lack of access to farming new technologies" were moderately perceived by the majority of farmers in Al-Dhulel as barriers as the responses were 72.7%, 60.2%, and 51.1%, respectively. Dairy farming is known as one of the major economic field that leads to maintainable rural livelihoods and makes an important input to the country's export income. Therefore, the government institutions in Jor-

Table 5 - Barriers to climate change adaptation strategies for dairy farmers.

<i>Barriers</i>	<i>Dairy Farmers Response Percentages (%)</i>				
	<i>low</i>	<i>medium</i>	<i>high</i>	<i>mean</i>	<i>sd</i>
Insufficient or inaccessible counseling services	15.9	11.4	72.7	3.98	1.11
Insufficient or no information on climate change	25.0	14.8	60.2	3.66	1.28
Insufficient or lack of access to farming new technologies	22.2	26.7	51.1	3.63	1.20
Limited land space for livestock performance	15.1	10.5	74.4	3.99	1.09
Government policy restrictions on land use	0.0	8.9	91.1	4.50	0.66
Shortage of financial support and capital investment	4.5	5.7	89.8	4.50	0.88

Source: Authors' computations.

dan have established a number of programs that assist the development of livestock and dairy farming in the area, and grant loans to farmers in the country to support their business and mitigate any difficulties that might facing them. As a result, extension and agricultural representatives should start making visits to dairy farmers for encouraging them to get benefit from the governmental loans and agricultural programs to deal with the issue of climate change and reduce its effect on their farms.

4. Conclusion and recommendations

This study was designed to evaluate dairy farmers' perception in Al-Dhulel area about the climate change, the main adaptation options that could be used to address the adverse consequences of climate change, and the barriers preventing the implementation of suggested adaptation techniques. The study used a structured questionnaire to elicit information from dairy farmers located at the study area.

The analyzed results showed that most of dairy farmers from the study sample that was randomly chosen from dairy farmer population of Al-Dhulel were aware of the impact of climate change on dairy cattle. From the farmers' point of view, the variation in temperature and precipitation during the different seasons affected dairy cattle production and increased the occurrence of diseases and in some cases led to the death of the animals. To reduce the effect of these adverse consequences, farmers agreed to adopt some strategies that might reduce the impact of climate change on dairy cattle such as using new technologies of farming and feeding at their farms, and to find proper procedures of litter disposing to reduce the gaseous pollution effect that might be caused by animals.

Given the above research findings and according to the farmers' recommendations and opinions, the authors suggest some polices to be introduced to the agricultural institutions in Jordan to help dairy farmers to adapt and to reduce the impact of climate change on their farms, as follow:

1. Regarding the lack of knowledge about climate change impact on dairy farming in

Al-Dhulel and other rural regions in Jordan: government and non-governmental institutions should encourage and design farmers' organizations that agricultural extension workers be able to organize regular workshop to discuss the climate change issues and the mitigation procedures used to reduce its effect with farmers through these organizations.

2. Dairy farmers, as they responded to the questionnaire, stated that lack of using improved technologies, limited land for dairy farming activities, government policy restrictions on land use, and the shortage in financial support are the main barriers to climate change adaptation. Therefore, government improvement on the existing research capacity on advanced climate change adaptation technologies is preferable, and facilitating farmers' access to these technologies by including farmers' representatives in all land use policy issues. Furthermore, improving procedures of obtaining grants and financial support for farmers considered as an important step in reducing the effect of climate change on dairy farming.
3. Due to farmers not accepting using resistant and cross bred dairy cattle in their farms as a solution to climate change issue, agricultural and governmental institutions should encourage farmers purchasing and raring resistant strains to climate change and to diseases by reducing importing fees of this kind of animals and facilitate the purchasing and importing procedures of resistant strains from other countries for local farmers.

Jordanian governmental institutions and organizations are improving the adaptations and mitigation procedures to climate change as they trying to provide new polices and rules helping to reduce the effect of climate change on the agriculture sector. As a result, the Ministry of Environment introduced a national climate change policy which provides strategic guidance framework with a long and short term goals and objectives helping reducing the effect of climate change on the different sectors (MOE, 2013). Despite that the governmental institutions are fo-

cusing on reducing the effect of climate change on agriculture, animal production sector still not getting full attention regarding this problem, for that reason this current study might encourage policy makers to focus on the importance of this sector, and with that providing new adaptation and mitigation policies for climate change to improve its outcomes.

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